FIRST PRESBYTERIAN CHURCH OF STAMFORD, CT
CONSERVATION MANAGEMENT PLAN

FINAL REPORT

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First Presbyterian Church Conservation Management Plan

Stamford, CT

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The project team was led by Dr. Theodore Prudon FAIA, principal of Prudon & Partners,LLP Architects, assisted by Dorit Zemer and Amanda Gruen. Old Structures Engineering (Donald Friedman PE and Mona Abdelfatah), Building Conservation Associates (Ray Pepi, Chris Gembinski and Laura Buchner), and Bicaluro Associates (Lucian Nicolescu) served respectively as structural, materials conservation and mechanical/electrical/consultants in the project. Propellerheads provided aerial photography and laser scanning recording was completed by Berkshire Dimensions.

Finally, throughout the various stages of the project, the support and encouragement of Antoine Wilmering of the Getty Foundation was greatly appreciated and critical to the final results.

Executive Summary

This Conservation Management Plan (CMP) is an essential document to assist in decisions that concern the long term preservation and conservation of the First Presbyterian Church (FPC) property as a vital part of its congregation and the community at large. The CMP includes a broad analysis of significance of the various building elements of the complex, and an assessment of the conditions challenging the property's use and conservation, including initial material testing to identify and evaluate current problems with the FPC complex in general and the Sanctuary specifically. The CMP concludes with policies and recommendations which seek to retain and enhance future use, management, alteration, or repair with recognition of the relative significance of the property's features. The CMP's policies and recommendations intend to ensure that the church's significance is not inadvertently lost through inevitable necessary interventions.

The CMP has several major components, which are outlined below:

- A detailed history including design, construction and subsequent repairs
- Graphic and photographic recording of the existing sanctuary
- A statement of what is significant about the architecture, history and local appreciation of the complex
- Surveys and assessments of existing conditions which endanger the materials and systems of the complex by architectural, conservation and engineering professionals
- Policies and recommendations for implementation
- Recommendations for next steps

Figure a. Photo by Propellerheads. Fall, 2016

General Description

The First Presbyterian Church Complex located at 1101 Bedford Street in Stamford, Connecticut, consists of three distinct parts: The Sanctuary and related spaces, the Parish Unit, which is connected to the sanctuary by an enclosed glazed walkway, and the freestanding Carillon Tower. The Sanctuary and Parish Unit were constructed in the 1950s to the design of Wallace K. Harrison and associated architects, Sherwood Mills and Smith. The Carillon Tower was constructed a decade later to the design of Harrison. The architecture of each is distinctly different reflecting its meaning and purpose.

- The Sanctuary with its fish shaped plan is constructed out of large precast concrete panels that are leaning into each other at various angles and directions forming the structural backbone. Overall the impression is one of folded and slanted planes. Openings in the precast are filled with glazed sections made in *dalle de verre*, a modern technique using chunks of glass to evoke the medieval tradition of stained glass. FPC's *dalle de verre* consists of irregularly shaped and faceted sections of colored cast glass placed in a matrix of either concrete or epoxy and formed into panel sections. These panels in turn are placed in the openings left in the precast. This arrangement is respectively found in the north, south and east elevations. Where the precast is not filled with glazed panels, the solid precast panels are covered with slate. On the interior, the result is an awe-inspiring experience, which Harrison described as being inside a sapphire.

- The Carillon Tower is a tall freestanding structure entirely made of poured in place reinforced concrete. Precast concrete stairs lead up to teak clad enclosures housing the carillon's 56 bells on two levels, with the console in an enclosed cabin sandwiched in between.

- The Parish Unit, the first part to be constructed is reminiscent of mid-century schools in its design and construction. This part of the complex is largely the work of the associated architects, Sherwood Mills and Smith.

The church complex and particularly the sanctuary and the carillon tower are early and visually impressive examples of the bold designs that came to characterize post World War II American ecclesiastical architecture. The sanctuary evokes Gothic cathedrals in its use of exposed structure and narrative with decorative glazing colored with a medieval palette. To achieve this remarkable result for FPC, the only church Harrison designed, he worked with two seminal figures, the British engineer Felix Samuely for the structure and the French artist Gabriel Loire for the execution of the glazing for the sanctuary.

The sanctuary is an iconic modern building that upended tradition in Stamford and affected suburban church design in the community for all denominations. While the visually prominent building is significant to Presbyterian identity in Stamford, it is used and respected as spiritual space by other religious traditions, for secular community purposes, e.g., voting, music, education, and is frequently visited for enjoyment and/or spirituality by many in and outside the community.

Levels of Significance

The CMP recognizes that it will be necessary to introduce repairs and improvements over time to ensure the continued use and stewardship of the FPC complex. To guide such interventions, the CMP zones the building's exterior and interior according to the relative significance of the physical features within the church complex and how it is viewed from the street., In zone 1, the areas and features of highest significance, it is the intention to preserve the original appearance and integrity of forms, materials and spatial relationships as much as possible when future interventions are planned. Zone 2 consists of parts of the building which contribute to the overall appearance and experience of the complex but are of lesser significance than zone 1. Changes to finishes and spatial relationships in zone 2 would not impact the building's significance. Zone 3 acknowledges the need for change and adaptation to use and needs.

While the overall complex retains most of its original form, the site has seen a number of changes, which are largely located in the rear and to the east. Seen from Bedford Street the site rises towards the sanctuary and the carillon tower and has retained its overall topography and is defined by the curved roadway. This area has been assigned the highest significance, zone 1. The same designation, zone 1, has been given to the area enclosed on three sides between the parish unit and the east elevation of the sanctuary and called sometimes the cloister. The remainder of the site has been given designations of zones 2 and 3, lower degrees of significance reflecting subsequent changes or lesser impact on the overall appearance.

The highest significance, zone 1, was assigned to all parts of the sanctuary both inside and out. It represents in its form, construction, and use of *dalle de verre,* a landmark of national significance that has engendered a broad meaning in the community at large. The exterior of the choir room and the attached walkways have been given the same significance as the sanctuary. The interior of the choir room was also recognized as zone 1, since it still retains the original finishes and built-in furnishings.

The same high significance, zone 1, was given to the carillon tower, which with its striking silhouette and sonorous carillon is not only a symbol and marker of the church but also a visual beacon in the Stamford community at large.

The elevations of the parish unit surrounding the so-called cloister were assigned the highest degree of significance, zone 1. These contribute importantly to the overall view of the church complex. A similar designation was given to the south elevation of the parish unit, which includes the facade of the chapel. The elevation of Fellowship Hall, while reflecting the original design but of recent construction, was given lesser significance, zone 2. All other elevations of the parish unit were given a lesser significance designation ranging between zones 2 and 3.

For the interiors of the parish unit, only the Chapel and the Chapel entrance were designated zone 1. Fellowship Hall was designated zone 2, with the exception of its overall volume and its diagrid ceiling, which were designated zone 1. The classrooms and offices were designated zone 2, since many still contain original materials in good condition. All utility functions in the parish unit were designated zone 3.[1]

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[1] For a more detailed discussion of Levels of Significance, see the Significance Hierarchy section (p. 115)

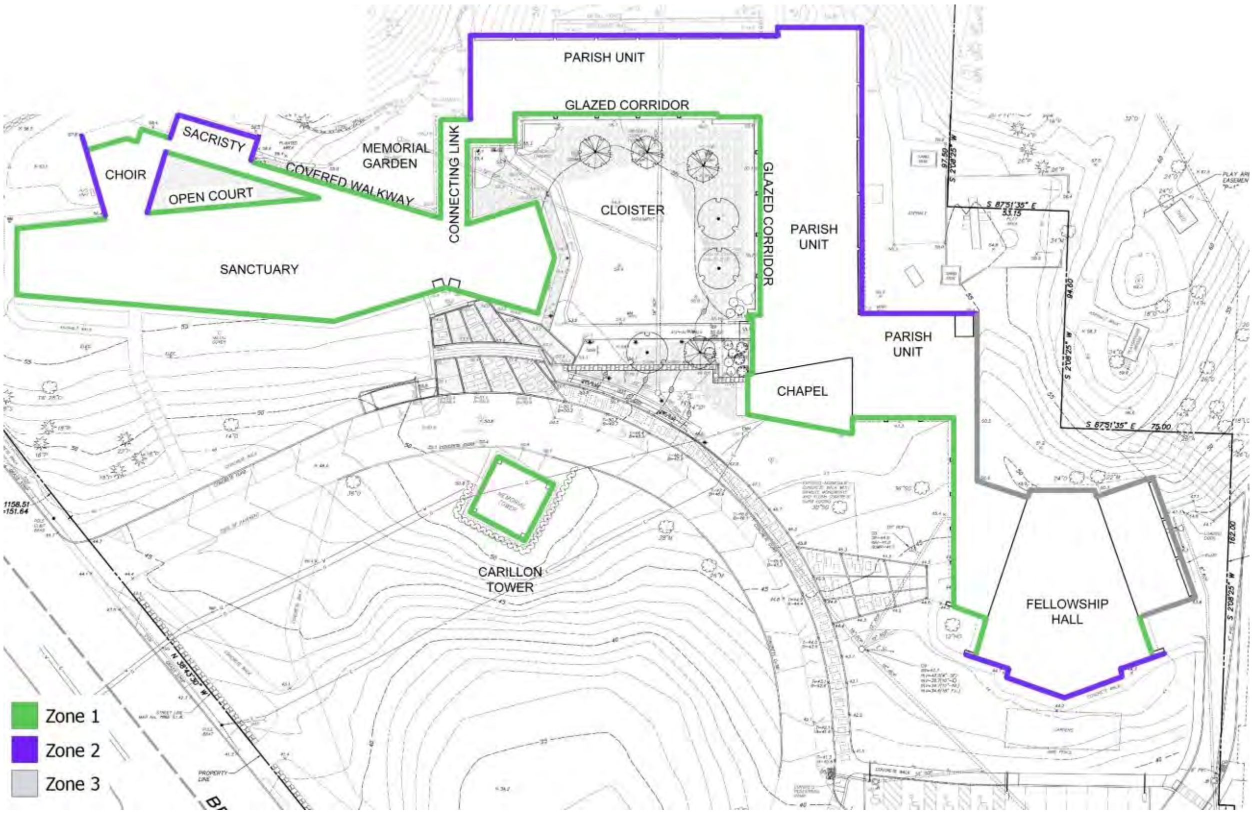

Figure b. Zones of Significance – Facades

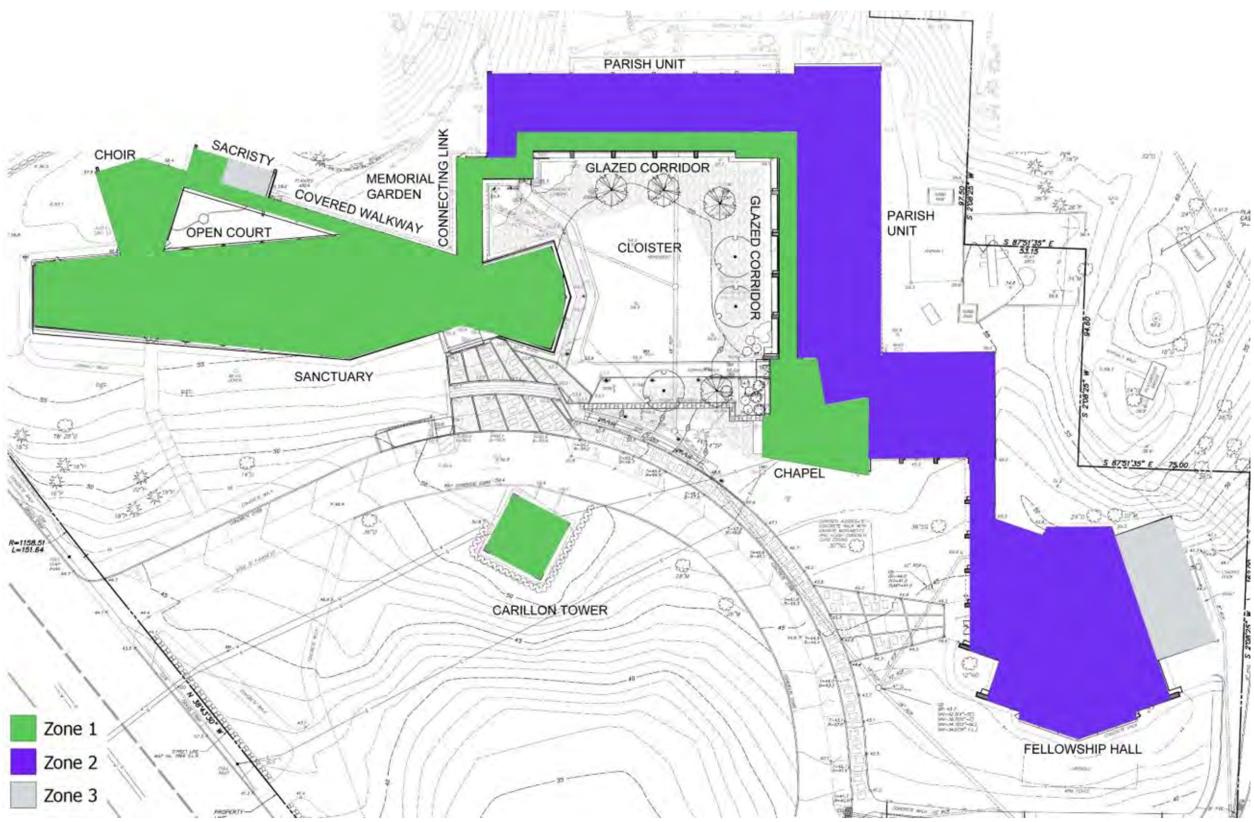

Figure c: Zones of Significance - Ground Floor Interiors

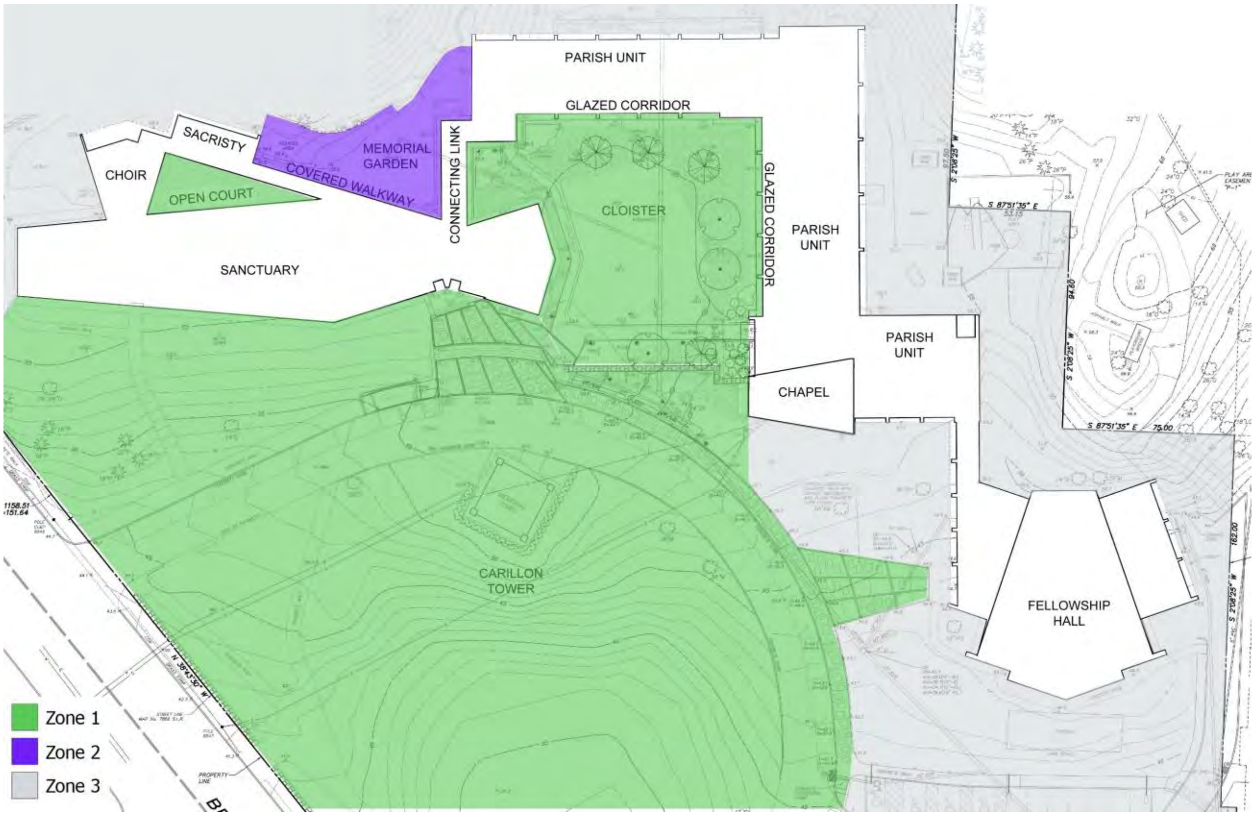

Figure d: Zones of Significance - Landscape

Scope of the CMP

Before a comprehensive survey and assessment of existing physical conditions was undertaken, a detailed history of the design and construction of the church complex was prepared. This was drawn from compilation and review of existing drawings, photographs and documents and resulted in a narrative history and data base catalogue of these materials. The history of the original construction and subsequent repairs was summarized in a time line describing the scope and efficacy of prior interventions and was detailed especially with regards to earlier Sanctuary envelope and *dalle de verre* repair efforts.

All three components of the church complex were surveyed for physical deficiencies, with greater emphasis placed on the Sanctuary because of its level of significance. The current condition of the Sanctuary was recorded with a new set of drawings derived from point cloud laser scanning. Elsewhere, original drawings were used as reference and updated. Existing physical deficiencies were visually surveyed by the consultant teams in the areas of architecture, materials conservation, structural, and mechanical, electrical and plumbing engineering systems. Visual surveys of high reach areas were conducted with the use of aerial (drone) photography for the sanctuary both inside and out. The Sanctuary survey focused on the north, east and south elevations with the *dalle de verre* panels. Preliminary laboratory testing of the Sanctuary's *dalle de verre* and concrete materials was conducted to identify properties.

The results of the conditions assessment identify minor deficiencies in the Parish Unit and carillon and greater problems needing repair in the Sanctuary. The *dalle de verre* panels on the lower sections of the east and south elevations, which had been replaced in their entirety in the 1980s, are in poor condition and in need of replacement. The original lower panels on the north elevation, however, are in better condition than their corresponding replacements. In addition, the original sky-facing upper sections of all elevations that had been protected with secondary glazing systems from the beginning are also in better condition than the lower replacements. The surviving original sections are in sufficient sound condition to warrant more detailed conservation. Material testing of glass and concrete informed these assessments.

Policies and Recommendations[2]

On the basis of these surveys and assessments, detailed policies and recommendations have been prepared or have been identified as needed to be developed, taking into account the relative significance assigned to the elevation, space or detail. These policies are intended to guide future maintenance, repair or interventions and comprise the ultimate goals of the CMP. A summary of further scientific research and development needed for the conservation and replacement of the *dalle de verre* panels is also included. Given the scope of the project it is anticipated that it will be well beyond the capabilities of the congregation. However, because of the significance of the church complex in the community in general, and of the sanctuary, in particular, an outreach to the broader community is anticipated.

On site visual inspections and samples of glass and concrete, removed and tested in the laboratory, provided an indication of the extent and severity of deterioration, particularly for the glass, whether dating from the 1950s or the 1980s. The specific causes of the deterioration remain unclear as to whether they are systemic, environmental, material based or a combination of all. Because an earlier extensive replacement of the south elevation in the 1980s deteriorated more quickly and more severely than the earlier glass, great caution is required for future interventions. Replacement, repair and conservation methods were identified but these remain experimental and have not been tested adequately in either laboratory or field applications. These more detailed scientific studies are to be combined with evaluations of architectural interventions to protect the *dalle de verre* more directly and improve overall rain water runoff. These supplemental studies and research are to be completed before commencing the preparation of construction and conservation documents.

Conclusion

With the significance of the First Presbyterian Church complex firmly established and the existing conditions established and documented, the CMP provides guidance to address the most urgent problems confronting the Sanctuary. The policy and recommendation section of the report set out in more detail actions to be taken. In some instances, it notes the need for particular and more detailed policies that remain to be formulated to be formulated.

[2] Specific policies and recommendations are discussed in Conservation Policy and Guidelines & Recommendations sections (p.147-182).

Contents

Introduction

Preserving significant sites and buildings in the face of changing needs and perceptions is a constant challenge. While the CMP preparation process and format follow a general outline, ultimately every CMP is different, and reflects the character and needs of the project. In all instances a Conservation Management Plan (CMP) is an essential document that seeks to retain and enhance the established significance of the property in any future use, management, alteration, conservation or repair. Because repairs and some interventions cannot be avoided, the CMP ensures that the significance is not lost over time. In the case of the First Presbyterian Church, all aspects of the significance of the Church property were considered in order to manage the preservation process, and to assure that decisions concerning changes, conservation and repair are made in the best interests of the congregation and the community at large. The following CMP concerns the entire First Presbyterian Church complex consisting of the Sanctuary, the Carillon Tower, and the Parish Unit.

An important part of the CMP preparation process is to analyze and determine more formally and more comprehensively the significance of the site and its buildings. A key start to establishing that significance had been made with the preparation of the nomination for the designation as a National Historic Landmark.[3] In the subsequent analysis the concept of significance has been expanded beyond traditional consideration of architectural and historical significance to include broad cultural and community values in order to establish the importance of the complex for the community at large.

To facilitate the determination of significance several other tasks were undertaken. A detailed history was prepared based not only on existing published resources but also on the review of primary documentation available in the church archives. These documents, which included a substantial number of drawings and photographs, were catalogued for future reference and use by those managing the CMP or outside researchers. The last component of determination of significance process was outreach to the community at large to include their perceptions in the final statement.[4]

The second major component of the CMP consisted of the surveying, recording and determination of existing conditions. Aided by the catalogue of existing documents, such as drawings and photographs, the detailed history, which includes a timeline of construction and subsequent repairs, drawings of currently existing conditions were prepared. For the Sanctuary these new drawings were derived from a point cloud model compiled from laser scanning the exterior and interior of the building. With these drawings in hand, surveys to document the

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[3] The designation National Historic Landmark (referred to as NHL) is made by the Secretary of the Interior for districts, sites and buildings considered of "national historic significance" as defined and authorized in the Historic Sites Act of 1935. The nomination including comments made by the National Park Service upon review was submitted June 22, 2017 and remains pending.

[4] The relative significance of the different parts of the complex both inside and out are reflected in the designation of so-called zones ranging from one, for the greatest significance to three for the least.

existing physical conditions were conducted by the architectural, conservation, structural, mechanical, plumbing and electrical engineering disciplines. The architectural and conservation visual survey was further assisted by high resolution aerial photography of the exterior and the interior made possible through drone technology.

While overall conditions for all components of the complex were addressed. the primary focus was on the challenges facing the conservation of the Sanctuary. To augment the understanding of the existing conditions, in particular of the *dalle de verre* and the various types of concrete, representative samples of various constituent materials were taken in the field for further laboratory examination. This included samples of glass, from both the 1950s original installation and the 1980s replacements, and for the concrete, cores from the precast sections, the poured in place infills and the *dalle de verre* matrix.

The assessment of the existing conditions together with the determination of significance became the basis for the formulation of general and more specific conservation policies and recommendations. These policies address various aspects of the continued use and management of the complex as well as more detailed aspects concerning the physical fabric. In some instances, only a general recommendation is provided citing the need to establish a specific policy in the future.

An integral part of the recommendations was the assessment of the adequacy of the data and information gathered. Given the complexity of the deterioration and failure of the *dalle de verre* panels, both original and replacement, and the need to formulate effective conservation and replacement methods, it was determined that the results were not complete and that additional, primarily scientific and laboratory data, would be warranted to supplement what is at hand.

The additional data desired can be divided into three broad categories: architectural interventions to better manage overall rain water removal on the exterior walls of the Sanctuary, compilation of more research data on other *dalle de verre* conservation efforts and on-going conservation research (including other CMP projects) and, as noted in particular, the need of expanded scientific data about the composition and deterioration of the *dalle de verre* in the Sanctuary.

A broad fund development strategy reflecting the significance of the First Presbyterian Church complex will be developed to facilitate and ensure that the policies and recommendations are implemented. The CMP and the research data it contains will be made available as a physical document but primarily as a digital document, located onsite along with the archive material and database at the site.

The Conservation Management Plan has been made possible through the generous support of the Getty Foundation and its "Keeping it Modern" Planning grant program. Additional funds were also provided by the Connecticut Trust for Historic Preservation, which were matched by the Highland Green Foundation.[5] The grants and the project were managed by the Highland Green Foundation.

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[5] The Highland Green Foundation (HGF) is a Connecticut nonprofit corporation approved as a 501(c)(3) organization affiliated with First Presbyterian Church. A purpose of HGF is to assess and initiate long-term actions to preserve and maintain the FPC's Sanctuary and related buildings on the FPC campus

Research and Fieldwork

Preparation

To better understand the site and its buildings, a thorough compilation of background material was deemed necessary and accomplished before any actual survey or investigative work was undertaken. This effort consisted of five tasks:

1. Assessing and determining the cultural significance

   The project began with assessing the cultural and architectural significance of the church complex as an integral and important part of the Conservation Plan. This work had been started earlier by others with the preparation of a context statement for the National Historic Landmark (NHL) nomination and was further expanded during the preparation of the Conservation Plan.[6] The assessment and determination of cultural significance of the FPC was seen to have at least the following components:

   a. As a building designed by Wallace K. Harrison.
   b. As a building with architectural and physical integrity and authenticity.
   c. As an example of its typology as a modern suburban church within the decades immediately following WWII.
   d. As an example of its technology with a focus on the early use and influence of structural precast and *dalle de verre* in the United States after WWII.
   e. Within the suburban community and congregation.
   f. As a landscape and open space within the suburban setting.

   Based on the above criteria, a statement of the significance of the complex and its components was formulated in detail and included in the CMP.

   To arrive at the initial and final statement of significance and its implications, a close collaboration between members of the Highland Green Foundation, members of the congregation, and the consultant team was maintained. To obtain a better understanding of the significance and meaning of the complex within this larger context, a special consultation meeting was held on November 7, 2016, in which members of different organizations and constituencies in the community participated and helped guide and establish appropriate parameters.

2. Existing drawings and records

   A substantial number of original architectural, structural, mechanical and electrical drawings have survived in one form or another. In a few instances, it was possible to

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designed and constructed in the 1950s through the 1960s. HGF is committed to preserving these structures, while increasing the effectiveness of its urban programs and events.

[6] The *National Historic Landmark Nomination* was prepared by Wesley Haynes, of the Highland Green Foundation, and was submitted to the National Park Service. The latest nomination was submitted in June, 22, 2017. The nomination remains pending as of the date of this report.

identify changes that occurred during the design and construction phase and which were not documented elsewhere through the review of these drawings and records. This examination utilized such documents as the original construction drawing set as prepared by the firms Harrison & Abramovitz and the associated architects Sherwood, Mills & Smith, as well as the precast drawings prepared by the British engineer Felix J. Samuely. All drawings were catalogued and organized for use in the project and subsequent reference. In addition to the records at the church, records including design sketches were reviewed. The records are located in the Wallace K. Harrison Architectural Drawings and Papers collection at Avery Library, Columbia University. These proved to be particularly important in fully understanding and appreciating how Harrison's intent evolved in the design of the complex and its details. These drawings were significant in assessing the impact of later changes, as well as serving as a guide to design modifications that may be needed to ameliorate waterproofing issues.[7]

3. History of changes and repairs

   The review of existing records was not limited to those dating to FPC's original construction. While the building complex is in relatively good condition due to ongoing and consistent maintenance, some changes were made over time — most notably in the Sanctuary—with the installation of the new organ. At the maintenance end, not all interventions proved to be entirely effective or satisfactory in alleviating conditions, whether technically or visually. The records were reviewed and, where possible, the outcomes assessed in the field to fully understand what was done and why to serve as a guide for future interventions. A detailed summary of all repair work was compiled. This has served several distinct purposes in the preparation of the CMP: to understand what was done, what was or is systemic, what worked, and what did not work. In this context, it is interesting to note that early on, after the completion of the project, even Wallace Harrison himself was involved in supervising remedial work.

4. Relevant literature

   Some effort was dedicated to compiling research on projects executed by others that involved work relevant to the work needed at FPC. Of interest was any research or publication with regards to the *dalle de verre* as it exists in the Sanctuary. The assemblies and their materials in FPC were at the forefront of the techniques in the United States at the time. The original installation by Gabriel Loire was the first to be installed in the country, thereby introducing his work to the American design and religious community. Whereas the original assembly used concrete for its matrix, a subsequent and later replacement of the south and west walls used epoxies for that purpose. This was a practice that became commonplace in the United States, but was less common in Europe. As a result, a review of both European and American sources was warranted.

   Since at first glance some of the damage seemed to be systemic and to occur in both types of applications, this effort proved to be warranted. Examples of this effort is the work executed at the New York Hall of Science—a project designed by Wallace Harrison

[7] During the research phase, construction records relating to the *dalle de verre* panels were identified at Rohlf Studios and were given to the church for its archives.

as part of the New York 1964 World's Fair. Research on *dalle de verre* included the work by Kristal de Vis at the University of Antwerp in Belgium, the graduate thesis at Columbia University's Graduate Program in Historic Preservation by April Joost, in which actual mockup samples of *dalle de verre* in an epoxy matrix were tested, and in the same program the thesis by Lacey Bubnash, which provides an overview of projects across the country involving repairs of *dalle de verre*.[8]

5. Catalogues of drawings and research

   An integral part of the research effort was the compilation of catalogues of drawings and related records. The catalogues were formatted in an Excel database to allow for future searches and reference to these materials. For researchers, the Highland Green Foundation will make the database available upon request, along with the on-site records and drawings.

[8] See bibliography for the complete references.

Graphic and Photographic Documentation of Existing Conditions

While the original construction drawings for the Sanctuary exist, and are available, they show Harrison's design intent and do not necessarily reflect the as-built or currently existing conditions. To complement original documentation, laser scanning technology was utilized to create a point cloud model of the Sanctuary and the Carillon Tower. The model was used to generate current base plans, elevations, and sections for the Sanctuary and the Carillon Tower, as well as detailed drawings of the wall and roof panels, identifying the particular precast sections and *dalle de verre* infill panels. For consistency, the designations originally used for panel-identification were kept, and additional designations were added for more accurate identification. The point cloud data remains available for creating additional cross sections, views and other representations of the sanctuary with the aid of software tools such as Geomagic and Scene LT. This documentation served as a basis for further documenting existing conditions and may be used for preservation planning in the future.[9]

The existing condition drawings for the Sanctuary and Carillon Tower were supplemented with similar drawings for the Parish Unit. However, these as-built drawings for the Parish Unit were derived from the original construction drawings and verified with surveys in the field. Because these drawings were to serve during the survey phase, this entire effort was carried out at the beginning of the project and in parallel with the research efforts outlined above.

Aerial Photography

The firm Propellerheads Aerial Photography, LLC performed high-resolution photography of the interior and exterior of the Sanctuary using the following camera equipment mounted to two drones:

1. Exterior façade: Zenmuse X5 (16-megapixal camera with a 15-mm lens and a 30-mm focal length) mounted on a DJI Inspire 1 Pro drone
2. Interior surfaces: Sony A7R II (42-megapixal camera with a 50-mm lens) mounted on a DJI Matrice 600 drone

The detailed photographic survey took two days and provided an extensive and detailed record of existing conditions in and on the Sanctuary. This record was particularly important because it gave a closeup look at exterior and interior surfaces that were not otherwise accessible except with extensive (and expensive) scaffolding.[10]

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[9] Because of its size, the point cloud is not included directly in the CMP but remains accessible for future reference in the Church's archives.

[10] Propellerheads Aerial Photography was unable to photograph all the exterior of pre-cast panels. Access to Panel N1-N8 was impeded because branches from a nearby tree did not allow for sufficient clearance. In addition, the lower sections of interior elevations were photographed separately by BCA. The pews prevented clearance for the drone in the side aisles.

Prudon & Partners and BCA reviewed these photographs for conditions not accessible from the ground. Conditions such as water infiltration, efflorescence, cracks, and previous repairs are visible in these images.

A limited number of selected images have been included in this Conservation Plan (Appendix 2).[11]

[11] Because of the file size a separate hard drive with all the images has been placed in the FPC Archives for future reference.

On-Site Surveys and Investigations

1. Methodology and Access

   Due to the configuration of the building complex and its components, parts (both inside and out) are relatively inaccessible except from vantage points at grade level. This required that different survey methods be used to supplement the visual inspections from grade. The surveys conducted and the conditions observed were documented graphically and photographically. Apart from the Parish Unit, the on-grade visual surveys and observations were complemented in two ways:

   a. Binoculars
      The visual inspection from ground level was augmented with binocular surveys of sections higher up in the Sanctuary, both inside and out, and the Carillon Tower.

   b. Aerial Photography
      With the availability of drone technology for remote but close-up inspection, high resolution aerial photography made it possible to survey the Sanctuary comprehensively on the exterior and interior. This provided sufficient detail for a comprehensive overview to serve as the basis for the Conservation Management Plan.

2. On Site Surveys

   Each professional discipline—architectural, structural, mechanical and conservation—conducted on-site surveys and documented existing conditions. The results of their assessment of the condition observed and the causes of such conditions are summarized below. The full consultant reports have been attached as an appendix. Policies, interventions, repairs, and remedial actions have been included where appropriate. For the four primary disciplines involved, the following was addressed:

   a. Architectural

      The architectural survey addressed the existing conditions of the three component buildings of the campus. The survey documented all architectural elements and materials, their configuration, and conditions. The conditions noted were documented in drawings, sketches, and photographs.

   b. Structural

      The structural survey had a threefold focus: the Carillon Tower with its reinforced poured in place concrete, the Sanctuary's precast concrete in terms of both performance and condition, and the Sanctuary's poured-in-place concrete connecting the precast sections.

Only a cursory review of the Parish Unit was included and no deficiencies seemed to be apparent.

c. Mechanical, electrical, plumbing and fire protection

Some changes and upgrades to the existing systems have been made over time or are contemplated. A general review of systems was conducted. Consideration was given to the current plans to install air conditioning in the Sanctuary.

d. Conservation

An important component of the preparation for the conservation management plan was the survey and assessment of the exterior envelop and the respective materials and assemblies that make up the architecturally and visually important components of the Sanctuary. It is here in particular that the history of repairs was found to be particularly pertinent. Two aspects stand out: the *dalle de verre* assemblies (both original panels and replacement ones) and the constituent materials and concrete components whether precast sections, *dalle de verre* infill panels, and poured-in-place concrete. Given the configuration of the Sanctuary walls, this survey (both inside and out) was greatly assisted by the close-up views provided by high resolution aerial photography. This and other portions of the survey were supplemented by the testing of material samples such as glass and concrete.

3. Investigations and Testing

As noted above the surveys and the material conservation assessment of the glass of the Sanctuary's *dalle de verre* and the concrete was complemented with the testing of various samples. Some were removed from a small section of an original *dalle de verre* infill panel and others were obtained on site. This original panel had been removed from the south elevation during the 1980s repair and replacement program and had been salvaged.

For the various types of concrete, petrographic examinations and determination of the extent of carbonation were conducted. Fragments of glass were examined microscopically. Both original glass remaining on the north elevation and the replacement sections on the south and east sides did show a similar type of deterioration. Samples of the efflorescence encountered on both concrete and glass surfaces were analyzed to determine their composition and potential origin.

Copies of the testing reports have been attached as appendices.

Documentary Evidence

Archive

The research for and the preparation of the conservation management plan was greatly aided by the availability of a great deal of archival documentation whether in the form of original drawings, construction photographs or written records. Most of the archival material related to the design, construction, history and maintenance of the First Presbyterian Church complex is in the hands of the church and located onsite. To enable thorough research a database was created that also will continue to serve as a reference tool for future research by scholars and those charged with maintaining the complex. The archives have been well arranged and reasonably preserved.

The oldest material is from the bell tower of the original church on Broad Street, and the oldest material for the existing church complex on Bedford Street dates to October 1954 (structural drawings of the Sanctuary produced by the British engineer Felix J. Samuely). There are approximately 800 drawings in the database alone. Many written records, particularly relating to the history of the congregation, currently remain in storage and have yet to be documented. This material would, when researched, provide a better understanding of the decision-making during the design process and the subsequent maintenance efforts. Maintenance records written by Winthrop P. Moore have been particularly helpful in understanding design changes and preservation attempts over the years.[12] This documentation archiving project was the first time that all the archive sources were documented and systematized; in fact, most of the drawings were removed from storage to proceed with the database.

In anticipation of the database project, some of the original drawings by Wallace Harrison were scanned and the approximately 200 photos from the DeLuca Archive were collected. The DeLuca Archive includes many progress photos and some personal photos taken onsite by architect Yen Liang, who worked for the design architect Wallace Harrison.

The other main sources for archive material are the Wallace K. Harrison and Max Abramovitz Archives housed at Avery Library, Columbia University in New York City. These collections hold original drawings and an abundance of additional records, including correspondence, brochures, photographs, and advertisements relating to the project. These were useful in piecing together some of the missing portions of the church complex's history.

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[12] These records, not always clearly dated, have been extensively referenced throughout the text.

Archive Scope

The archive includes many documents related to the design and construction process. Among the documents are architectural drawings, finish schedules, and additional records for the First Presbyterian Church in Stamford, CT. Drawings included are by Harrison & Abramovitz and Sherwood, Mills & Smith, who collaborated on the design which was commissioned in 1953; by Felix J. Samuely, consulting structural engineer; by Edwards & Hjorth, the structural engineers for the Sanctuary; by Bryan J. Lynch, the landscape architect; by Fred S. Dubin & Associates, mechanical engineers; by Seelye, Stevenson, Value, & Knecht, engineers for the Parish Unit; W. Lee Moore, landscape architect; and Viggo Bonnesen & Associates; and others.

The database was updated on an ongoing basis as the conservation management project proceeded to assure that it included all documents generated regarding this project.

Archive Content and Organization

The First Presbyterian Church Architectural Archive uses an Excel database. This format was selected to make updating easy and provided enough search capabilities to be effective. In consultation with several archivists responsible for drawing collections, the following categories were created:

Drawing Number
Date of Creation
Date of Revision
Document Title
Author/Creator
Drawing Author
Design Author
Type of Document
Building
Medium
Dimensions
Scale
Condition
Description/Keywords/Notes
Location of File
Digital Copy
Cataloguer & Date

Condition has been defined on the following scale, and terminology is based on standard criteria.[13] The definitions are as follows:

Poor, the drawing is deteriorated; substantial material may be torn off and/or lost; severe discoloration and/or stains affecting the legibility of the print

Fair, the drawing is slightly deteriorated and may exhibit some of the above threats affecting legibility, including discoloration, folding, and/or moderate tearing around the edges

Good, the drawing may exhibit one or two of the above threats, but is in overall good condition; legibility is not affected

Excellent, the drawing is completely legible and does not exhibit any of the above threats; the print is not deteriorated

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[13] As defined and accessed at https://psap.library.illinois.edu/format-id-guide/archdrawingrepro

Using the Archive

The following is a guide on how to use the archive. A starting-point to find any item in the archive is a search in the Excel database, which is organized by the above-mentioned categories. The sequence of the materials reflects the order in which they were catalogued. Each database entry has been entered with standard keywords and language to create a straightforward searchable database.

To navigate the database at a general level, search (Ctrl F) for a basic keyword (such as 'landscape'). To navigate the database at a more complex level, use the dropdown at the top of each Excel sheet to create a more specific search. For example, to search for a diagrammatic drawing by engineering firm Fred S. Dubin that was created on 2/22/1955, first find the "Author/Creator" column and use the dropdown to select "Fred S. Dubin." Then, use the dropdown in the "Date of Creation" column to select "2/22/1955" and then use the dropdown in the "Type of Document" column to further refine search results.

The standard language is consistent with the Getty Research Institute's Art & Architecture Thesaurus (accessible at: http://www.getty.edu/research/tools/ vocabularies/aat/index.html).

Literature & Other Research[14]

Until this project, comprehensive research had yet to be accomplished for the First Presbyterian Church. Initial research took place to produce the pending National Historic Landmark nomination.[15] A considerable amount of additional research was necessary to further understand the building's construction timeline and narrative to establish FPC's values and assess its overall significance, in addition to analyzing the design and structural history.

Several prominent architectural journals published articles about FPC in the 1950s, soon after its completion, including *Architectural Forum.* Otherwise, FPC was only mentioned briefly in books about modern church design and architecture, and when it was featured in MOMA's exhibition. Typically, FPC is discussed only peripherally in the general work of contributors, such as Wallace Harrison, Gabriel Loire and Felix Samuely.

Architectural historian and author Victoria Newhouse wrote a monograph on Wallace K. Harrison's career: *Wallace K. Harrison, Architect*), published in 1989. Here an entire chapter is devoted to First Presbyterian Church in which Newhouse discusses the design and construction of the church and quotes conversations with the Reverend Campbell and with Harrison.[16]

The research contained here has focused on the physical documentation of the Sanctuary envelope, including drawings and reports by architects that have worked on past restoration projects, particularly for the weatherproofing and waterproofing of the Sanctuary.[17]

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[14] See also Appendix 4: Bibliography

[15] As noted the preparation of the *National Historic Landmark Nomination* Draft was largely the work of Highland Green Foundation board member Wesley Haynes. The content of the nomination and the assessment of significance of the building was the basis for much of the following section as noted. At the moment of the writing of this report the designation remains pending.

[16] Some of the research of primary documents contained in this report expands on the narrative and clarifies some of the questions that had remained.

[17] For more detailed descriptions of the research, see the respective chapters on the building timeline and particular materials.

Coordination of Data and Assessment of Results

The surveys for the specific disciplines are accompanied by extensive graphic and photographic documentation that illustrates the extent of deteriorated conditions and their location. These surveys and documentation have been attached in their entirety as appendices. In the following sections, the data and information gathered during the various surveys and investigations are reviewed and assessed to determine scope, severity, overall impact, and priority and to establish overall priorities and strategies for the CMP. In addition to illustrating conditions encountered, where appropriate, further areas of research, testing and monitoring have been noted.

Aside from the extensive surveys and testing, an important part of the CMP considers the original intent of the design and materials, subsequent changes and repairs, and on-going use. This CMP in part is intended to confirm and establish why the FPC is significant and how that significance may be sustained in future use, management, alterations, and/or repairs. The Plan is intended to be used to care for the site and manage change over both the short and the long term.

Description of the Site

Existing drawings and records were reviewed to establish a construction timeline of the site and to establish a basis for the assessment and determination of significance in the above-outlined aspects. From there, an expanded history was written to document the history of the site and to present a foundation for assessing the condition of the physical fabric.

This exercise began with an identification of the site and setting and was expanded to explore the thematic history of First Presbyterian Church. The subsequent section includes the Identification of Site and Setting, followed by the Thematic History.

Identification of Site and Setting

The First Presbyterian Church is located in Stamford, Connecticut, 1.3 miles from the Stamford train station and Route I-95 and only a few blocks north of the central business district.

The First Presbyterian Church campus is a property bounded by Bedford Street to the west and adjacent lots to the north, south, and east. The original property extended east to Morgan Street, but the church sold this frontage in 2014 for multi-family residential development. This space was previously used for parking, and the sale reduced the property size from 9.7 to 6.7 acres (for the current site plan see further below). The property, an approximate trapezoidal lot, runs along Bedford Street, from the parking lot of the residences at 1425 Bedford at its northwest edge to 999 Bedford (currently a bank) at its southwest border. Along its eastern edge it borders the new Element One apartment complex (111 Morgan Street). The elevation is highest at its northern edge, where the landscape is mostly rugged and uncultivated. The grade descends more gently toward the east and south, until it reaches its lowest elevation as it approaches the intersection of Morgan Street and Bedford Street.

The building complex on the property consists of three distinct parts:

1. The Sanctuary, which is constructed of precast concrete panels with *dalle de verre* infills that depict the crucifixion on the north wall and the resurrection on the south wall. Adjoining this section are a choir room, a sacristy and support spaces. A covered walkway serves as a connection between the Sanctuary and the Parish Unit
2. A freestanding Carillon Tower that is constructed of a poured in place reinforced concrete structure, precast and wood elements, that rises 260 feet from the base and contains 56 bells comprising four and one half octaves.
3. A Parish Unit that includes church offices, education spaces (church school & afterschool program), a chapel, and a large multi-purpose room called Fellowship Hall.

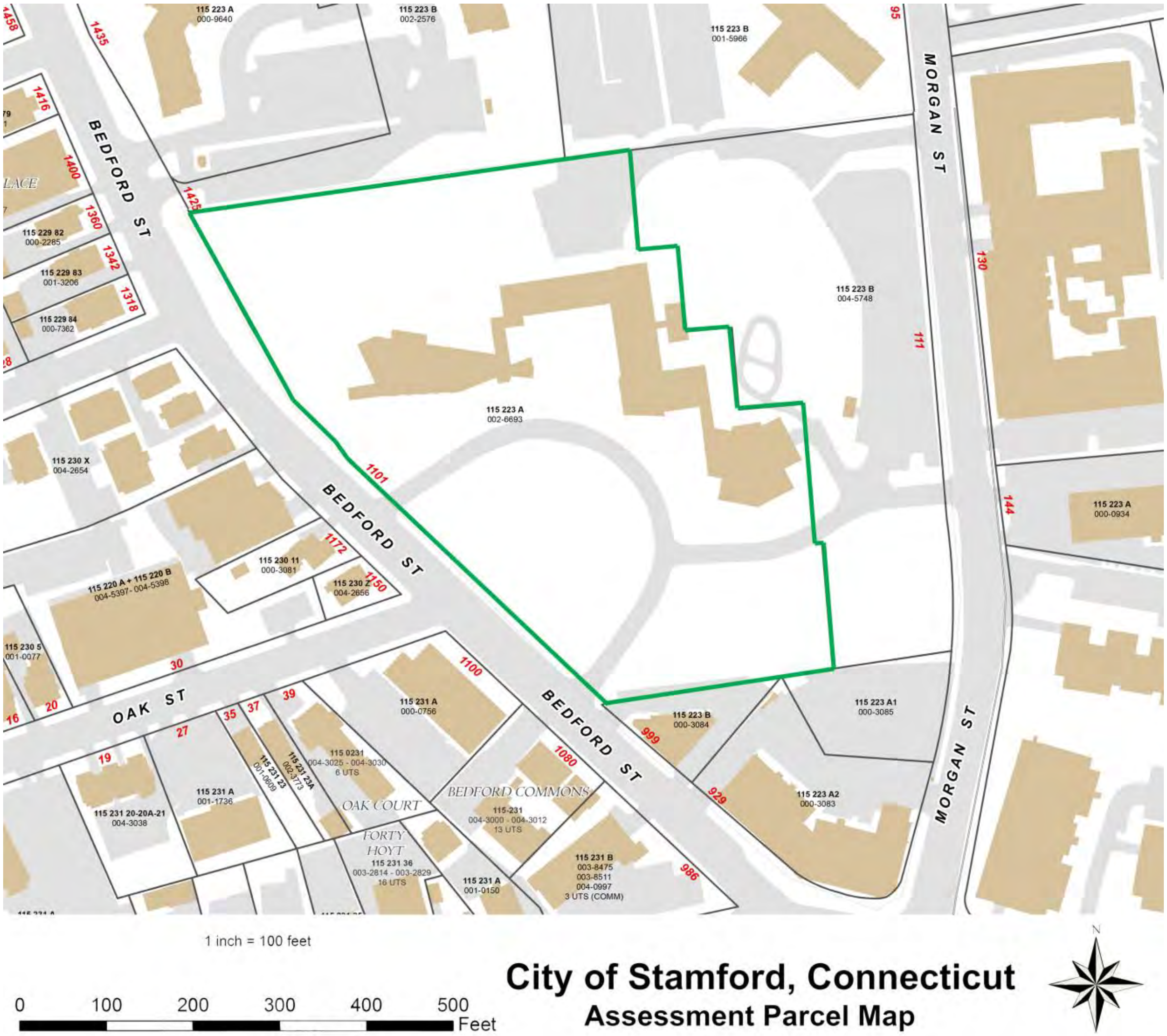
The Sanctuary is positioned at the site's highest elevation (near the crest of the ledge) and the Carillon Tower sits across the driveway, significantly contributing to Stamford's skyline. The Parish Unit, containing the small chapel and Fellowship Hall, extends away from the Sanctuary in a southeasterly direction as it descends the sloping grade. The Sanctuary and the Parish Unit with their connector form a U-shaped enclosure open to the south. A large Celtic cross, in memory of WWII soldiers stands in the middle of this space.

The front of the complex is accessible from Bedford Avenue by a one-way semi-circular drive that borders a dramatic sloping lawn, colloquially referred to as "The Bowl,"[18] and begins and ends at Bedford Street. A secondary drive, leading to a parking area south of Fellowship Hall, is accessed by a two-way drive. In an area that has seen much development since the church's opening in 1958, the site maintains its original open, suburban character—an unusual expanse of open space situated close to downtown. Toward the rear of the property, north of the Parish

[18] This lawn is referred to as "The Bowl" in a few sources, including Winthrop P. Moore's maintenance notes quoted in more detail further below.

Unit, is a large parking area reserved for church and school staff. This parking area is reached from the east, and accessed by a driveway off Morgan Street.

Site Plan[19]



The above site plan shows the City of Stamford, Connecticut, Assessment Parcel Map from GIS parcel data that dates to October 2015 (Map 115), and the map was produced in March 2016. The map shows the boundaries of the property post-sale.[20]

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[19] The text in the Site Plan section is partially derived from the pending *National Historic Landmark Nomination*, as submitted on June, 22, 2017

[20] Stamfordct.maps.arcgis.com. Accessed April & may 2017. http://stamfordct.maps.arcgis.com/apps/SimpleViewer/index.html?appid=8bd89187b7324a57b263d51bd020cc40.

Sanctuary[21]

The Sanctuary is a large single-story structure. Its nave is oriented east-west and its main entrance is at the narthex, located on the south elevation facing the semi-circular drive and Bedford Avenue. The building's unusual form appears to be inspired by Harrison's analysis and abstraction of traditional building methods.[22] As viewed from Bedford Street, the Sanctuary presents its south elevation as a large, asymmetrical structure. The building is characterized by large and exposed precast concrete panels, which hold either multi-colored *dalle de verre*, or are covered with dark grey slate. These 152 precast concrete panels are of varying triangular and quadrangular shapes, and incline inwardly forming the interior volume. The solid precast panels are surfaced with dark grey slate, and the smaller *dalle de verre* panels are clustered within larger inclined precast plates that form the north, south and east walls. The precast panels are joined together through protruding rebars that extend into the space between the panels, which in turn holds extensive reinforcement and is filled with cast-in-place concrete. These reinforced seams form a structural frame that is expressed as edged ribs on the interior. The British engineer Felix J. Samuely is generally credited with this concept, to which he referred as "space construction."

The Sanctuary's main entrance on the south elevation (at the inward fold of the narthex) features a projecting sculptural concrete portal in the shape of a cross; its outward edge depicts the crucified Christ, a projecting hood depicts the arms of the cross, and the wall between the two separate doorways depicts the post of the cross. The doors have been replaced, and the concrete was originally exposed, but is now painted a light grey. A secondary entrance giving direct access to the nave is located on the south elevation toward the western end of the elevation. This simple door is only accented with a rectilinear concrete portal.

Wallace Harrison maintained a traditional division of church architecture, yet he abstracted the form of the chancel, nave and narthex into modern construction methods. The interior space evokes a cathedral's spatial hierarchies, yet remains open due to the "space construction" and lack of columns or other structural supports interrupting the space. The volume itself widens out towards the narthex suggesting the shape of a megaphone to narrow again at the connection to the narthex. The narthex is the narrowest in height and width at the main entrance. A portal directly opposite leads to an enclosed corridor ("Connecting Link") to the Parish Unit. The narthex ceiling rises and widens to the east, toward a large precast concrete and *dalle de verre* wall. The narthex has a flight of cast-in-place concrete stairs encased in millwork at the south wall. The stair leads to a balcony that spans the width of the narthex.

The *dalle de verre* panels have specific iconographies that convey major themes of Christianity. Whereas Gabriel Loire designed the narthex glass in its entirety, from selecting the theme and colors to execution, the other two elevations (north and south), were the result of the close collaboration between Wallace Harrison and Reverend Dr. Campbell, the pastor at the time (Appendix 4: Figure 1). The panels hold, in total, close to 20,000 pieces of approximately one inch thick glass. The panels created in the studio in Chartres by Loire remain complete in the

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[21] As noted above, the text in the subsequent sections is partially based on research conducted for the pending *National Historic Landmark Nomination*, as submitted on June, 22, 2017.
[22] The inspiration for Harrison's design is discussed in greater detail further below.

north nave walls, while the glass and panels in the south nave wall and east narthex wall (below the roofline) date to a major intervention in 1986. All the glass above the roofline at the north, south and east sides is original. The replacement glass presumably matches the shape, color, and faceting of the original *dalle de verre* closely.

All the pews and branched lighting pendants for the nave are original and were designed by Harrison for the nave. The pendants have cylindrical canister down lights suspended from thin steel rods with branches. The chancel holds the original table and pulpit, though the pulpit has been modified—with Harrison's approval, the original sound deflecting hood was removed. The chancel and the appearance of the west interior elevation have been altered by the installation of a new organ in 1991. The original below-grade organ pit was closed and the organ front was changed to accommodate a new configuration. The suspended cross was maintained over the altar table, but appears somewhat less dramatic than it was originally, as the new organ is visually more dominant in style when compared to the original organ which was set behind a perforated wall, forming a backdrop for the cross.

The original space was described as extending:

> …even as it envelops. The nave ends in darkness as it closes down, with a large cross reaching from peak to wall, its position and dimensions suggesting a retrofit wooden frame. Originally, the ambivalent hierarchy of the nave… terminated in a sort of shadowy perforated wall…[23]

The original organ (an electric organ built by the Allen Organ Co. of Pennsylvania) was thought to be state-of-the-art at the time of construction and was integrated into the original perforated west wall. This was replaced with an Opus 87 Visser-Rowland mechanical action pipe organ conceived by Pieter Visser in Houston.[24] The new organ's "shiny pipes act as a visual crescendo to the space."[25]

Harrison remained involved in the design of the church after its completion. In the late 1970s, he supported a redecoration of the narthex and vestibule area. At this time, a canvas mural designed by Harrison was installed, and was hung on the north wall of the narthex. The 16-foot tall mural was created by Harrison in 1975 and depicts a crucified Christ.[26]

In 1994, a suspended filigreed four-foot-tall mobile titled "Fishers of Men and Women" was purchased from Michael Myers of Stained Glass Poetry, LLC (located in Lake Ann, Michigan) and installed in the narthex. Made of leaded iridescent stained glass, it reflects the color and

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[23] Wagner, George. "This Crushed Lantern: Wallace Harrison and the First Presbyterian Church of Stamford, Connecticut." *AA Files*, No. 36, Summer 1998, pages 31-39.

[24] Barton, Ann "First Presbyterian Church, On the 40th Anniversary of the Completion", March 1998, p. 19: the organ was sold for $15,000 to Tom Previte, Massachusetts lobsterman with an interest in electric organs, particularly with vacuum tubes. He personally dismantled the original organ over the course of a month.

[25] Wagner, "This Crushed Lantern", 38.

[26] It is interesting to note that Harrison was an Episcopalian, which uses the image of the crucified Christ; Presbyterians, however, use an unadorned cross and not the crucifix.

echoes the imagery of fish in the stained-glass window of the narthex.[27] Myers himself offers the following description of the mobile on the Northern Michigan Artists Market website:

> The mobile represents the spiritual interconnection we share as humans. The mobile is three-dimensional and consists of three fish shapes that can be rotated independently from one another inside the largest fish. The textured filigree that I create between the pieces of stained glass is my own original and unique soul felt creative expression. This filigreed piece elicits personal reflection and stirs emotions within…[28]

Adjacent to the north side of the Sanctuary is the Choir Room, which can be accessed by an entrance on the Sanctuary's north elevation. The Choir Room is at the far west end of the complex and is not visible from the main south elevation. The structural form evokes that of Fellowship Hall but is constructed of concrete block walls painted white with a wood framed roof. The Choir Room can also be entered from the North Corridor, which links the space to the sacristy (with restrooms and mechanical space) and extends further east to the Parish Unit. The rear wall is set back deeply from the eaves to create a sheltered porch with concrete slab floor that can be accessed by a separate single door. The North Corridor, which runs along but is largely separate from the north elevation of the Sanctuary, creates a small interior court that can be accessed only from the corridor.

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[27] Barton, "First Presbyterian Church": The title refers to Jesus' call to Simon and Andrew as they cast their nets into the sea: Jesus said to them, "Follow me and I will make you fish for people." Mark 1:17 New Revised Standard Version.
[28] Northern Michigan Artists Market. *Online Art Store:* http://www.nmam.us/show_art/10747/

Parish Unit

The Parish Unit is an approximately 30,000-square foot split level structure connected to the Sanctuary by an enclosed glazed corridor. The building houses FPC's administrative, classroom and meeting spaces, and includes a small chapel and Fellowship Hall.

The exterior is modest in scale and massing compared to the Sanctuary and, not entirely surprisingly, is reminiscent of suburban school design of the immediate postwar period. Situated on terrain that gradually slopes down from the Sanctuary, the building's sections are arranged along a linear plan that partially forms a three-sided enclosure with the east end of the Sanctuary. The primary elevations facing south and east are expanses of floor-to-ceiling glass walls with wood mullions, bracketed by piers and masonry wall areas. Some of the multi-colored grey quarry-faced stone is presumably from the 1884 church. All the stone is set in random ashlar coursing. The secondary elevations facing north and west are constructed of painted concrete block. Where visible from the street, the grade is terraced up and gives the appearance of a one-story flat-roofed building set back from the Sanctuary. The rear—or north—elevation is two stories and faces the rear parking lot.

The enclosed passageway which connects the Sanctuary and Parish Unit is on axis with the Sanctuary's main entrance and runs along the exterior of the Sanctuary's north elevation, leading west to the Choir Room, and then in the other direction the passageway turns at a right angle toward the Parish Unit. The corridor of the Parish Unit, with its floor-to-ceiling wood and glass window-walls, seems to continue the fenestration of the enclosed passageway. The corridor glass walls incorporate small sections of colorful and figurative stained glass that were salvaged from the earlier church. Across the window-walls, on the other side of the corridor, is a solid plaster wall that is punctuated by doors, almost all identical, giving access to church offices, classrooms, and meeting spaces.

The Parish Unit also includes a lower level, which is entirely below grade on the south and west elevations (the "front"), and partially above grade on the north and east (rear) elevations. The Parish Unit partially encloses a courtyard to suggest a "cloister wing". The cloister wing corridor adjoins another section of the Parish Unit containing the chapel. The solid stone walls of the Chapel's west and south elevations, along with its sloped roof, emphasize the Chapel space on the exterior.

The Chapel and the adjacent entrance are located at the southeast corner of the cloister. The space originally had a small organ (the organ pit has been closed off from the chapel, but is still accessible from the basement). The chancel is raised slightly, and the original pews for the congregation have been removed and have been replaced with individual chairs. The north wall of the Chapel facing the corridor is a "wall of faith" that features 112 stones that were gathered during World War Two by former pastor, Dr. George Stewart, from the world's historic centers of Christian faith. On the Chapel's interior, there is an original wood screen at the rear (west) wall. A small *dalle de verre* skylight, covered on the outside by translucent corrugated roofing, sits above the raised chancel.

Fellowship Hall is a five-sided two-story structure at the southeast end of the Parish Unit and is constructed below the grade of the main level. Fellowship Hall can be directly entered from the outside because of the slope in the existing grade. On the inside Fellowship Hall is reached from straight stairs that lead down to a corridor with plywood paneling. The multi-purpose hall widens from 30 feet to 78 feet and is 85 feet in length. The space has a one-story circulation and kitchen area set back from the front elevation. The gabled south elevation is centered on a full-height glass curtain wall interspersed with tinted glass in rose, amber, and turquoise. The interior ceiling exposes a diagrid structure—a network of steel I-beams that form triangles of varying sizes arranged symmetrically below the gable roof; with its ribs, it appears to suggest a vaulted structure.[29]

The interior of Fellowship Hall and the adjacent corridor was remodeled in 2016 and 2017. Updates included asbestos abatements, kitchen update, and updates to the bathrooms and stairs for ADA compliance. The south elevation of Fellowship Hall was refurbished in its entirety with a new thermally broken window assembly that loosely resembles the original configuration. The original plywood paneling in the corridor leading to the Hall was replaced with new paneling of a more modern design.

The plan of the Parish Unit remains similar to its original construction, with minor interior changes, such as the addition of ADA compliant bathrooms, changes to the kitchen, and the lounge. The two levels of the L-shaped Parish Unit are connected in three locations by staircases with two at either end and one in the center. One is located on the west end of the Parish Unit, one to the northeast at the end of the office corridor. This is in addition to the straight staircase that connects the Parish Unit to Fellowship Hall. In plan, other than the fan-shaped Chapel and Fellowship Hall, the interior spaces in the Parish Unit are rectilinear.

[29] At the time of the survey, construction was taking place in Fellowship Hall, the kitchen and the adjacent corridor. The space was surveyed subsequently and its current configuration is reflected in this report.

Carillon Tower

The Carillon Tower, a 260-foot-tall freestanding concrete structure anchored to a 550-ton concrete base, is a highly visible structure and can be seen from several important vantage points in Stamford. The Tower is located across FPC's main drive in front of and to the south of the Sanctuary. The Tower has two square belfry levels and an octagonal clavier level in between them; these spaces occupy the lower section, which rests on four inwardly inclined poured-in-place concrete piers. The octagonal upper section rises from the roof of the upper belfry and consists of eight inwardly inclined square piers that project above the lower section and converge at the pinnacle.

The belfries are reached by a central flight of precast spiral stairs, which, up to the lower level, are enclosed in a circular, galvanized steel cage. The cage is fully enclosed by an octagonal wood screen constructed of now weathered Burmese teak. The same teak wood encloses the belfries.

This carillon is today a combination of 56 bells from Gillet & Johnston (England) and Paccard (Annecy-le-Vieux, France at the foundries of Les Fils de Georges Paccard).[30]

The only changes to the Tower include the addition of sound isolation material and replacement of two hammers in 1981 (performed by the I.T. Verdin Co. of Cincinnati)[31] and the sealing of the hairline cracks in the lower stage piers in 1997.[32] The concrete piers remain unpainted but the metal of the cage has been repainted.

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[30] A more detailed discussion of the carillon and its bells can be found in the *Thematic History* section of this report further below.
[31] Douglas Marietta, "Maguire Memorial Tower", (FPC write-up, January 19th, 1996)
[32] Further details about these repairs can be found in the section *Renovation and Repair Work Since Construction*
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Landscape

The design and layout of the landscape in the 1950s was minimal and incorporated the site's existing natural topography and rock outcroppings. The original site work was limited to terracing between the Sanctuary and the Parish Unit, constructing vehicular driveways along the natural contours of the site to give access to the various entrances, and minimal regrading in the rear sloping area for parking (Appendix 4: Figure 38). Original planting was limited to some trees. Changes have been made since; aside from the construction of the Carillon Tower and the landscaping at its base, most changes have involved the reconfiguration of parking areas.

Apart from the sale of property along Morgan Street, the plan and nature of the original landscape have been maintained. The sold property included a parking lot, and necessitated moving the lot to a new area south of Fellowship Hall. This is accessible from the original one-way main driveway. Another parking lot to the rear of the Parish Unit is original to the 1958 plan, but has been slightly enlarged after the sale of the Morgan Street property to maintain the same number of parking spots. The lot is accessed from Morgan Street.

The covered passageway that connects the Sanctuary with the Parish Unit encloses a small Memorial Garden and features an outcrop of natural ledge in its design. This space, designated by the Trustees of the church as a final resting place for the ashes of members of the church and their families, is accessed via the passageway, and incorporates minor additions of shrubs and small monuments[33] The site consists of a retaining wall to the north in which are embedded small memorial plaques. Additional space for memorial plaques was added to the exterior wall of the utility room bordering the Garden in 1982, and another low wall with plaques, along the covered walkway, was added in 2015.

Between the north elevation of the Sanctuary and the north covered passageway is a triangular shaped paved and minimally landscaped courtyard ("Open Court") that is accessed through a single door from the passageway and a single door from the Choir Room. This enclosure has a wood bench and poured in place concrete curbs, which are designed to form a planting bed for one large tree and minor shrubs along the passageway. Aside from these details, the Open Court has no other notable features.

The open "cloister" space between the Sanctuary and the Parish Unit is enclosed on three sides by the glazed walls of the Parish Unit and passageway. The space is accessed from the sidewalk along the main driveway, up a short flight of steps or a paved ramp serving the main entrance to the narthex. Paved paths lead to two entrances to the Parish Unit—one to the Northwest corner and the other to the Chapel. A Celtic cross is centered within the open space. Carved from Barre granite and erected in 1958, the cross was offered by the youth group of First Presbyterian in memory of those who died for their country in World War II.[34] Along with the installment of the cross, three oaks and a few blue spruces were planted in the "cloister". The spruces were removed in the 1980s and the oak nearest to the sanctuary was removed in 2012 since it was found to threaten the Narthex. The remaining two oaks were removed in

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[33] Love, Jane, ed. *Docent Notes,* (FPC write-up, October 2016).

[34] Barton, "First Presbyterian Church"

2013, after Hurricane Sandy.[35] Today, apart from modest shrubs planted along the paved walkway to the chapel and sparsely along the passageway (the Connecting Link between the Sanctuary and the Parish Unit and the corridor within the Parish Unit), in addition to a few small trees, the cloister space features minimal landscaping.[36]

The landscape contains features that were initially planned in the 1940s and carried out later, including the Stamford Historical Wall and the Memorial Walk. The Historical Wall is a stone wall that runs along the Bedford Street edge of the main lawn, beginning at the entrance of the circular driveway and ending at the exit. In 1941, FPC's pastor, Rev. Dr. George Stewart, inspired by London's Westminster Abbey, conceived of the wall that features 72 inset granite tablets with inscriptions describing important people and events in national and local history that made contributions to the physical, religious, and cultural growth of Stamford from 1641 to 1941. This wall was constructed in 1964, and two new stones were added in 1978 at the 20th anniversary of the completion of the Sanctuary.

Rev. Dr. Stewart also conceived the Memorial Walk, which is incorporated in the sidewalk along the driveway and runs from Fellowship Hall to the Sanctuary steps. The Walk consists of 106 tablet stones of Barre Granite, inset in the paving, and incised with the names and dates of biblical figures, theologians, politicians, artists, pioneers and others who "helped change the focus and direction of the Christian Church."[37] The names were selected in consultation with Protestant church historian Roland Herbert Bainton (1894-1984).[38] The walk is largely intact as installed in 1964, though it was expanded in 1977 and the stones were reset in 2016 in a larger landscape and paving maintenance project, during which a few broken stones were replaced.

Both landscape features were originally built by the DeLuca Construction Company, as were the buildings of the entire complex.

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[35] From an email by Jane Love, dated 10/6/2017. Email also recounts that the stumps of the oak trees remained and were removed during the 2016 renovation (ADA compliance of sidewalks and ramps).

[36] It appears that the currently existing plant selections were inspired by the religious symbolism for each as well as how they relate to the pre-existing plant palette. For example, the dogwood "blush of shame" was used during the crucifixion, and the pink and white blooming Broad leafed evergreen shrubs represent joy, happiness, and purity. This is noted on the Planting Plan and Site Details drawing L-100 dating to June 10, 2016 as part of the 2016 alterations for the church.

[37] Barton, "First Presbyterian Church"

[38] Roland Herbert Bainton was an American Protestant church historian, theologian, and educator. Born in Britain, he moved to the United States in 1902 and attended Whitman College and Yale University. He specialized in Reformation history and was a professor of ecclesiastical history at Yale. He authored *Here I Stand: A Life of Martin Luther* (1950) and *The Reformation of the Sixteenth Century* (1952). In: "Guide to the Roland Herbert Bainton Papers Record Group 75. Overview", Yale Divinity Library, accessed May 2016, http://drs.library.yale.edu/HLTransformer/HLTransServlet?stylename=yul.ead2002.xhtml.xsl&pid=divinity:075&clear-stylesheet-cache=yes

Thematic History[39]

The compilation of a detailed thematic history and context began by reviewing drawings and records, as many of the originals have survived in one form or another. These were useful in establishing the intent and extent of the design and physical history of the First Presbyterian Church. Many other records aided in understanding the history of subsequent repairs. Relevant literature was also compiled to further assist with establishing a timeline for construction, in addition to providing context for the design of the church. The thematic history section addresses the following topics:

1. Site and Congregation
2. Suburban Church Architecture: Postwar Building Boom
3. Selection of Architects
4. Design
5. Precast Concrete Construction
6. *Dalle de Verre*
7. Carillon Tower
8. Modern Architecture

[39] The text of this history section is greatly indebted to the *National Historic Landmark Nomination*., submitted June, 22, 2017. Subsequent references will continue to acknowledge the NHL as a source.

Site and Congregation

By 1952, when the congregation voted to relocate to its present location on Bedford Street, the First Presbyterian Church (FPC) had already been a well-established presence in Stamford's central business district for nearly a century. The central business district gradually developed around the original site of the Congregational meeting house (FPC's precursor).

Stamford's initial settlement dates to 1641, however it wasn't until the 1848 arrival of the New York and New Haven Railroad that businessmen from New York were attracted to move to the suburbs. Among them were Scottish immigrants of the Presbyterian faith. There were five Protestant churches in Stamford by the mid-19th century but not one of the churches was Presbyterian. Scottish stonecutter Alexander Milne organized a meeting to discuss a new church.[40] The first indication of this movement to organize a Presbyterian church for Stamford can be found in the records of the Congregational church. In a church meeting on January 2, 1853, members of the Congregational church "called for letters of dismission from the church, to constitute a Presbyterian church about to be formed."[41]

FPC was officially organized on February 25, 1853 with 26 members under the Third Presbytery of New York and the Reverend J. Leonard Corning served as its first pastor.[42] Until 1854, the congregation worshipped in the Town Hall. The small congregation then acquired property at the northwest intersection of Atlantic and Broad Streets, where it built a modest white-framed church (with a steeple of 135 feet) at 90 Broad Street, just two blocks north of the original Congregational church.

Over the next century, the church congregation grew steadily as residential neighborhoods were built near Stamford's commercial center, and the wood frame church was enlarged in 1877. The church was struck by lightning and burned to the ground on August 8, 1882,[43] and in 1885, the church constructed a larger eclectic Romanesque and Byzantine revival masonry sanctuary on the site for a price of $90,000,[44] designed by architect Josiah Cleaveland Cady[45] with a prominent belfry (Appendix 4: Figures 2 and 3). A large addition (a parish house) was made to the church building in 1920.[46]

Over the next 50 years, a residential neighborhood of single-family-homes developed along Bedford and Summer Streets, north of the original church, while earlier residences south of the

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[40] *First Presbyterian Church: Celebrating Our First 150 Years in Stamford*. Pamphlet. FPC Archive, 2003
[41] Huntington, Elijah Baldwin. *History of Stamford, Connecticut: From its Settlement in 1641, to the Present Time*. Stamford, CT: Published by the Author, 1868, 336.
[42] Ibid.
[43] Grant, Walton Alfred. *Stamford Historical Sketches*. Stamford, CT: Cunningham Press, 1922, 98.
[44] "… And they Strengthened Their Hands." *First Presbyterian Building Fund Campaign.* Ketchum, Inc.: Pittsburgh and New York, 1953.
[45] Josiah Cleaveland Cady (1937-1919) was an architect based in New York. He is known for designing buildings such as the American Museum of Natural History and the original Metropolitan Opera House. Cady designed several churches (including at least two Presbyterian churches) over the course of his career, several of which survive and are listed on the U.S. National Register of Historic Places.
[46] Grant, "Stamford Historical Sketches", 38.

church were gradually replaced by commercial buildings. The business district continued to expand; by the 1930s, commercial development fully surrounded FPC. The church building—later demolished to make way for commercial development—was:

> Built for permanence, its architects could scarcely have foreseen the coming of the automobile or the need for extensive Sunday School space. There was no room for expansion at 90 Broad St.[47]

In 1942 under the leadership of the Reverend Dr. George Stewart, the Presbyterian congregation purchased the site of its present building (he negotiated the price down from $35,000 to $15,000), located three long blocks north of the Broad Street site. The acquisition was a clever investment, as Bedford Street's underdeveloped east side indicated a potential northern area for the next wave of downtown development. The church's new parcel was an undeveloped ten plus acres that had been previously used as a pasture. The congregation had yet to develop a plan to relocate, though Reverend Dr. Stewart obtained a rendering of a new masonry "Byzantine style sanctuary" by architect Frederick Rhinelander King,[48] but did not take any further action to develop the site during his tenure. Instead, the Bedford Street parcel was leased to the city of Stamford for use as an open space accessible for public use.[49]

It was around this time (1939-1946) that the Nestlé Company relocated some of its employees to Stamford, CT from Switzerland. Many of the company's employees and officers attended FPC,[50] and as a gesture of appreciation to the community for its hospitality, Nestlé gifted the congregation a 36 bell carillon (26 bells with additional 10 due to favorable tariffs) in 1947. Dr. Edouard Muller, president of the company, offered the gift as a "gesture of faith and international good-will," and suggested that the carillon would "add richness and beauty to our city and nation."[51] Dr. F. Andre Perrochet, executive vice president of the Stamford division of the Nestlé Company, said the bells were given in gratitude for: "The wonderful Christian acceptance which we met in Stamford and in this church particularly."[52]

The bells were cast in 1947 by Gillett and Johnston of Croydon, England. Twenty-Five of the bells were dedicated with the name of a Swiss canton, one was dedicated to Switzerland, and the remaining 10 to Swiss historical figures (today, only 21 of the original Gillet and Johnston

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[47] *First Presbyterian Church: Celebrating Our First 150 Years in Stamford*. Pamphlet. FPC Archive.

[48] Frederick Rhinelander King (1887–1972), was then a partner in the firm of Wyeth, King and Johnson who had recently completed renovations of the Dean's office and residence at the Cathedral of St. John the Divine in New York. A graduate of Harvard College who had attended the École des Beaux-Arts, Paris, King had met Harrison when the two worked in the office of McKim, Mead & White before the First World War. King, a Harvard classmate of CIA Director Allen Dulles, helped Harrison & Abramovitz earn several important commissions including the U.S. Embassy offices in Rio de Janeiro and Havana (1952) and later the new CIA Agency Building in Langley, VA (1961) in which King collaborated. In: *National Historic Landmark Nomination.* February 29, 2016. Draft.

[49] "Church Asks City to End Lease on Bedford Street Tract." *Stamford Advocate*, 26 January 1953, pages 1 and 6.

[50] "Impressive Carillon to be Heard." *The Hartford Courant*, 15 June 1968.

[51] "Carillon Given to Church." *New York Times*, 29 May 1944.

[52] "Impressive Carillon to be Heard." *The Hartford Courant*, 15 June 1968.

bells remain).[53] The gift was installed in a temporary tower on the site of the old church, where it remained until 1956. Known as the "Friendship Carillon," it was dismantled and then stored at the site of the new FPC after the property was sold.[54]

The congregation grew steadily; by 1951, approximately 100 new members joined per year. Concurrently, Stamford's population in the early years of Reverend Dr. Stewart's successor, Reverend Dr. Donald F. Campbell, (beginning in 1945) also grew; Stamford's master plan anticipated a doubling of its population over the next two decades. Based on these projections, the congregation expected enrollment in its school to reach 850 and general membership to reach 3,000 by the early 1970s.

In anticipation of this growth, the congregation appointed a Planning Committee of fifteen congregational members plus pastoral leadership by August of 1951. The Committee was to conduct a cost benefit analysis that would examine two options: renovating the existing church and developing the Bedford Street site. After investigating, the Committee found that renovating the existing church would cost $26,000 less; however, additional factors emerged from growth projections such as the location of the Bedford Street site—ideal for the growing suburban population—and the need for more parking and programmatic space. Based on this, the Committee decided to build a new church. A church history reported that:

> The downtown location, so desirable in the congregation's early years, lost its luster when the automobile brought families from further away… parking at the Broad Street site was understandably limited and there was no space for expansion [of parking]. Nor was there room for a much-needed new church school.[55]

Unanimously, the Planning Committee concluded:

> It would seem that the choice is obvious when the approximate amount required to put our present church into condition for the next twenty years would build a church.[56]

In April of 1952, the Planning Committee formally recommended the construction of a new church. Two weeks later, on May 7, the congregation approved the Committee's recommendation to Session to appoint a Building Committee that would select an architect and

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[53] http://www.towerbells.org/data/CTSTAMFP.HTM, accessed September 2016;
additional information found in: http://www.waymarking.com/waymarks/WM7HMK
And in Barton, "First Presbyterian Church"

[54] Barton, "First Presbyterian Church", 46-50: because of the "peculiarities of the tariff law" Gillett and Johnston sold FPC 36 bells for the price of 26 and that because of the hope of a new church on Bedford Street, a temporary carillon tower was established on Broad Street in 1947. The tower was dismantled in 1956 and brought to Bedford Street. It seems that during this time of transition, three of the bells were stolen. Additional bells were added upon construction of the currently existing Carillon Tower.

[55] Barton, "First Presbyterian Church"

[56] Barton, "First Presbyterian Church", 7-8.

raise funds, with major decisions subject to approval by Session, the Board of Trustees, and the congregation.[57]

Suburban Church Architecture: Postwar Building Boom

The Planning Committee's decision to construct a new place of worship coincided with the postwar building boom, which was a period of mid-century development that involved in all faiths thoughtful deliberations and conversations about church appearance and function. According to Gretchen Buggeln, author of *The Suburban Church: Modernism and Community in Postwar America*, the availability of print resources increased substantially, allowing building committees access to the most up-to-date advice for "no more than the price of postage".[58] These print resources, including a wide range of books, consisted of discussions about theology and liturgy, in addition to practical assistance. Buggeln mentions that in addition advice was also readily available via popular religious periodicals, which were packed with information about church architecture and the usage and management of facilities. Because many prominent architects were engaged in designing churches and synagogues, professional architecture journals frequently issued articles about remarkable ecclesiastical structures and trends in modern church design.[59]

Both nondenominational and denominational groups consulted with building committees, circulated photographs, and printed materials containing countless ideas, relating to aspects ranging from acoustics to landscaping. At conferences, architects, church leaders, manufacturers, artists and lay-people convened to share information and to discuss the relationship of architecture to the purpose of the church. As quoted by Buggeln, an architect claimed that: "we are inundated with data, new and old ideas, constant reworking of similar themes and concepts."[60]

This was the first time that this level of energy was directed toward American church design; the merging of religion, modernism, and the demand for new religious and social facilities in suburbia became the stimulus for the First Presbyterian Church's noteworthy postwar development and offers an insight regarding the substantial collaboration between Reverend Dr. Campbell and Wallace Harrison to create a modern suburban church north of Stamford's downtown district, particularly one that would become a new facility in a recently established neighborhood with no amenities.[61] As Buggeln affirms, "by 1960, it was hard to find a voice in

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[57] "Presbyterians Hear Report on Building Plan," *Stamford Advocate*, 6 May 1952. Discussion continued in the "Selection of Architects" section.
[58] Buggeln, Gretchen. *The Suburban Church: Modernism and Community in Postwar America*. Minneapolis, London: University of Minnesota Press, 2015, 1 – 29.
[59] Ibid.
[60] Ibid.
[61] One amenity that was lacking was a school building, and FPC was constructed on an ideal location for a school. According to Connecticut's State Department of Education publication titled *Public School Building Guide Including Standards for Approval*, 1950 (to which Willis Mills contributed his expertise): "…the use of school buildings has extended to the total community, increased interest in the schoolhouse as a community service center has grown… in general appearance as well as in function the school building should be an asset to the community." The inclusion of a Parish House ("School Building") offered this amenity to a newly developed neighborhood.

[the community] that would advocate for anything but a contemporary approach to church architecture."[62]

Following the discordance of the war, the church sought to be nonpolitical as it shifted its focus to facilities that could offer rituals that "nurtured the forms of community that accompanied suburban growth."[63] With rapid expansion into the suburbs and the development of new automobile-accessible facilities (which offered better program space for education and other programs), FPC was planned accordingly and to principles championed by its own advocate for a contemporary approach to church design. Dr. Elbert Moore Conover, an influential proponent of this type of suburban property, advocated for FPC, just one of the many suburban religious campuses constructed during this postwar ecclesiastical building boom.[64] Since the mid-1920s, Conover had advised churches across the United States and Canada; prior to his death in 1952, Conover served as FPC's specialized church building consultant.[65]

Known among Protestant denominations as an authority on church planning and construction through his writings and consulting work as executive director of the Interdenominational Bureau of Architecture, Conover (1885-1952) was an ordained Methodist minister, who understood that the country was in the midst of a building boom.[66] Thus, he advised clergy and congregation members on practical matters and basic design principles.[67] As art became an integral matter related to the design and as major artists began to create art specifically for churches, Conover encouraged them to acknowledge new sanctuaries as works of art.[68] He

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[62] Buggeln, "The Suburban Church", 1 – 29. This is also as the construction of new modern houses rose in popularity.
[63] Wagner, "This Crushed Lantern", 31-39.
[64] *National Historic Landmark Nomination*. Submitted 22 June 2017
[65] "Church Building Plan Hits Billion." *Los Angeles Times,* 2 February 1950.
[66] Conover's books included: *Building the House of God,* Nashville: Methodist Book Concern*,* 1928; *Building for Worship*, New York: Interdenominational Bureau of Architecture, 1945, 1952; *The Church Building Guide*, New York: Interdenominational Bureau of Architecture*,* 1946; *The Church Builder*, New York: Interdenominational Bureau of Architecture, 1948; and *Church Building Finance*, New York: Interdenominational Bureau of Architecture*,* 1945.
[67] White, James F. "Change in American Church Architecture." *Ecclesiology Today: Journal of the Ecclesiological Society, successor to the Cambridge Camden Society of 1839*, Issue 26, September 2000, page 9: "The Interdenominational Bureau of Architecture was established in 1934 by executives representing 25 Protestant denominations. Its function is to give counsel and guidance to local churches and to promote better church architecture through institutes, conferences and literature. Frequently the Bureau is in a consulting relationship with enterprises whose total current values run into many millions of dollars. The Church Building Committee, composed of denominational executives, meets twice yearly to discuss church building problems and exchange ideas respecting counsel to local churches on church building finance and the guidance needed in advance of planning projects." Conover is the namesake and first recipient posthumously of an AIA award to non-architects influential in creating sacred space. For many years, he was a professor of liturgical theology at Notre Dame University. He spent over 40 years teaching, writing, lecturing, and consulting on church architecture. In his essay, *Change in American Church* Architecture, he writes that his "real mission has been to help congregations think through who they are and what they do when they come together… [his] chief concern has been with how a church works, not with how it looks… [his] approach is liturgics, not aesthetics." White also wrote that Conover may have influenced more church buildings than any other 20th Century figure.
White (1932-2004) himself was the author of 19 books on worship.
[68] Bullock, Alan. *The Norton Dictionary of Modern Thought*. New York and London: W.W. Norton &

viewed the new church, including its sanctuary and support spaces, as an "instrument of evangelism" and he sought to cultivate and stabilize faith in the congregation through worship and education.[69] To achieve this, he urged FPC to depart from its downtown Stamford location and relocate to the Bedford Street site. He advised FPC that it needed sufficient parking and must secure "an adequate plot of ground," as a "church building should be spread out with outside light for all rooms… this requires adequate space."[70]

Conover emphasized the importance of the church's exterior appearance and the impression it would present to both the congregation and Stamford community:

> Church architecture must express religious truth. It must show in its texture the growing life of its time and the lasting details of the past. No one style of architecture is required for an effective exterior design. Great expressions in any style architecture adhere to fundamental principles of design.[71]
>
> Despite attention given unusual and so-called modernistic buildings, churches are going to continue looking like churches for years to come… it must look like a church—whatever the style.[72]

Conover encouraged the Building Committee to become familiar with basic architecture so that participants would be able to "distinguish between passing fads and functionally sound designs that will not become wearisome." For anything beyond basic design, Conover recommended deferring to the architect:

> After the floor plans have been fairly well developed the architect should present exterior sketches, but it remains for the people to reject or adopt the architect's exterior design. If they are intelligent and sincere in their responses and criticisms, they may assist the architect in achieving the design most suitable for their church. However, wise churchmen having engaged the architect to design a church will trust his superior experience and knowledge… Don't tie the architect's hands and stifle his creative ability by telling him before he begins his work that the church must be designed in any certain 'style.' Let him be entirely free in the matter of exterior design until he has offered his

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Company, 1999, 49. In 1935, *L'Art Sacré* magazine was begun in France as a movement for the "renewal of religious art." In America, a publication called *Art in America and Elsewhere* was founded in 1913 and could have influenced architects of the following decades in their artistic decisions; one such decision may have been the selection of a modern form of stained glass and Gabriel Loire.

69 Conover, Elbert Moore, "The Church Builder" New York: Interdenominational Bureau of Architecture, 1948, 19.

70 Ibid. 17.

71 Ibid. 28: "The Church makes one of its most important contributions to the religious and cultural experience of the community through the exterior appearance of the church building…. Church architecture has affected the lives of myriads of people who have never entered the portals of a church. Wholly apart from the activities of the church program, the physical existence of the church structure re-enforces religious life in the community. The church building must be distinctive and easily recognizable as a place of divine worship."

72 "Church Building Plan Hits Billion." *Los Angeles Times,* 2 February 1950.

> proposed solutions for the design problem.[73]

An *Architectural Forum* article reports FPC's congregation as conservative; the church was designed for traditional Presbyterians and the design took advantage of a unique opportunity for expression that was rarely accepted at the time by "proper churchgoers."[74]

Regardless of denomination, at least a quarter of new churches "during the post-war period did not make use of architectural form traditionally associated with ecclesiastic design, but instead were built in a 'modern' idiom," as *Time Magazine* stated in 1955.[75]

A booklet commemorating the successful completion of the new church states that:

> One-third of the churches recently built in America were boldly experimental in design. They seemed to express little continuity with the great traditions of religious feeling coming from the past. Other churches, copying the old forms used for centuries, seemed to reflect little of the feeling of modern man as he strives toward God… [FPC sought to symbolize its faith] not in narrow ecclesiastical cliché inherited from the past, or in equally narrow tentative attempts to make a church look as if it had been made in a factory.[76]

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[73] Conover, "The Church Builder", 33.
[74] "A Piranesi for Today." *Architectural Forum*, December 1953, page 93.
[75] "The New Churches." *Time Magazine*, 19 September 1955.
[76] *The First Presbyterian Church, Stamford, Connecticut*. Wallace K. Harrison Archive, Avery Library, Columbia University, New York.

Selection of Architects

FPC's Building Committee was chaired by local attorney Walter N. Maguire[77] and met for the first time in July of 1952, at which point it defined its initial scope. The Committee agreed that a layout would need to be planned in collaboration with an architect, that construction costs and fundraising specifics would need to be determined, and that the Broad Street property would need to be sold. With recommendations from outside advisors, the Building Committee met over the next two months and engaged Dr. Elbert Moore Conover[78] as a church building consultant.

FPC also had funding estimates prepared for the new church; to build both the Sanctuary and the Parish Unit, it was estimated to cost approximately $1,000,000; according to a booklet prepared five years after completion of the Sanctuary:

> The old site on Broad Street, now a valuable business property, was sold for $605,000. A legacy from a devoted parishioner, the late Mrs. Henry B. Witten, brought the building fund to nearly $900,000. Five hundred families in the church pledged for the building fund more than $430,000.[79]

Considering the previous masonry "Byzantine style sanctuary" design by architect Frederick Rhinelander King, by the end of the summer the Building Committee abandoned his scheme for the new church; one reason given for this was the fact that the early architectural concept did not allow for adequate space. The Building Committee also decided that King's use of stone was too expensive.

Meanwhile, local architects Sherwood, Mills & Smith solicited the Building Committee to consider their firm for architectural services; there is no known direct connection between the firm and Maguire, chair of the Building Committee.[80] The firm lacked prior experience with church

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[77] Walter Maguire first attended First Presbyterian Church as a student at the church school, then as a teacher, scoutmaster, and then an Elder and Trustee. He was a church member for 62 years and was involved with nearly every committee of the Session of the Church. He offered leadership and vision that contributed to the present church buildings. Maguire was an American member of the Advisory Committee of the Council of Europe and a member of the Executive Committee for the National Presbyterian Church and Center of Washington, D.C., and was also one of the youngest students to graduate from Yale Law School; he built one of the most successful law firms of the 1930s in Stamford.

[78] As described in more detail above, Elbert Moore Conover (1885-1952) was a minister who influenced the design of Protestant churches.

[79] "The First Presbyterian Church", *Commemorative Booklet,* FPC Archives, 1958/1959. The booklet also states that the property was sold in 1956 and then dismantled (some elements of the original church were integrated into the new church).

[80] Architects Thorme Sherwood (1910-1994), Willis N. Mills, Sr. (1907-1995), and Lester W. Smith (1909-1993) formed a partnership in 1946 after serving in the military in WWII. Mills had designed and built one of the first Modern-influenced houses in New Canaan, known today as Mills House 1 (1941). Based in Stamford, Sherwood, Mills & Smith became one of the largest firms in the area. The firm, according to an Architects' Roster questionnaire in the AIA archives, "executed important commercial, industrial and residential commissions but has specialized in educational buildings." The same roster also lists Seelye, Stevenson, Value & Knecht as a structural engineering firm often employed; this firm worked on FPC's Parish Unit. Additionally, the roster lists Bryan J. Lynch as the landscape architect typically employed.

design, but was invited to consult on the project in partnership with a more experienced firm to be selected from a list provided by Conover (neither Sherwood, Mills & Smith nor Harrison & Abramovitz were on Conover's list).[81] Mills was retained to design the Parish Unit, which was strategically completed before the Sanctuary so as to allow for the sale of the old church and to offer a site of temporary worship to the congregation. Willis N. Mills was known at the time for his glass-walled schools[82] framing woodland views.[83] The Broad Street site was sold only after this part of the project was constructed.

The Building Committee interviewed architects of traditional and contemporary design approaches, and Conover offered a list to the Building Committee of 15 architectural firms who met his suggested standards for knowledge of church design and construction, and all of which were located within a reasonable distance from Stamford. On September 7, 1952, the Committee selected a firm from his list—the New York architectural firm of Ferrenz & Taylor, whose previous work mainly focused on schools and hospitals[84]—to prepare plans for the new church. They were to prepare two sketches, one of Georgian and the other of contemporary design, at a cost of $2,000. Apparently dissatisfied – for reasons unknown today – with both of Ferrenz & Taylor's sketches, Session decided to investigate other contemporary architects.[85]

Much of the Building Committee and congregation preferred the firm's traditional neo-Georgian plans (the architects may have considered the recently constructed neo-Georgian St. John's Lutheran church only a mile to the north for their design, which also recently relocated from downtown).[86] However, committee members Emma Light and Benton Grant regarded FPC's new church as an opportunity to express a modern style.[87] They convinced the Building

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[81] The research has not been able to date to locate the original list of 15 architecture firms.

[82] On the drawings of the Sanctuary, the Parish Unit is referred to as the "School Building," as all the rooms are designated as classrooms for various grades. Additionally, Willis Mills contributed to the Connecticut State Department of Education's *Public School Building Guide,* published in 1950.

[83] "Speech #1." *Old Symbol, New Shape, Daring Space Construction.* Date and audience Unknown. Deluca Archives.

[84] *American Architects Directory.* (Washington DC: American Institute of Architects, 1962): George Hils Ferrenz (1904-) and William J. Taylor (1912-1992) formed their partnership in 1945 after working in the office of Eggers & Higgins and continuing as chief and assistant architects of the Kellex Corp. for the Manhattan Project, Oak Ridge, Tennessee (1943-1945). Eggers & Higgins carried out the construction phase of the Thomas Jefferson Memorial after John Russell Pope, the original architect, died. Both Eggers and Higgins were associates at Pope's firm, and designed many buildings in the classical style, including churches, and later designed a few buildings in the Brutalist style. Ferrenz & Taylor's primary work focused on schools and hospitals; many of their buildings are brick high-rises throughout New York City. From: "Wins Design Award: New York Architectural Firm Cited in Church Contest." *New York Times,* 24 January 1950: Ferrenz & Taylor had experience with church design; the firm was given an award of the Church Architects Guild of America and the North American Conference of Church Architects for the best design and layout of a small church building in Packanack Lake, NJ in 1950.

[85] *First Presbyterian Church*. First Presbyterian Church Archive, N.D., Document. This information has been reported in FPC's history and is stated in a typed document found in the church's archives, but the research has not found any evidence of any correspondence and/or drawings by Ferrenz & Taylor.

[86] *National Historic Landmark Nomination*, June 22 2017.

[87] Barton, "First Presbyterian Church": Emma Light pressed for a modern architect and she had one ally on the Building Committee, Benton Grant, who saw Alden B. Dow's (apprenticed with Frank Lloyd Wright) modern St. John's Episcopal Church in Midland, Michigan (1949). He was so enthralled with the church that he supported Emma Light in convincing the Committee to consider a modern architect. Grant was

Committee to break from Ferrenz & Taylor's neo-Georgian sketch. The Building Committee sought a firm that had previously designed significant churches, and it proceeded to contact three additional firms that were not on Conover's original list.[88] One of the three was Wallace Harrison of Harrison & Abramovitz, as the Committee believed that he had previous experience with church design, and likely came from a recommendation by Smith and Sherwood of Sherwood, Mills & Smith, who had worked earlier as draftsmen and designers in Harrison's firm.[89] Many years later, Reverend Dr. Campbell recalled that the Building Committee, following Conover's guidance, intended to find what the Committee referred to as a "top drawer architect."[90] In notes from a tape made at the time of the 25th Anniversary Celebration (October 1983), it is suggested that Alden Dow and The New York firm of O'Connor and Kilham (architects of the Princeton Library) were also considered.

In October of 1952, First Presbyterian awarded the contract for the building's Sanctuary, its primary feature, to Wallace Harrison of Harrison & Abramovitz, though the Committee was unaware that Harrison had no prior experience in church design.[91] Willis Mills of the local firm Sherwood, Mills and Smith would design the remainder of the building complex, the Parish Unit, in concert with Harrison's study of the Sanctuary.

Harrison, who valued the new and yet did not reject the old,[92] impressed the congregation and the firm of Sherwood Mills—who had already been retained by the Building Committee—at his

politically very active in Stamford and became a state senator for Connecticut in the 1950s. In notes from a tape made at the time of the 25th Anniversary Celebration (October 1983), it is suggested that Ben Grant talked of first seeing Alden Dow at Higgins Lake – a summer cottage, and discussed with the Building Committee how he happened to become interested in modern architecture. Dow said he would be interested in building a church, which would be related to the landscape and planting, not just an isolated building. He felt what had been lost in traditional churches in this country was this relationship and that "the modern church would relate to the grounds, the landscape, the people, and their needs."

[88] Because Conover had died earlier that year, 1952, the Building Committee would not have been able to consult with him on additional architecture firms; in: Von Eckardt, Wolf. *A Lay Report on Harrison's Stamford Church: The Final Question*. Wallace K. Harrison Archive, Avery Library, Columbia University, New York, 37-38. Russell Davis, a trustee of FPC, said "when our congregation first started talking about a new church back in 1952, most of us had visions of English Gothic. That, we found, would have cost us at least three or four million dollars. So our thoughts shifted to the traditional church architecture you find around here. You know, Colonial. We talked to about fifteen architects, but we weren't satisfied. Then someone suggested we try a modern architect and we decided to approach a really good one. Someone else knew Harrison, so we asked him. We had no idea what would come of it."

[89] It may have been that because one of the partners in the firm of Sherwood, Mills & Smith had a connection to Harrison, the Building Committee decided to reach out to Harrison. Sherwood and Smith were both draftsmen designers for Harrison & Fouilhoux – Sherwood from 1939 to 1942 and Smith from 1934 to 1939; Jacques André Fouilhoux was an engineer and architect from Paris who joined Wallace Harrison after working with Raymond Hood, where he worked on projects such as the American Radiator Building (1924), and then, with Harrison, contributed to the New York World's Fair project (1939). He was one of Harrison & Abramovitz's partners until his death in 1945. See "Fall Kills Fouilhoux, Architect; Designer Fair Trylon Perisphere", *New York Times*, June 21, 1945 and "Designer Chosen for Tower at Fair", *New York Times*, November 25, 1936, where Harrison and Fouilhoux are shown in a photograph signing contract.

[90] Newhouse, Victoria. *Wallace K. Harrison*, *Architect*. New York: Rizzoli, 1989, 167.

[91] Barton, "First Presbyterian Church".

[92] "The First Presbyterian Church", *Commemorative Booklet*, 1958/1959

initial interview meeting, in which Reverend Dr. Campbell later recalled that Harrison:

> expressed his interest in getting to know me and our theology. He wanted to go to Europe to look at churches there. Wally didn't know what he would do, but he was honest about it. He was the only one without preconceived ideas for the project.[93]

Design

Harrison's architectural practice is best known for some of its larger scale commissions, such as Lincoln Center in New York and the Empire State Plaza in Albany as well as his role as executive architect of the United Nations complex. However, Harrison's design ability is best showcased in his smaller achievements, such as his residential designs, which show a "more intriguing, more complex talent."[94] He confessed his fondness for small-scale work; when questioned during his Lincoln Center project if he enjoyed coordinating large projects, he responded:

> I hate it. But I've had to do it because I've had to make a living… I get more fun out of designing a small thing than a big one. Architecture is something small—something you can touch with your fingers.[95]

Meanwhile, Harrison's partner, Max Abramovitz, was designing three chapels at Brandeis University (completed the same year that the Sanctuary was largely designed, in 1955)[96], and Harrison had previously trained with Bertram Goodhue, one of the country's leading church architects;[97] the influence of both architects likely contributed to making the design of a religious building a fascinating challenge for Harrison. At Harrison's initial meeting with Sherwood, Mills & Smith and members of the congregation, Reverend Dr. Campbell recognized Harrison's interest in the project and was especially impressed that he wanted to visit European churches. It was at this meeting that Harrison was retained to design FPC in collaboration with

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[93] Newhouse, "Wallace K. Harrison", 167.
[94] Newhouse, "Wallace K. Harrison", 166.
[95] Dudar, Helen. "The Road to Success, Five Famous Men Take You Along." *New York Post Daily Magazine*, 4 December 1962, 37.
[96] Howe, Jeffery. *Houses of Worship: An Identification Guide to the History and Styles of American Religious Architecture,* San Diego, CA: Thunderbay Press, 2003, 316, 318.
[97] Goodhue was identifying himself as a leader of a new architectural style, as he was "severing his ties to traditionalism." His ecclesiastical and secular projects are better-known than his residential designs. The work he designed over the course of his 33-year career "demonstrates clearly his role in the modern movement." In: Wyllie, Romy. *Bertram Goodhue: His Life and Residential Architecture.* New York: W.W. Norton, 2007. Goodhue's office employed several notable architects before they established their own practices, including Wallace Harrison, Raymond Hood, and Clarence Stein. Some of Goodhue's most significant ecclesiastical buildings include St. Bartholomew's Church in New York City (built from 1916-17), St. Thomas Church in New York City (designed in 1906 and built from 1911 to 1913), and the West Point Cadet Chapel at the United States Military Academy in New York (built in 1910), which was designed as part of the firm Cram, Goodhue & Ferguson.

Mills.[98]

Harrison was presented with a challenge, as the spiritual order of Presbyterianism consists of ministers and ruling elders elected by the congregation, and Presbyterian procedure requires that each member of the congregation must endorse each decision made by a parish, including the design of a church. Walter Maguire, chairman of the Building Committee, was the first person with whom Harrison worked. He was of the mindset that the new church would be designed in the New England colonial style, which was the style recommended by his subcommittee, and Harrison's design departed from this.[99] Ultimately, Harrison proposed plans "based not entirely on contemporary design" and integrated elements of traditional church design.[100]

The architects were selected by October of 1952, and in the last part of the year, Harrison and Mills coordinated the master planning and determined the general repeated elements of the design between the Sanctuary and the Parish Unit, such as the enclosed passageway connecting the two units and the covered corridor, the material language relating to the *dalle de verre*, and repeated form relating to the choir room, Fellowship Hall, and the chapel. Mills and Harrison focused on a cohesive exterior design that would "blend into the overall panoramic picture."[101] Other than these related elements, the two architects agreed that the two structures were to be designed and built as distinct units.

Harrison and Mills also sequenced the construction schedule to allow for the partial use of the Parish Unit and its Fellowship Hall prior to the completion of the Sanctuary; this was arranged so that the congregation could have a space for worship, while the Sanctuary was under construction. By September 9, 1956, Fellowship Hall in the Parish Unit was ready for use, and it served as FPC's house of worship for seventeen months (Appendix 4: Figures 30 and 31).[102]

In 1953, when Harrison presented his initial ideas for the Sanctuary, the congregation voted unanimously to go ahead with the plans with the thought that "it was right that [the] church be expressive of modern times."[103] He worked closely with Reverend Dr. Campbell over the course of the design process, 1953 to 1954, to preserve the traditional symbols within his design of the new Sanctuary. Reverend Dr. Campbell later said:

> Although this is more advanced than any known church of our denomination, the eternal symbols of our spiritual values will be preserved. People will find the communion table, the pulpit and the lectern where they expect to find them. The acoustics and visual qualities of the church will, I am told, be perfect. True, there is a restless element in the congregation disturbed by what they cannot yet see for themselves. We had no

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[98] Newhouse, "Wallace K. Harrison", 167.
[99] Ibid.
[100] "The First Presbyterian Church", *Commemorative Booklet*, 1958/1959.
[101] Ibid.
[102] As previously mentioned, the old church was sold in 1956 for $605,000 (which largely contributed to the funds for the new church).
[103] Von Eckardt, Wolf. *A Lay Report on Harrison's Stamford Church: The Final Question*. Wallace K. Harrison Archive, Avery Library, Columbia University, New York, 37-38.

> point of reference. It is all so new and different. Yet, you know, the same has been the case with every advance in ecclesiastical architecture, even with early Gothic.[104]

Early in the design process Harrison expressed to a *New York Times* reporter in 1954 that:

> The church in Stamford is, I think, the kind of church the old builders would have built if they had had modern materials.[105]

In designing the Sanctuary, Harrison was aware of the architectural opportunities of modern structures and envisioned a structural solution that would allow the interior space to be unencumbered by intrusive structural elements:

> If we had used ordinary methods of building such as steel or concrete beams, these beams would have to be over twenty-eight inches deep and the airy splendor we were trying to achieve would have been lost.[106]

One of the first sketches for FPC shows a masonry vaulted roof, reminiscent of the Gothic groin vault, that seems to soar above a wall of jewels (two-inch-thick vari-colored glass), traced with patterned faceting (Appendix 4: Figure 4). The idea was that at night the jewel would be reversed and it would gleam from the inside out. As reported in an article from *Architectural Forum* (December 1953), the arrangement on the site that was suggested at the time appears to be similar to how it was eventually built—with the Sanctuary at the high point and in the same location, leading to a Parish Unit and auditorium (Fellowship Hall), with parking space on the southern and eastern boundaries. The plan also shows a bell tower design in the same location of the existing Carillon Tower. The plan includes a courtyard between the Sanctuary and the Parish Unit, which appears to be enclosed in this version. The original shape of the chapel seems to have been maintained as well (Appendix 4: Figure 5).[107] The basic plan of the 1953 design was kept in the final (extant) design, as from the beginning. Mills and Harrison agreed on basic repeated elements, including fan-shaped volumes. As executed, the architects carried that same form into the Choir Room, the Chapel and Fellowship Hall.

Reverend Dr. Campbell maintained that it was a time to "let go of old ideas while holding on to eternal truth." Harrison worked for months on the floor plan, collaborating with the congregation to discuss the chancel, choir stalls, organ, space for 800 seats, and the balcony.[108] Harrison reached out to experts from several nations, including Felix J. Samuely of London,[109] England and Gabriel Loire of Chartres, France. Harrison's associate-architect in charge of the

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[104] Anderson, David. "Glass is Stressed in Church Design." *New York Times,* 5 July 1954.
[105] Anderson, David. "Glass is Stressed in Church Design." *New York Times,* 5 July 1954.
[106] "W.K. Harrison's statement for MoMA." 15 February 1959, Wallace K. Harrison Archive, Avery Library, Columbia University, New York.
[107] "A Piranesi for Today." *Architectural Forum*, December 1953, page 93.
[108] Von Eckardt, "A Lay Report on Harrison's Stamford Church", 37-38.
[109] Samuely was the consulting structural engineer who worked with Harrison to evolve the structural design of the Sanctuary; the engineers of record for the Sanctuary were Edwards & Hjorth, a local New York based firm.

day-by-day work was Yen Liang,[110] who had worked with Harrison previously on the United Nations project.

Harrison apparently visited Europe twice to find inspiration for the Sanctuary design, first in early 1953 when he first began drawing plans for the church.[111] Harrison sought to depict everyday life in concrete—a vernacular, cost-efficient contemporary building material. Harrison knew of Felix J. Samuely through the engineer's previous work in England involving precast concrete panels. On Harrison's first visit to Europe during the project, he visited London and met with Samuely to discuss his idea of using precast concrete panels to appear as folded plates in the structure (which Samuely referred to as "space construction").[112]

It does not appear that Harrison and Samuely had previously collaborated, though it is possible that Harrison read one of Samuely's many publications. Journals of the time extensively reported on Samuely's buildings, which has been attributed to his work with architects of the Modern Movement.[113] Samuely published papers himself, and initially his publications focused on technical design and construction issues. Historian David Yeomans writes that Samuely was as interested in "communicating with architects as with fellow engineers." Postwar, Samuely wrote for architectural publications and concentrated on "space construction" and "stressed skin structures; structures that derived their properties from their geometrical forms."[114] Of his relationship with Samuely, Harrison said:

> We didn't have the engineers and I had to get Felix Samuely, a British engineer, who had done two or three of these things in England. He took two trips here and I went over twice on this job.[115]

Another design element that Harrison considered were the acoustics, which were of utmost importance to the congregation. The acoustics needed to be "as near perfect as possible."

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[110] Tafel, Edgar. *Frank Lloyd Wright: Recollections by Those Who Knew Him*. Mineola, NY: Dover Publications, 2001, 127-129. Yen Liang (1908-2008) studied in Beijing and then traveled to the United States in 1928 to study architecture. He finished his undergraduate degree at Yale and subsequently enrolled in the Harvard graduate school, where he read *Frank Lloyd Wright: An Autobiography*. This inspired him to apply to Wright's Taliesin Fellowship; at 23 years old, Liang became Wright's earliest apprentice (and later became a close friend). Liang moved back to China in 1934, where he designed the International Club in Nanking and the Bank of Yunnan Mining Industries, among other projects. Post-war, he returned to Taliesin and then moved to New York City in the 1940s, where he worked for the United Nations Planning Office until 1950. From 1950-1973, he was the chief designer with Harrison & Abramovitz for projects including the United Nations Headquarters in Manhattan. This relationship demonstrates an interesting association between Harrison and Frank Lloyd Wright.

[111] Von Eckardt, "A Lay Report on Harrison's Stamford Church", 39.

[112] "The First Presbyterian Church", *Commemorative Booklet*, 1958/1959, also mentions that Samuely referred to this method as "space construction." Von Eckardt, , "A Lay Report on Harrison's Stamford Church", 37-39, quotes Harrison: "We are only beginning to open up an exciting new world of space construction… of domes and rounded, hyperparaboloid frames to span space."

[113] Yeomans, David. "The work and influence of Felix Samuely in Britain." *Proceedings of the First International Congress on Construction History*. Madrid: Instituto Juan de Herrera, Escuela Técnica Superior de Arquitectura, 2003, 2136.

[114] Ibid.

[115] Von Eckardt, "A Lay Report on Harrison's Stamford Church", page 39.

Harrison hired Bolt, Beranek, and Newman of MIT for the job.[116] They designed the acoustics in a way that avoided any obstructions to the smooth flow of sound; in this process, they repeatedly re-modified until they determined the final shape—an elongated megaphone that could project sound to the rear of the Sanctuary. In the *Journal of the AIA,* Von Eckardt quotes Harrison:

> The acoustical people I brought in, Bolt, Beranek and Newman of M.I.T., didn't want any obstructions to the smooth flow of sound. A square arrangement wouldn't do. We had to modify and remodify… Finally we arrived at the shape of an elongated megaphone to spread the sound toward the rear. That determined the shape. The fish symbolism was discovered much later…[117]

It appears that Harrison's consultation with Bolt, Beranek, and Newman occurred prior to developing the design for the Sanctuary, rather than waiting for recommendation regarding the acoustics after the space had already been designed.[118] The NHL nomination goes on to state

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[116] Leo Leroy Beranek (1914-2016) was a sought-after acoustics genius, according to the *New York Times*, and an engineer whose company designed the acoustics for the United Nations and concert hall at Lincoln Center. Dr. Beranek was a National Medal of Science recipient who was a founder of the Cambridge-based acoustics consulting firm Bolt Beranek and Newman. In: Rifkin, Glenn. "Leo Beranek, Acoustics Designer and Internet Pioneer, Dies at 102." *New York Times,* October 2016.
National Historic Landmark Nomination, June 22 2017, states: "The firm was at the leading edge of the new field of acoustical engineering that emerged in response to the unconventional volumes made possible with new construction materials. The firm was most frequently retained in their early projects to redress problems resulting from unusual shapes and surfaces. For example, in Eero Saarinen's Kresge Auditorium, there was a problem of modulating over-amplification from the stage, which was not conducive to large orchestral performances. Kresge's problem may have provided the empirical solution for First Presbyterian's volume, which adapted the fan-shaped, megaphone massing to amplify the spoken word and organ from the chancel. Harrison's consultation with the firm prior to developing the plan was a departure from the firm's usual experience. It was a pragmatic commitment on Harrison's part for the Sanctuary's form to follow its function. The acoustical consultants revisited the Sanctuary upon its completion. They found the sound projected well when the pews were full, but recommended additional deflecting above the pulpit to eliminate excess reverberation when the space was partially empty. Harrison followed up by designing a marble sounding board in the shape of an open Bible above the pulpit to correct the problem (the open Bible was to remind the preacher that he is always under the Bible and not preaching his own word). Use of the sounding board over the pulpit is an old tradition and found frequently over pulpits in the 17th and 18th centuries." Bolt, Beranek & Newman recommended the "use of a pulpit canopy to provide additional 'close-in' reflections reinforcing the minister's voice and indicated the size and orientation that would be desirable. The architects, using [Bolt, Beranek & Newman's] recommendations, made a canopy having symbolic as well as acoustical significance—it represents an open bible." In: Klepper, David L. "First Presbyterian Church, Stamford, Connecticut." *Journal of the Acoustical Society of America*, Vol. 31, No. 7, July 1959.

[117] Von Eckhardt, "A Lay Report on Harrison's Stamford Church", 39, writes that the "result is phenomenal. There is no loudspeaker system and the minister, speaking in a normal voice, can be heard clearly anywhere in the church."

[118] *National Historic Landmark Nomination*, June 22 2017, reports that this was a "departure from the firm's usual experience," and cites "Leo Beranek: An Interview Conducted by Michael Geselowitz" IEEE History Center, 30 August 2005, Interview #454 for the IEEE History Center, The Institute of Electrical and Electronics Engineers, Inc.: "Often, after the architect has conceived something unique and impressive, he engages an acoustical consultant with the statement 'Can you add some things to the design to give it great acoustics?' But there is one acoustical principle that is inviolate: Every hall that

that it was a "pragmatic commitment on Harrison's part for the Sanctuary's form to follow its function."[119] In a *Journal of the Acoustical Society of America* article by David L. Klepper of Bolt, Beranek, and Newman's firm, the author writes that the church is:

> Unusual in that the basic architectural shape provides the desired acoustical environment, requiring no "applied" sound-absorbing material.[120]

Klepper defines the collaboration between architects and acoustical consultants as fitting into four general approaches; he claims that FPC falls into the fourth category, which includes:

> Projects where the architect chooses an idealized acoustical shape of the building, or one in which the basic design possesses no inherent acoustical problems and is a definite contribution to good hearing conditions… it is under this rare purely "creative" category that [FPC] seems to fall.[121]

In 1953, Harrison produced his first design for the Sanctuary that was published in *Architectural Forum*, in which his central idea was a megaphonic-massed crystalline interior immersed in colorful glass, which is an idea that seems to have been inspired by viewing the extensive and impressive use of windows in Saint-Chapelle in Paris, which he visited on his earlier trip to Europe. Harrison's study presented a steel framed skylight massed with slanting, folded prismatic planes resting upon rubble stone faced walls (Appendix 4: Figure 6). A dramatic interior rendering by Hugh Ferriss[122] illustrates an axial-planned nave with curved Gothic vaults and massive colored glass walls of windows (Appendix 4: Figure 4). Reverend Dr. Campbell said Harrison's first sketch was:

> Startlingly beautiful: it was made entirely of glass and steel in the shape of a modified megaphone [for acoustical purposes]; [Harrison] knew it wasn't practical, but he wanted

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looks different sounds different. If you make a violin square or triangular it won't sound like a Stradivarius." The nomination continues: "After the firm revisited the Sanctuary upon its completion, they found "the sound projected well when the pews were full, but recommended additional deflecting above the pulpit to eliminate excess reverberation when the space was partially empty. Harrison followed up by designing a marble sounding board in the shape of an open Bible above the pulpit to correct the problem." Clergy later found that the pulpit was restrictive and later removed it." Klepper's journal article also references the pulpit canopy, which "provides additional 'close-in' reflections reinforcing the direct voice of the minister. It symbolizes an open bible."

[119] Ibid.

[120] Klepper, David L. "First Presbyterian Church, Stamford, Connecticut." *Journal of the Acoustical Society of America,* 31, 7(July 1959) 879.

[121] Ibid.

[122] Hugh Ferriss (1889-1962) was an architect and American delineator. When he first arrived in New York City in 1912, he was employed as a delineator for Cass Gilbert. He created renderings for the Woolworth Building and the Daily News Building in New York City, in addition to buildings in cities across the country, such as Detroit, Michigan, and Chicago. He is known for a certain style that showcases buildings at night and for experimenting with shadows cast upon the buildings to emphasize their monumentality. He published his most recognized book, *The Metropolis of Tomorrow,* in 1929. In: Marter, Joan M. *The Grove Encyclopedia of American Art.* Oxford: Oxford UP, 2011, Volume 1, 141

> to show the possibilities of what might be accomplished.[123]

To keep within budget ($800,000), Harrison worked on reducing the building's size by adjusting its massing, restructuring with thinner precast panels rather than steel, and replacing plate glass with *dalle de verre*.[124] This was in following with Conover's advice; where in *The Church Builder,* he wrote:

> The effectiveness of the exterior design does not depend upon the size or cost of a building. Let the size of the building be decreased rather than accept shoddy materials or defects in design.[125]

After revising plans and gaining support from every member of the congregation, Harrison's design was approved, even by Maguire, who had preferred a more conservative design approach. Harrison met with Reverend Dr. Campbell every month for the first two years of preliminary design (the end of 1952 through 1954). In the subsequent three years, while final design decisions were made and carried out, architect Yen Liang assisted Harrison.[126] Several design changes occurred throughout the construction process, and it is not entirely clear who made the decisions. However, it is likely that Liang, as the onsite architect, contributed to changes such as the design of the passageway connecting the Sanctuary to the Parish Unit—which was designed with inclined walls (this design would have been consistent with the Sanctuary's inclined walls)— and other modifications that are not shown on the original architectural drawings, such as the orientation of cabinets in the choir room.[127] Additionally, the sculpture of Christ in Profile surrounding the Sanctuary's narthex entrance was originally a more simple design (as seen in an *Architectural Record* article from November 1957; Appendix 4: Figure 7).[128]

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[123] Newhouse, "Wallace K. Harrison", 167.

[124] Harrison was asked to revise the design in the early design stages, but ultimately the alternate drawing (AA-1) compromised the design. The alternate drawing shows reduced *dalle de verre* panels and a cement exterior rather than slate. According to the Specifications for the First Presbyterian Church of Stamford, prepared by Harrison's office, the glass was originally to be plate glass as manufactured by the Pittsburgh Plate Glass Company and obscure glass (Factrolite ¼" thick) as manufactured by the Mississippi Glass Company. FPC Archives.

[125] Conover, *The Church Builder*, 33.

[126] Yen Liang was the chief designer with Harrison & Abramovitz for projects including the United Nations Headquarters in Manhattan. See note 96 for more detail on Liang.

[127] The original drawings for the sanctuary show slanted glass walls for the covered passageway connecting the Sanctuary with the Parish Unit. While this more complex construction may have been rejected for cost, the more likely assumption is that the design was changed to resemble and integrate better with the Parish Unit, which was built first. Similarly, the window wall of the choir room and the corridor along the north wall showed windows divided by muntins and mullions in many smaller units in the design drawings. The executed design resembles closely the corridors of the Parish Unit.

[128] "Precast Sections Form Monolithic Concrete 'Whale'." Technical Roundup. *Architectural Record,* November 1957, page 221: this article offers a rendering of the Sanctuary as designed in 1957, and it indicates that the design of the entryway to the Sanctuary was changed sometime in the final year of construction. The rendering does not include the Christ on the Cross sculpture that was built. It is unknown who proposed this idea and when exactly (after November 1957) this was added to the design. The sculpture is referred to as "Christ in Profile" (Barton, "First Presbyterian Church") or the "Writhing

After a preliminary review by the congregation in July 1954 of Harrison's revised plans—which addressed theological concerns and reduced the cost without departing from the initial scope, in addition to preserving the traditional symbols within his design of the new Sanctuary—there was strong support for the Sanctuary concept.[129] The proposal included Samuely's initial structural plans for the Sanctuary, and at this time the Sanctuary design attained the general form in which it would eventually be constructed.

Although some members were displeased with having to vote upon "nebulous phrases" such as "final preliminary design" and "minimum concept," at this time the congregation authorized Harrison to proceed with preparing construction drawings for the Sanctuary (without the Carillon Tower) within a budget of $1,250,000.[130] It was also agreed that improvements, modifications, and changes could still be made, though supporters for the church found the sketches to show "the most beautiful church this country has ever known."[131] At this meeting, Mills' plans for the Parish Unit were unanimously approved.

The congregation contributed many elements of international origin to the Sanctuary, including the wood for the cross; Reverend Dr. Stewart transported the material back from England, and it was eventually used for the crosses in the Sanctuary and in the chapel (the cross is made of one-inch lumber beams).[132] A FPC commemorative booklet indicates that the chapel cross is faced with wood from the bombed-out library of Canterbury Cathedral.[133] Reverend Dr. Stewart also collected the ancient millstone (a symbol of bread) that is imbedded in the floor before the communion table, in addition to the five millstones set into the walks of the church.[134]

While Harrison was responsible for the Sanctuary design, Mills worked out the plans for the Parish Unit (referred to as the "church plant")[135] including the chapel, Fellowship Hall, and education space (originally 15 classrooms). Mills designed the Parish Unit as a low fieldstone and glass structure, framing the Sanctuary to its east. A two story (one story as viewed from the front) elongated structure, covering 30,000 square feet of floor space. The Parish Unit stretches from the wood and glass connector (walkway) of the Sanctuary, wraps around the central open Cloister, and culminates at Fellowship Hall. Mills' design included offices and

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Christ" (FPC's docent notes, October 2016). *Architectural Forum* 108, 4(April 1958), 104-107 states that it is a "modern version of the portal sculpture seen on Gothic cathedrals."

129 Anderson, David. "'Modern' Church Due in Stamford." *New York Times,* 7 July 1954.

130 *National Historic Landmark Nomination.* June 22 2017.

131 Anderson, David. "'Modern' Church Due in Stamford." *New York Times,* 7 July 1954.

132 Additionally, from Barton, "First Presbyterian Church": the "32 foot high cross [is] made of 1 inch lumber from the beams of the library of Canterbury Cathedral in England, damaged by bombing in WWII." The 40th anniversary write-up continues that this is attached to a steel I-beam and the cross was a gift from Pastor Charles Stewart.

133 Ibid.

134 Price, Jo-Ann. "Stamford Presbyterians to Dedicate Their Fish-Shaped Church Tomorrow." *New York Herald Tribune,* 7 March 1958.

135 Von Eckardt, "A Lay Report on Harrison's Stamford Church", page 39. Additionally, the Specifications for the FPC of Stamford clearly indicate that the Sanctuary and the "School Building" (Parish Unit) were executed completely separately and under two distinct contracts. This can be seen on the original drawings, where items are marked N.I.C. (Not in Contract).

classrooms, a recreation room, and nursery rooms.

By the beginning of 1955, Mills had developed architectural drawings of these spaces, including a corridor with embedded glass medallions, which were removed from the windows of the old sanctuary (there were a total of 18 in the old sanctuary, according to Barton's write-up for the 40th anniversary of the Sanctuary). These symbolic medallions portray imagery such as the eagle, human face, lion, and oxen mentioned in the book of the Revelation.[136] Mills later developed plans for a potential expansion of the Parish Unit, which were not executed.[137]

For the chapel, Mills integrated into the design a window of creation; shaped as a long triangle, the window occupies the entire slanted ceiling along the wall behind the altar, flooding the chapel with color. This window was designed by Matthew Wysocki.[138] The chapel originally contained a small organ with organ pit, which was filled in at some point. Additionally, the chapel wall facing the corridor would be a "wall of faith":

> Studded with 112 stones gathered during World War Two by a former pastor, Dr. George Stewart, from the world's historic centers of Christian faith. The stones are arranged in chronological order, beginning with one each from Bethlehem and Jerusalem representing the life on earth of Christ. Then come blocks from places St. Paul visited on missionary journeys, followed by items from Italy and North Africa. The reformation is represented by stones from Germany, Holland, France, Britain, and Switzerland.[139]

For Fellowship Hall, Mills incorporated:

> A wall of clear glass, almost three stories high… inset with panels of rose, amber, and turquoise glass. It has been likened to a Mondrian painting. It is shaped, as is the narthex of the Sanctuary, like a fan. The weight of the fan-shaped structure is supported by buttresses hidden in the wings, and by a steel column… visible in the center of the great glass wall. The steel beams that support the roof are exposed. They show inside the building as three sets of triangles that meet at the ridge pole, forming the Gothic symbol of hands touching in prayer.[140]

Fellowship Hall was designed with excellent acoustics and a stage. In the structure's wings,

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[136] Barton, "First Presbyterian Church".

[137] In an April 12, 1965 letter (presumably to Wallace Harrison), Maguire stated that a reason the Carillon Tower was moved from a location east of the Parish Unit to its current location is that it would "release all of the church property to the east for future development without any obstacle to hamper this expansion. Having the area free will permit the Parish House to expand to the east and possibly even to the north in the event that facilities become inadequate. There is a good possibility that this expansion will be needed within the next two or three years. Mr. Mills has worked out some plans for expansion in that direction." FPC Archives

[138] The design and *dalle de verre* of this window is discussed further below under *dalle de verre*.

[139] *Historic Relics from Many Lands in New Stamford Church*. Davis, 4-9522. First Presbyterian Church Archive. Marked "M&LB".

[140] First Presbyterian Church, *Commemorative Booklet*, 1958/1959

Mills included a cloakroom, a storage room, a large kitchen and serving space. Built to accommodate between 300 and 400 people, Fellowship Hall is generally used for public events such as lectures, public performances, and meetings.

Mills worked with structural engineering firm Seelye, Stevenson, Value & Knecht on the Parish Unit (the star-beam diagrid ceiling is particularly noteworthy),[141] while Felix Samuely, along with New York based structural engineers Edwards & Hjorth, focused on the Sanctuary.[142] Samuely created detailed instructions for the precast panels in the form of several drawings that detailed the coordinates of setting out points—which was the system he designed for the construction company to use in its installation of each of the panels—totaling over 80 final drawings. Samuely also drew force diagrams for the framework, plans and elevations, and details of each panel, and local firm Edwards & Hjorth reviewed these drawings.

Bryan J. Lynch, the landscape architect, produced drawings for the new church site in 1955.[143] Lynch's design was modest and conservative; it incorporated much of the site's existing natural topography and some pre-existing flora. He proposed minor terracing between the buildings—it does not appear that terracing was executed, but instead slight regrading was carried out to create a flat open space in front of the Parish Unit (to the east of the Sanctuary)—and introduced vehicular drives that followed the site's natural contours, in addition to minimal regrading in the gently sloping area behind the buildings for parking. He designed the setting to project a natural, pastoral public image as viewed from Bedford Street, utilizing both the existing grade and the new buildings to screen the parking lot areas from view. The property was given minimal landscape treatment at the time of construction.[144]

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[141] Seelye, Stevenson, Value & Knecht was founded in New York City in 1912 and is known for unusual and high profile projects including the parachute jump at the 1939 World's Fair, NASA's Vehicle Assembly Building at the Kennedy Space Center in Florida (1966, the tallest single story building in the world), and the FermiLab Wilson Hall at the Enrico Fermi National Accelerator Laboratory in Batavia, Illinois (1974). In: Highland Green Foundation's e-mail response to the Getty Foundation's Follow-Up Questions, 16 May 2016.

[142] Edwards & Hjorth worked with the firm Harrison & Abramovitz on several other projects across the United States, including the Borden Building in Columbus, Ohio (built by 1974 and is, as of 2016, the Columbus' ninth tallest skyscraper), the United Nations Headquarters in New York City (built in 1948-52), and the Continental Can Company Building (now referred to by its address, 633 Third Avenue) in New York City (built in 1959-61). Edwards & Hjorth are listed by Harrison & Abramovitz's as the firm's consulting structural engineers, along with Seelye, Stevenson, Value & Knecht. *Questionnaire for Architects' Roster*, October 15, 1947, American Institute of Architects Archives, Washington DC.

[143] Bryan J. Lynch (1907-1986) designed for the Rockefeller family – one project was a vista of the Ottauquechee River as indicated in the Cultural Landscape Report for the Mansion Grounds at the Marsh-Billings-Rockefeller National Historic Park and another project was the Wethersfield House Museum in Amenia, NY. "The Rockefeller Legacy." Woodstock History Center. Accessed October 16, 2017. https://www.woodstockhistorycenter.org/the-rockefeller-legacy

[144] Early images show minimal landscaping and not much more than foundation plantings. According to maintenance reports, during the first several years a substantial number of evergreen trees and shrubs were planted as memorial gifts by church members. An example of this activity was the planting of 13 "Christmas" trees along the Bedford Street side of the Sanctuary lawn. Winthrop P. Moore wrote that "this has served as an admirable sound barrier and provides a welcome wind break for those using the walk to the choir area. It enhances the privacy of an area of heavy vehicle and pedestrian traffic." In: Winthrop Moore's maintenance notes, *Introduction and Background* (n.d.): "…shortly after completion

Nearly two decades after the Sanctuary was constructed, Wallace Harrison designed a church gate to complement the existing landscape. Sketches that date to November of 1979, including elevations and floorplans, indicate that Harrison considered several different schemes. Schemes 1 through 4 show a triangular structure that mimics the shape of the Sanctuary (Appendix 4: Figure 40). This would have been approximately 20' wide and situated along Bedford Street. Scheme 5 (Appendix 4: Figure 41) shows a rectilinear structure with a sign that reads:

> First Presbyterian Church
> Stamford, Connecticut
> All Are Welcome

Scheme 6 also shows a rectilinear structure, though this design features what seems to be an additional removable sign with which the congregation would be able to feature events, such as Sunday Service (Appendix 4: Figure 42). Schemes 5 and 6 incorporate wood beam elements.

It also appears that Harrison explored designs for a larger sign, in addition to a gate. None of these designs (from 1979) were executed.

Precast Concrete Construction

The precast concrete was an identifying characteristic of FPC's design from early in the design stage.

> Medieval church craft and modern structure are daringly joined in this Presbyterian church which was precast and put together like a giant puzzle.[145]

For the Sanctuary, Harrison sought a solution that would eliminate the need for columns and buttresses found in traditional cathedrals, and therefore chose precast concrete as the construction system.[146] While precast concrete panels had been previously utilized for both

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of the Sanctuary, construction of the Bank and one story retail stores along our south border were undertaken… we permitted [the owner] to construct and use a parking lot extending about 60' into our lawn area from the rear of his bank building. This created an unsightly view from our sanctuary and lawn areas… Walter N. Maguire provided a generous money bequest with which to start a planting of screening evergreen trees and we arranged for other tree donations, making it possible to screen our entire south boundary."

145 *Architectural Forum* 108, 4(April 1958), 104-107 describes FPC as a "brilliant canopy for worship" and "strangely provocative." A *dalle de verre* precast panel is featured on the cover, with additional photos of FPC by renowned architectural photographer Ezra Stoller.

146 In earlier concepts for FPC, Harrison experimented with stone columns, beams, and flying buttresses before taking a trip to Europe at which time he made the realization that "we have lost the fundamental effect of architecture on the pupil of the eye which the Egyptians mastered." He wanted a structure "as clear and honest as Gothic" in which he could carry the stained-glass high without supports. He is quoted in Von Eckardt, "I was intrigued with folded concrete. It would span the space without supports. At that time nothing of the kind had been done in this country…" In: Von Eckardt, "A Lay Report on

residential and industrial buildings, the material had not yet been applied to large church construction. In the United States, concrete had also not been used as an exposed interior finish in an ecclesiastical setting, despite exhibiting a long pattern of use in European church design since 1921, as it was deemed suitable for a Gothic like expression.[147] Precast concrete was not common in Europe for non-utilitarian structures until postwar circumstances made prefabrication economical and precast concrete found wide application particularly in residential construction.[148]

Harrison wanted to use precast concrete for several reasons, one being that it was a material he recognized as an economical choice from his past experience. At least a decade prior to securing the First Presbyterian commission (1939), he was an associate professor of architecture at Yale and planned the Yale-*Life* Conference on pre-fabrication in residential construction.[149] The conference presented new materials—including precast concrete—that could potentially support the demand for low-cost housing in American and Latin American cities.[150] Harrison observed methods of pouring concrete roadbeds in Venezuela and believed

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Harrison's Stamford Church", page 39.

[147] The use of concrete at Notre Dame du Raincy (1922-23) outside Paris "… signalized a radical break with all preceding ecclesiastic building… architect Auguste Perret (1874-1954) was primarily responsible for establishing contemporary church architecture…" In: Smith, G. E. Kidder. *The New Churches of Europe*. New York: Holt, Rinehart and Winston, 1963, p. 9

[148] *National Historic Landmark Nomination,* June 22 2017, states that the earliest known use of concrete as an implied folded plate is thought to have been Eugène Freyssinet's cast-in-place, barrel vaulted dirigible hangar at Orly Airport in Paris (1921).

[149] At the Yale-*Life* Conference, over 200 architects, engineers, and scientists met to discuss the problem of the "prevailing conservative attitude toward housebuilding techniques," according to C.L.V. Meeks in the *Bulletin of the Associates in Fine Arts at Yale University* (June 1939). 26.The conference questioned whether new methods and materials of fabrication could be better for housing. Paul Cret, Walter Gropius, R.H. Shreve and Antonin Raymond participated in the opening meeting. An exhibition included a full-size section of a prefabricated house, a room heated by radiant panels, and a sheet of flexible glass; Yale's architecture students created most of the installation work.

[150] *National Historic Landmark Nomination,* June 22 2017, notes that during the war, Harrison also assumed directorship of the Office of Inter-American Affairs, part of FDR's broader Good Neighbor policy to promote American culture in Latin America to prevent an alliance with the axis powers.
Grosvenor Atterbury (1869-1956) was one of the most instrumental architects, town planners, and inventors of the first part of the twentieth century. He "embodied the progressive spirit that began to permeate the American psyche after the Civil War" and pursued new technology to introduce well-designed, low cost, prefabricated concrete construction to the working-class. In: Pennoyer, Peter, and Anne Walker. *The Architecture of Grosvenor Atterbury*. New York: W.W. Norton, 2009. p. 38

While some of Atterbury's early work focused on weekend homes for wealthy industrialists, he was given the commission for Forest Hills Gardens, a model housing community, in 1909 under the Russell Sage Foundation. He invented an innovative construction method that consisted of each house being constructed from around 170 standardized precast concrete panels, fabricated off-site and assembled by crane. The complex system involved moving the panels to the site in only two operations—formwork to truck and truck to crane. In: Gray, Christopher. "Designing for High and Low." *New York Times*, 24 October 2009.

Atterbury established the Precast Building Section, Inc. along with Alfred Rheinstein, who had been the chairman of the City Housing Authority (1937-39) and focused on low cost housing and slum clearance. Rheinstein founded a construction company in 1925 (Rheinstein Construction). The PBSI company was the technology to have further potential. After the war, he experimented with precast concrete panels by designing and constructing cost-efficient housing at his own home in Long Island.[151] The housing was built to Federal Housing Administration (FHA) standards and could be built within 24 hours by utilizing the technology already available in Latin America.

Harrison discovered that he needed to find a lighter precast system than the panels used for the low-cost housing to construct a Sanctuary of larger volume.[152] Thus, he looked to Europe for ideas, where post-war material deficiencies and unfortunate economic circumstances provoked the need for innovations in thin shell concrete construction. Harrison said:

> …I wanted a structure as clear and honest as Gothic. I groped and fussed a year or two. But I don't think, right off, you should ever know too clearly where you are going… I was intrigued with folded concrete. It would span the space without supports. At that time nothing of the kind had been done in this country.[153]

Samuely was a pioneer in "skin structures" and he was the first engineer to introduce "folded plate roofs" to small-scale commercial and institutional buildings in England, where he opened the space below without columns or other supports.[154] In his projects for schools and college campuses, particularly the jobs between 1945 and 1952, he developed the use of precast concrete and "folded plate construction" and sometimes joined the two methods. His work in Britain stretched from immediately before World War II and immediately after the war. He practiced across Europe – first in Germany, then briefly in Russia, followed by moving to Britain (where he settled in 1933). He was one of the most influential engineers in Britain, where:

> Development of structural forms as a means of architectural expression… was encouraged firstly by engineers who worked for architects of the Modern Movement in the inter-war period and then by the need for innovative structural design to deal with the shortages in the period of post-war reconstructions.[155]

When he first arrived in Britain, he worked with Ove Arup at Kiers, where they both utilized an atypical form of structure—reinforced concrete, which had been used as a type of substitute for steel, "simply as a series of repeated frames on a regular grid."[156] Until then, the alternative was the use of flat-slab construction, which the United States had introduced to Britain.

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dissolved by the 1960s, when Rheinstein rejected a license for the Schokbeton system. A few PBSI employees, including Donald Rothenhaus (who managed PBSI in 1952; he managed the concrete prefabrication at FPC), left PBSI and established Eastern Schokbeton in 1960 with a Schokbeton license. From Presentation for the Docomomo National Symposium, Minnesota, June 2015, http://www.docomomo-us-mn.org/uploads/5/1/7/7/51772709/session_9-concrete___schokbeton.pdf, accessed October 2017

151 Von Eckardt, "A Lay Report on Harrison's Stamford Church", 39.

152 *National Historic Landmark Nomination,* June 22 2017

153 Von Eckhardt, "A Lay Report on Harrison's Stamford Church", 39.

154 Samuely, Felix J. "Skin Structures and Shell Roofs." *Architectural Design*, September 1952, pages 242-56.

155 Yeomans, "The work and influence of Felix Samuely in Britain.", 2128.

156 Ibid, 2131.

Samuely, along with Arup:[157]

> Used reinforced concrete… to treat the external wall frames as primary structural elements with the floor slab spanning across the building to a spine beam (rather like medieval timber-frame construction). Apart from eliminating the regular frames of columns and beams across the building, this arrangement allowed greater flexibility in the placing of columns because there was no necessity for those supporting the spine beam to respond to those on the external walls… they could be wherever was convenient for the plan.[158]

He used this method for several structural layouts, including Gilbey's offices in Camden Town, London, and for the concrete framing of Whittingham College for Pilichowski, and for a small block of flats in Golders Green by Pilichowski, where the structure was compared to a fish skeleton by *Architectural Review* in 1935.[159]

Samuely was one of the first to expand "space-frame" construction—as he referred to it, thin shell plates and vaults reinforced by triangular or square grids—beyond industrial buildings.[160] In response to a lack of construction materials (such as timber),[161] Samuely's cost-effective method combined precast panels with cast-in-place reinforcement; subsequently, Harrison used this method at FPC, where he and Samuely carried these structural concepts further, by inwardly inclining the precast panels, in folded forms, to strengthen the shell. The folds were described as "kite-shaped projecting bays" by a *New York Times* journalist in 1954.[162] Of the FPC project, Samuely wrote that:

> Whereas normal skin structures are used for roofs alone, in this instance the walls have also been included, resulting from the use of the crystalline shape of the surface.[163]

Throughout his career, Samuely collaborated with architects and prior to FPC had previously proposed the use of "folded plate roofs" for structures such as schools and colleges. The buildings frequently relied upon precast concrete as the underlying formwork, and the final structures were composites of precast and poured-in-place concrete. Samuely's track record

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[157] Arup was the engineer for the Sydney Opera House, an "astonishing architectural – and engineering – feat," according to the Arup website. The structure was designed by architect Jørn Utzon in a prominent location on Sydney Harbor. The design process began in the 1950s and Ove Arup was involved early on in the design. His engineers created a complex design for a performing arts center of large precast concrete panel "shells." The panels are supported by precast concrete ribs. "Arup." Designing Sydney Opera House - Arup. Accessed October 2016. https://www.arup.com/projects/sydney-opera-house
[158] Yeomans, "The work and influence of Felix Samuely in Britain.", 2132.
[159] Ibid.
[160] Samuely, Felix J. "Space Frame Defined." *Architectural Forum*, 98, 2(February 1953) 152-53; Eero Saarinen's American Embassy in London (1957-1960), one of the earliest applications in a federal building, was built after First Presbyterian. Roman, Antonio, *Eero Saarinen: An Architecture of Multiplicity*, New York, NY: Princeton Architectural Press, 2003, 192 -197.
[161] Yeomans, "The work and influence of Felix Samuely in Britain.", 2133.
[162] Anderson, David. "Glass is Stressed in Church Design." *New York Times,* 5 July 1954
[163] Felix Samuely, "First Presbyterian Church, Stamford Connecticut: Description of Structure." Wallace Harrison Collection, Avery Library.

indicates that this type of working collaboration was standard throughout his career; this is evidenced through his commentary about being "surprised to be asked to work on something that had already been designed," when he explained the structural design of the Skylon, a feature of the 1951 Festival of Britain.[164] Even so, he altered the Skylon's design based on a structural analysis that he had conducted of the planned structure.

When he returned from his trip to Europe and his meeting with Samuely, Harrison had samples of full-size precast panels delivered to his home in Huntington, Long Island.[165] There, he conducted tests to determine the structurally allowable tilts and load-bearing capacity of the precast concrete panels. These studies, along with Samuely's conviction that the precast system would work for FPC, underscored Harrison's confidence in his inventive Sanctuary design.

The method of thin shell construction was also used by other architects of the time, for example Eero Saarinen at the American Embassy in London (completed in 1960),[166] since a new system of high quality precast created in the 1930s allowed for these shells. The so-called Schokbeton production system, a Dutch method licensed to several companies in the United States, was the result of a global need for economic building materials; for concrete, cement was the priciest component.[167]

The Schokbeton production system produced high quality precast concrete panels of exceptional strength and dimensional accuracy. The story is that concrete worker G. Lieve discovered this method involving shocked concrete through moving a wheelbarrow of concrete along wood scaffolding and observed the consequences this had on the concrete.[168] This shaking or shocking resulted in a product that was considerably denser and stronger than regular concrete. The technique also allowed for using less cement with water controlling shrinkage and reducing dimensional tolerances. According to a Docomomo US presentation on concrete and Schokbeton,[169] use of the method has declined for at least two reasons: the first would be a loss of craftsmen that are able to produce custom form work, and the second would be the cost of labor and the fact that high density concrete can be created more efficiently

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164 "Joints Between Precast Panels Frame Church." *Construction Methods and Equipment*. April 1958, accessed at Wallace K. Harrison Archive, Avery Library, Columbia University, New York.
165 It is unknown how Harrison obtained the full-size precast panels.
166 "U.S. Embassy, London, England (UK)." U.S. Embassy, London, England (UK) | Docomomo US. <http://www.docomomo-us.org/register/fiche/us_embassy_london_england_uk> and Roman, Antonio, *Eero Saarinen: An Architecture of Multiplicity*, New York, NY: Princeton Architectural Press, 2003, 192 - 197.
167 The name Schokbeton, translated 'shocked concrete' referred to a method of compacting by placing the concrete forms on a shock table.
168 It took a few years to test water-to-cement ratios, the construction of molds, and calibrated shocking (vibration) of the cement during placement. Additionally, Berger indicates that it is "important to note… the use of glass-making equipment in place of typical equipment for manufacturing concrete to afford a more precise and higher quality product." Berger, Allee, *On the Preservation of Principles: Determining the Adequacy of Historic Preservation Theories, Charters and Guidelines for the Philadelphia Police Headquarters*, Master Thesis, University of Pennsylvania, 2013, 75 – 80.
169 Normandin, Kyle, Lucas van Zuijlen, and Jack Pyburn. "Concrete and Schokbeton." Modernism on The Prairie, 2015 Docomomo US National Symposium, Minnesota, 4 June 2015.

using different methods and products.

Precast concrete was a popular product at the time and, for instance, Marcel Breuer said in the 1960s that:

> The use of precast concrete is the most important change in the art of building since World War II. You can sculpt concrete; you can mold it; you can chisel it… it increases the vocabulary of architectural expression.[170]

This precast technology was essential to mid-century architectural design. Harrison worked with Samuely to innovatively use what was to emerge later as a system similar to the Schokbeton system, using Incor high early strength concrete, and the result was an integration of wall and roof, where the building is constructed as a single structural unit, "the shape of which defines the interior space. None of the inside walls stands at a right-angle to the ground: everything leans." [171] The system allowed for "assembly-line precision in casting… faster form re-use, maximum production with minimum form investment." [172]

DeLuca Construction[173] was awarded the contract for FPC in March of 1955 (the construction documents for the Sanctuary and Parish Unit were issued to ten firms for bid in March),[174] after Samuely's firm developed initial structural drawings for the Sanctuary. DeLuca worked on the coordination of PBSI's manufacturing of the precast panels, and initially was unsure how to estimate the bid. Patrick DeLuca said:

> In estimating… we were given six weeks to prepare our bid—while the plans were in the office… I didn't know how to start myself—of the six weeks allotted to us—I might say that for about 4 ½ weeks I just walked around the estimating table… I couldn't get a price on precast panels in the very beginning—so I estimated each and every panel. I had the concrete—the forms—the finish all taken off—then came the pricing…[175]

Harrison and Samuely worked with DeLuca and Precast Building Section, Inc. (PBSI)[176] to

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[170] Ibid.
[171] Wagner, "This Crushed Lantern", 31-39.
[172] "Space enclosed 'archi-structurally' makes this new church stand alone." Lone Star Cement Corporation. (Advertisement) Wallace Harrison Collection, Avery Library, Columbia University,
[173] From: "Patrick A. Deluca, Stamford Leader." *New York Times,* 23 January 1972. Patrick DeLuca was the president of DeLuca construction (founded 1936). He received a degree in civil engineering in 1921 from Princeton. Also, the Specifications for the FPC of Stamford indicate that DeLuca's scope of work included the Sanctuary, the one-story wing (with Choir Room, Sacristy, toilets, and utility space), "outside development of grounds within the contract," and general construction work that excluded, specifically, the organ, wood benches, coat room equipment, and any items marked N.I.C. (not in contract) on the drawing. In "Speech #2" it is indicated that Patrick DeLuca was a "very dear friend" of Reverend Donald Campbell. DeLuca Archives.
[174] Besides DeLuca, other firms that seem to have been interested in the FPC project were Geo. Fuller Co., Turner Construction, and Wm. Crow and two to three additional Stamford-based firms. In: "Speech #2." DeLuca Archives.
[175] "Speech #2." DeLuca Archives
[176] Alfred Rheinstein was one of the owners of PBSI and had hired Patrick DeLuca as an estimator when

produce all the panels. The company formed all but six of the panels individually.[177] From start to finish, PBSI manufactured the solid precast panels on Long Island, trucked them to Stamford, hoisted them in place, tilted, and then fitted and shored them with traditional wood scaffolding that was set up in the space of the nave (152 panels in total, some weighing 11 tons and towering 3.5 stories);[178] as the triangular precast panels were placed, the exposed reinforcing bars at their edges were bound to the adjacent panels to form rigid connections and further reinforced with rebars to create beam like configuration. Then concrete was poured into the seams to bring rigidity to the entire structure and 'set' the anchoring (with the exception of the precast ribs, the Sanctuary wall is never more than eight inches thick).[179] It has been said that upon the removal of the scaffolding from the complex interior construction, one of the workers on the Sanctuary exclaimed, "Magnifico!"[180]

The process of creating the precast panels started with laying out the basic precast shapes on a plywood bed. The forms were constructed to precise measurements, and the lens openings in the perforated triangular sections were formed with aluminum castings. The reinforcing members were carefully positioned and the poured concrete was vibrated to reach maximum density.[181]

A groundbreaking ceremony was held for the Sanctuary on November 24, 1955, with the recently constructed Fellowship Hall's steel star beam frame serving as the background (Appendix 4: Figure 8).[182] A year later (November of 1956), PBSI delivered the first four precast concrete panels to the site in Stamford (Appendix 4: Figure 36). The precast panels needed to be in place so that the *dalle de verre* panels could be accurately templated. The

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he graduated from Princeton (Rheinstein was a Princeton alumnus himself). Rheinstein knew about Schokbeton and PBSI was one of the first license holders of the system. At a meeting at FPC on November 7, 2016, the significance of the site was discussed and Patrick DeLuca's son was in attendance, at which time he shared this information. DeLuca asked Alfred Rheinstein of "Pre-Cast Products" for assistance with the bid and he had "told [DeLuca] he had been asked by Geo. Fuller Co. [and] hadn't given much thought to it, but if [DeLuca] were really serious he would quote [DeLuca] a price." In: "Speech #2." DeLuca Archives.

[177] There is no evidence that the panels were created using the licensed Schokbeton system, since PBSI did not hold a license for the technique. Though Donald Rothenhaus, who managed the project, had great familiarity with the Schokbeton system.

[178] "Joints Between Precast Panels Frame Church." *Construction Methods and Equipment*. April 1958, Wallace K. Harrison Archive, Avery Library, Columbia University, New York.

[179] Wagner, "This Crushed Lantern", pages 31-39; in a Lone Star Cement advertisement, it is stated that the "eight-inch band of concrete connects the panels, resulting in a monolithic structure of great strength and rigidity."

[180] Von Eckardt, "A Lay Report on Harrison's Stamford Church", pages 37-38.

[181] This method may be of the Schokbeton system, but the company did not hold a license for Schokbeton despite the project leader's close familiarity with the system. Allee Berger, *On the preservation of principles: determining the adequacy of historic preservation theories, charters, and guidelines for the Philadelphia Police Headquarters* (Philadelphia, PA: University of Pennsylvania, 2013), 78-79.

[182] According to notes from a tape made at the 25th Anniversary Celebration (October 1983), the initial ground-breaking and dedication ceremony of the entire site was preceded by a march of the congregation from the old church to the new property in 1953.

panels were completely in place by the beginning of 1957.

The cornerstone laying took place on November 25, 1957, exactly a year following the initial delivery of precast concrete. Since the *dalle de verre* panels were the items with the longest lead time, the *New York Times* reported that at this point the building neared completion:

> …but the cornerstone laying was delayed until the former church structure at 90 Broad Street was razed. The stone to be placed in the new church is the original from the old church.[183]

The granite cornerstone was cut in Scotland, brought to Stamford by Alexander Milne (who initiated the creation of a Presbyterian church in Stamford) when he emigrated in 1832, and placed in the Broad Street church in 1883. The construction dates of the new FPC complex were added to the inscriptions on the stone. The same article states that Fellowship Hall had been in use as a place of worship for the last year during construction of the Sanctuary and that the Sanctuary would open early in the following year.[184]

FPC was dedicated on March 9, 1958, upon completion of the Sanctuary (Appendix 4: Figures 37 and 39). Reverend Dr. Eugene Carson Blake, who at the time was the chief administrative officer of the Presbyterian Church in the United States, delivered the dedicatory sermon (Dr. Blake also spoke a decade later at the dedication of the Carillon Tower). The *New York Times* described the completed church as a "radical departure from conventional church architecture."[185] *The Hartford Courant* reported that more than 2,000 people attended the dedicatory services, in which Reverend Dr. Blake related the "spectacular edifice" to a unique time of the "mid-20th Century, which some dare call the beginning of the 'Post-Christian' Era."[186] The same article describes the Sanctuary as a "revolutionary concept of modern church architecture." Former pastor of the church Dr. George Stewart preached the sermon that concluded the dedication.

Dalle de Verre

Still an experimental technique in the US at the time of construction, the *dalle de verre* was the

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183 "Office Structure Set." *New York Times*, 17 October 1956: a new office building was to replace the former FPC at Broad and Summer Streets after the church moved to its new location.
184 "Stamford Church to Lay Cornerstone." *New York Times*, 24 November 1957. The old church was not demolished until Fellowship Hall was ready as a temporary worship space, additionally the sale of the church was necessary to pay for construction of the new church.
185 "Church is Built in Shape of Fish." *New York Times*, 8 March 1958.
186 "2,000 Attend Dedication of Stamford Church." *The Hartford Courant*, 10 March 1958; the Post-Christian Era mentioned in the above article refers to a shift in perspective from Christianity to secularism or nationalism. In: Jenkins, Philip. *The Next Christendom: The Coming of Global Christianity.* Oxford University Press, 2011.

last detail to be worked out for the Sanctuary. *Dalle de verre*, meaning "slab of glass," is the technique of laying thick slabs of colored glass in a structural matrix to form some modern versions of stained glass windows, oftentimes in three-dimensional constructions and using either resin or concrete.[187] The nature of *dalle de verre* seems to be suited best for abstract designs, since the material does not allow for fine detailing.[188] As opposed to traditional stained glass, the *dalles* are typically set in a concrete or epoxy matrix (the original *dalles* at FPC are set in a concrete matrix and the replacements are set in an epoxy matrix). *Dalle de verre* can be defined by the type of glass used for this purpose: cast glass slabs that typically exceed half an inch in thickness.[189] This type of glass treatment is also known as faceted glass, which refers to the effect that is created when small pieces of mostly the interior faces have been chiseled or chipped to produce a sparkling, jewel-like appearance.[190] As viewed from the interior, the *dalles* are usually more exceptional than their exterior appearance would indicate, since they glow as light is diffused through the slabs. They produce an effect called "halation," which refers to the spreading of light beyond the glass.[191]

The method of laying chunks of clear or colored glass within panels of cutwork stone or cast concrete was revived in the 1920s (in art salons in Paris) and, at the same time, was introduced in liturgical settings while reconstructing war-damaged cemetery chapels in France.[192] *Dalle de verre* became largely more accepted post World War II while replacing and rebuilding damaged houses of worship and public buildings in Europe, in addition to new facilities in North Africa and Latin America for French missionary religious orders (in what are now former European colonies). Then, as Modernism and the International Style became increasingly popular, attention focused on the relationship between glass and architecture and the desire for some form of monumentality, therefore permanently linking *dalle de verre* with modern architecture in the United States.[193]

In the beginning of 1956, Harrison made his second trip to Europe during the FPC project; this time, he went to view the recently installed *dalle de verre* designed by his friend, artist Fernand

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[187] Bray, Charles. *Dictionary of Glass.* Philadelphia: University of Pennsylvania Press, 1995, 86
[188] Joost, April Jannine. *Towards the Conservation of Faceted Glass.* Master Thesis, Columbia University, May 2000. Joost also writes that the artist "should take advantage of the thick line of concrete/epoxy and use the negative space as part of the art. In a newsletter from 1995 it was strongly suggested that one '… use epoxy as a design element.' Not only was the concrete/epoxy line important to use from an artistic stance, it was also important from a practical standpoint. The obvious point was that the concrete/epoxy was the source of strength and stability for these windows. This binding material was what held the glass together."
[189] Bubnash, Lacey. *Dalle de Verre / Faceted Glass: New Approaches to a Modern Material*. Master Thesis, Columbia University, May 2008, 1.
[190] Ibid.
[191] Ibid. Bubnash also writes that halation is typically an undesired effect in photography (or other film) because it obscures details, but it creates an "intense brightness in a space lit with sunlight through slab glass." In her thesis, April Joost cites Richard Millard: "slab glass halates more than antique glass and absorbs visually some of the epoxy."
[192] *National Historic Landmark Nomination*, June 22 2017, notes that Chapelle Saint-Aignan, Cimetière de Grivesnes (1929), reconstructed by architect Louis Duthoit (1868-1931), is the earliest documented use of *dalle de verre* in a liturgical setting. The geometric glass was designed and made by Atelier Gaudin the same year Gaudin re-introduced the form in a Paris salon exhibition of his first *dalle de verre* composition, *Afrique*.
[193] Bubnash, *Dalle de Verre / Faceted Glass,* 16.

Léger (1881-1955), in the church at Sacré-Coeur at Audincourt. Harrison and Léger had worked together at the United Nations and other projects and Harrison collected Léger's artwork. It seems that Léger had suggested to Harrison that *dalle de verre* (and Gabriel Loire) would offer an economical solution that achieved the interior aesthetic impact sought for the Sanctuary.[194] At the time, Harrison already knew he wanted to use colored glass, though he had not settled on *dalle de verre*. This can be seen from his early designs of both the Sanctuary and the Carillon Tower (Appendix 4: Figure 9).

During his trip, Harrison wanted to see examples of Gabriel Loire's abstract stained glass designs. He and Loire discussed the project in person, for which Harrison sought inspiration for the colored glass to create a visual impression of being inside a sapphire (as he later referred to the Sanctuary) and allude to a Gothic sensibility. Of merging this type of art with his work of architecture, Harrison said:

> But when you've plodded through it all methodically from the beginning—the human needs, the floor plan, the economics, the structure—you still must get an emotional reaction. The answer is to merge art and architecture. At Stamford we did it by bringing in color and the stained glass design. I would have liked to get sculpture, too. I don't mean going out to buy it, but sculpture which grows out of the architecture. The future belongs to the integration of architecture, painting, sculpture and landscaping—to what has been called 'total architecture'.[195]

Of finding inspiration in Europe, Harrison said:

> I went to Europe to get away from this thing and perhaps find an inspiration. In Paris I saw two things: Léger's stained glass windows and the Sainte Chappelle (sic)... [where] I thought: We could carry the stained glass even higher… I wanted to follow Fernand Leger's concept of contrast: round against flats, contrast in colors. I wanted the narthex dark, the nave light, and the chancel dim again because I wanted to make light and color an integral part of the structure. We have lost the fundamental effect of architecture on the pupil of the eye…[196]

Approximately two years before this trip, around 1954, Léger told Harrison about Gabriel Loire (1904-1996), a major figure in the adaptation and international diffusion of the glazing systems in the postwar era; Léger and Loire had collaborated at Audincourt. At the time, American stained glass companies did not have the expertise required to manufacture the thick *dalle de verre* and the panels, though many started to create the panels using European-produced glass with ready-mix concrete.[197]

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[194] It would appear that the suggestion had been made earlier given that Léger had died in 1955 before Harrison made his second trip.

[195] Von Eckhardt, "A Lay Report on Harrison's Stamford Church", page 40.

[196] Von Eckhardt, "A Lay Report on Harrison's Stamford Church", page 39.

[197] Van Den Heuvel, D, M. Mesman and W. Quist. *Challenge of Change: Dealing with the Legacy of the Modern Movement*. IOS Press, 2008, 357: The chapter on *dalle de verre* mentions that in the late 1950s, there were already reports of cracked panels and water infiltration related to faceted glass

Loire worked in Chartres with techniques based on early Christian art and was one of the forerunners of *dalle de verre* in the 1930s, at which time he worked in Charles Lorin's studio; he then became one of its leading global practitioners in the 1950s and 1960s.[198] He initially learned about stained glass, its design, and fabrication from Georges Merklen, the master glass-painter of Angers, who discovered Loire after he had climbed scaffolding around a 12th century window of St. Catherine of Alexandria in the Cathedral of St. Maurice, Angers.[199] He worked with Charles Lorin (1866-1940) and learned the techniques of traditional medieval stained glass. Loire soon discovered that *dalle de verre* could be the ideal material to produce a contemporary stained glass that would carry the traditions of the middle ages regarding light and color, and because of the association between *dalles* set in concrete its relation to contemporary architecture. Reinforced concrete had already been introduced to church construction; for example, Auguste Perret's Notre-Dame de Raincy (1922-23), a reinforced concrete structure in which the walls were completely opened by *claustra* of stained glass, which is antique glass set in lead (with abstract designs surrounding larger figurative bays).

Loire designed windows twice using *dalles* for the Lorin Studio in 1935. However, in 1936 he left the Lorin Studio, but not before signing an agreement that he would not design any stained glass for a decade, as this would have been competition for Lorin.[200] During those ten years, he worked mainly as a church interior designer creating religious spaces and designing religious works such as furniture, decoration, painting, and sculpture.[201] In 1953, he participated in an exhibition of French stained glass and religious artistic objects, which was presented in New Orleans, New York, Chicago, and Montreal.

In 1946, once his ten-year ban on designing stained glass passed, Loire established the Loire Studio, through which he would come to work on First Presbyterian Church. His studio grew lucrative over the next half century, as there was much work to be done after the war, including the reconstruction and repair of hundreds of Europe's destroyed and damaged churches in addition to the construction of many new churches in France.[202]

Charles and Joan Pratt write that a main reason for Loire's success was his use of faceted *dalle*. *Dalle* set in concrete (or later in epoxy resin) corresponded with contemporary architecture, which was often reinforced concrete. Its strength allowed for its structural use, which meant that entire walls could be opened, and its characteristics when chipped, or faceted, contributed

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installations in Europe and in the United States. In the 1960s, American studios, who were new to slab glass and concrete, began to experiment to address the "assumed root of the failures: the difference in thermal expansion and contraction between the glass and the concrete. They attempted solutions such as setting the *dalles* in a "concrete-latex mixture, installing an intermediate layer of latex or sealant between the glass and the concrete, and placing an outer layer of epoxy over the concrete. The most promising lead came in a formulation of newly available epoxy resin by Robert Benes specifically for *dalle de verre* that appeared to eliminate the cracking and thermal expansion problems."

[198] Pratt, Charles W., and Joan C. Pratt. *Gabriel Loire: Les Vitraux / Stained Glass*. Translated by Annie Loire. Chartres: Centre International Du Vitrail, 1996, 21. Much of the information in this section is based on Pratt's text, where indicated.

[199] Ibid. 24.

[200] Ibid. 31.

[201] Ibid. 220.

[202] Ibid, 35.

to its beauty.[203] While the material was suited well for modern construction, Loire felt that the *dalle* technique allowed him to also continue the medieval glass tradition he had experienced for twenty years in Chartres. For Loire, *dalle de verre* also allowed him to clearly transform his conception into completed work, without room for misinterpretation:

> When I made a figure, I could employ three or four very similar tones of glass… which gave already an impression of relief, replacing the grisaille of glass-painting. I liked this work, this craft in which, between me who composed the color sketch and made the cartoon, and the executant, there was no place for trickery.[204]

As the Pratts described it, this level of precision permitted Loire to trust the workers at his studio with the execution of the windows, though under his general supervision. Leaded glass would not have allowed for this, as the process requires additional steps and direct supervision, mainly of the painting. Loire's studio was one of the few experts in *dalle de verre* that was also equipped to complete larger scale projects in the material.[205] Another reason for Loire's rapid success was the "quality of his work, its rhythms, its colors, its expressive readability when figurative, its accessibility and emotional force when abstract."[206]

Willis Mills visited Atelier Loire outside Chartres in August 1954 to discuss the project, in which he was responsible for designing the Parish Unit, including a small chapel with smaller-scale *dalle de verre* (Appendix 4: Figure 29). By the time of Mills' visit, Loire had finished large-scale commissions in Notre Dame de Lourdes in Santiago, Chile (1948) and Notre Dame de Consolation in Hyères, France (1952-53). Mills and Loire discussed details including cost. Fabricating the glazed panels would cost $504,000 and crating, shipping and insuring would cost $90,000.[207]

They agreed that Mills and Harrison would test the process and quality of the glass in the chapel. From Loire's receipt of Mills' drawing of the window in September 1955 to its installation in April 1956, the chapel skylight took seven months to execute (the window was designed by New Haven artist Matthew Wysocki).[208] The chapel window:

> … is shaped like a long, low triangle, occupies the whole wall behind the altar and floods the chapel with wondrous color… the abstract design of jeweled shapes and glowing colors is laid out to suggest the wonders of creation. Five symbols can be recognized: the hands of God, the plants that grow, a flying bird, the stars of the heavens, and the crown of Christ's sacrifice for mankind on earth. Above a golden semicircle can be seen

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203 Ibid, 38.
204 Ibid, 39.
205 Ibid.
206 Ibid, 47.
207 As quoted in the *National Historic Landmark Nomination*, June 22 2017, referencing: G. Loire to W. Mills, carbon typescript, proposal, February 7, 1955 [Atelier Loire archives, Fr.].
208 "Speech #2." Likely delivered to the American Institute of Architects, 24 March 1959. Deluca Archives; Matthew Wysocki (1920-1971) was an artist and photographer who served as chairman of Dartmouth College's visual studies department and artist-in-residence program. He lived in New Haven, CT.

six white points, outlined by a border of sapphire and deep blue…[209]

The process for creating the chapel skylight included Loire generating maquettes (small scale preliminary models. See figure 44) for Mills' approval, the DeLuca construction company shipping plywood templates made in-situ to France, and Loire fabricating and shipping the cast panels by sea to New York.[210] This process would be the same for the *dalle de verre* in the chapel and for the *dalle de verre* in the Sanctuary. The *dalle de verre* in the chapel was not directly exposed to the environment but has been covered from the beginning by a translucent roofing material (Corrulux), and a protective material is still there today.

On May 22, 1956, Loire officially accepted the work as outlined by Harrison. Harrison, pleased with the method and the results, mailed the contract for the Sanctuary windows to Loire on May 31, 1956, aiming for installation in March 1957, nearly a year later, representing the design element that carried the longest lead-time and highest cost. Harrison sent Loire his designs for the north and south elevations and left the design of the narthex to Loire. In July of 1956, Loire sent color sketches for Harrison to approve and return before the work could start. The windows were to be installed by an American subcontractor retained by Loire (though it seems that DeLuca Construction was ultimately responsible for installing the glass); the collaboration between DeLuca and Loire for the Sanctuary would be the same process as executed in the chapel. According to Charles Pratt, union rules required that all the imported Loire glass in the United States must be installed by local workers, rather than representatives of the studio in Lèves, as was done in Europe.[211]

Harrison worked with Reverend Dr. Campbell to select themes and color palettes for the three large areas of the stained glass in the Sanctuary—the North, South, and East facades. Harrison and Reverend Dr. Campbell left Loire to design the narthex glass in its entirety, from selecting the theme and colors to execution. The production process involved Harrison drawing detailed *claustra* grillwork of the facades and sketching ideas for representational suggestions and abstract patterns; he sent these to Loire (see figures 45 and 46 for the maquettes), who provided 20,000 one-inch-thick chunks of amber, emerald, ruby, amethyst, and sapphire glass (86 different hues) that were embedded in matrices of concrete per the design specifications.[212]

Harrison and Reverend Dr. Campbell chose the Crucifixion as the theme for the Sanctuary's north wall and the Resurrection for the south wall, and Loire chose the theme of Christ's teachings to mankind for the rear wall of the narthex. According to a commemorative booklet prepared by FPC, the design on the north wall of the nave suggests the moving story of the Crucifixion, and it is not pictured literally and realistically as in a painting or as in more traditional stained glass windows, but is depicted more conceptually and only certain symbolic

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[209] First Presbyterian Church, *Commemorative Booklet*, 1958/1959

[210] It is unknown what the preliminary models illustrated, though this step is listed as part of the process as referenced in *National Historic Landmark Nomination*. June 22 2017: W. Mills to G. Loire, typescript, corrections to maquettes, October 3, 1954; W. Mills to G. Loire to DeLuca Construction, carbon typescript acknowledging payment, [Atelier Loire archives, Leves, Fr.]

[211] Pratt, *Gabriel Loire: Les Vitraux / Stained Glass* , 91. DeLuca Construction appears to have carried out the installation, as is stated in the original Specifications for FPC's Sanctuary. FPC Archives

[212] *First Presbyterian Church: Celebrating Our First 150 Years in Stamford*. Pamphlet. FPC Archive.

elements of the scene are directly recognizable.[213]

When the panels arrived from France containing *dalle de verre* embedded in concrete, the panels were placed in the openings left in the precast concrete panels and were supported on the reveals that had been created in the precast for that purpose. It appears that DeLuca Construction performed the installation by following a system established by Samuely and Harrison:

> The placing of the glass in the openings left out in the panels – this was done by working to pattern laid out by the architects – given to Pre Cast to work from – and then numbered etc. were sent to France for the glass panels. The laying of the glass panels was not a very difficult job – we worked from schedule and then caulked Thiokol thru. The glass panels on the roof slabs were protected with an additional plexi glass placed over same and wire mesh under… we were very careful to brace each and every panel – primarily against strong winds – since they had to remain without any concrete fillers for many days.[214]

FPC was Loire's second commission in the North Americas (the first was a window in Montréal), and the project was the first introduction of *dalle de verre* to the United States.[215] Logistically and technically, the FPC was his studio's largest and most challenging to date. The design was mainly worked out through the mail and marked a turning point for Loire. His work became more abstract in composition, as marked in his international projects such as the Kaiser Wilhelm Memorial Church in Berlin (1960), the Symphony Tower of Joy for Children in Hakone, Japan (1973-76), and Philip Johnson's Thanksgiving Chapel in Dallas (1976). Loire produced *dalle de verre* for other modern constructions, including the chapel for the Freres des Ecoles Chrétiennes in France and the new church of Notre-Dame of Lourdes in Casablanca.[216] In all of these buildings, the *dalle de verre* glass is an integrated element of the architecture.

The extensive publicity surrounding the Sanctuary's construction earned Loire subsequent commissions throughout the United States. Moreover, American studios began to embrace the *dalle de verre* technique.[217]

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[213] First Presbyterian Church, *Commemorative Booklet*, 1958/1959

[214] "Speech #2." Likely delivered to the American Institute of Architects, 24 March 1959. Deluca Archives. The Specifications for FPC indicate that the contractor (DeLuca) was expected to install the glass and concrete panels in the precast units of the structure.

[215] Bubnash, *Dalle de Verre / Faceted Glass,* 21. The use of *dalle de verre* is associated with modern architecture in the United States, and "most stained glass artists place its peak of popularity sometime in the early-to-mid 1970s…" Also: "the 'golden age' of *dalle de verre* design and production in the United States and Canada was from 1955 to 1975." In: Bubnash, Lacey, who cites Paul Pickel, Personal notes prepared for Art Institute of Chicago tour, December 2006.

[216] Pratt, *Gabriel Loire: Les Vitraux / Stained Glass* , 82.

[217] Pratt, *Gabriel Loire: Les Vitraux / Stained Glass* , 82: Today, over 400 churches and secular buildings in France, in addition to over 300 in the United States and elsewhere, showcase Loire's windows, both in *dalle de verre* and in traditional leaded glass. By 1960, Loire windows were installed in more than 50 buildings across the United States—along both coasts and the Midwest; this growth overlapped with the surge of church construction in the country.

Harrison came to be regarded as a liaison between the world of high art and that of a new form of monumental urban architecture;[218] he began FPC with an interest in Gothic space as a prototype for the integration of the arts, with the intention of creating:

> A place of worship with some of the splendor of colored light found in the great Gothic cathedrals.[219]

Harrison was fascinated with the visual possibilities of the material and sought to experiment with it further; in 1964, he presented the material in the Hall of Science at the World's Fair in New York.[220] In fact, Harrison and Loire almost worked together on this commission—Loire traveled to New York to sign the contract for the Hall of Science, but due to last-minute complaints the commission was given instead the American firm Willet Studios (as previously mentioned, apparently union rules required that all imported Loire glass must be installed by local workers).[221]

Carillon Tower

Not until a decade after the new FPC was constructed did Harrison develop his final design for the Carillon Tower.[222] After a preliminary review in July 1954 of Harrison's designs for the Sanctuary and Tower, there was strong support by the congregation for the Sanctuary concept, but not for Harrison's Tower design, which was the result of a rushed proposal that he was reluctant to complete.[223] The rejected design showed a faceted form of a solid steel frame with

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[218] Wagner, "This Crushed Lantern", 37.

[219] "W.K. Harrison's statement for MoMA." 15 February 1959, Wallace K. Harrison Archive, Avery Library, Columbia University, New York.

[220] It does not appear that Harrison used *dalle de verre* for any project beyond First Presbyterian Church and the New York Hall of Science.

[221] Pratt, *Gabriel Loire: Les Vitraux / Stained Glass* , 91. From the footnote in Pratt's book: "The incident illustrated the strength of Loire's example as well as of his competition: 'The influence of French studios on American architects and stained glass makers is apparent through a comparison of the window-walls by Gabriel Loire in the Kaiser Wilhelm Church in Berlin with those for the Hall of Science at the New York World's Fair of 1964, made by the Willet Studio.'" In: Helene Weis, "Faceted Glass and the French Connection," *Stained Glass,* Winter, 1994, 284.

[222] From Starmer, W. W. "Carillons." *Proceedings of the Musical Association,* vol. 31, 1904: *Carillon* is a French word that might derive from *quadrilionem,* a medieval Latin word for quaternary (carillons were initially sounded on four bells). The definition of a carillon is "a series of bells so hung and arranged as to be capable of being played by machinery or by means of a keyboard as a musical instrument." From *Musical News*, vol. 28, January 1905

[223] Anderson, David. "'Modern' Church Due in Stamford." *New York Times,* 7 July 1954: Anderson wrote that "Strangely enough, the small group of church members, less than 10 percent of the full congregation, asked no questions about the sanctuary of their new place of worship, although, according to the Rev. Donald Campbell, the minister, it will be unlike that of any other of the denomination. They were content to accept the modern approach of reinforced concrete lacery blocked with colored glass. The matter of a tower was different. After some disquiet had been voiced over the design submitted by Wallace K. Harrison, John Bainbridge caused a stir when he said: 'this is a radical departure from the broad, strong concept first submitted… the letter of the building committee explaining it has left me cold.'"

According to notes from a tape made at the time of the 25th Anniversary Celebration (October 1983), Bainbridge was on the Building Committee and a Stamford attorney who had a house in New Canaan folded glass planes located in the present location of the Carillon Tower (Appendix 3 Figure 5). The original scheme—rejected for its design (it was not a matter of finances)—was provisionally omitted until a better proposal came about a decade later.[224] Of the vetoed plans, Harrison said:

> I was asked to make a tower for around $75,000 to $100,000 and stick it on the church. I had seventy-two hours for the job. It was unstudied, entirely unrelated to the building and absolutely not what we want. We haven't any idea on the tower. For heaven's sake don't have the congregation pass anything that would freeze us.[225]

In 1966, a Carillon Committee was formed and Walter Maguire, the Committee's chair, offered a large gift to fund the construction of the Tower (and to ensure its perpetual care), which was part of the original program of the new church. Maguire died in 1967, a year before construction of the Tower was complete, and the Tower was named in his honor.[226] Maguire had sent Harrison a published photograph of sculptor Richard Lippold's work called *Primordial Figure* (1948, made of brass and copper wire), with a message that the sculpture might be inspiration for the tower design; Harrison may have incorporated the lines of the sculpture into his final design for the Tower, as they can be seen in the teak beams (Appendix 4: Figure 10).[227]

Over the course of a year, Harrison worked out details such as the spiral stairs, which include 16 treads to a circle and are made of precast concrete. While the original drawing indicates a stone wall and wood gate at the base, these details were not actually built.

DeLuca began construction of the Carillon Tower in the summer of 1967 on the massive foundations; the 30-foot tall, 18,000-pound stainless steel spire with five-foot cross was installed atop the Tower by helicopter (Aerial images of the site before the construction of the Tower and after construction can be seen in Appendix 4: Figures 27 and 28).[228]

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which had been designed by Abramovitz, Harrison's partner. Here it is suggested that it is through this connection that FPC approached Harrison, who told Abramovitz that he wanted to design a church.

[224] Once the Sanctuary was designed, it was structurally impossible to build the Tower upon the church. Harrison created several rejected designs for the Tower; in one scenario, Harrison placed the Tower to the east of the Parish Unit, but it was decided to build the Tower closer to its originally designed location. An *Architectural Forum* article, titled "Eleven US Churches", from December 1953 shows a steel and glass tower (with reinforced concrete frame) positioned where the current Tower is located.

[225] Ibid.

[226] From: *Service of Dedication: Maguire Memorial Carillon Tower, First Presbyterian Church. Stamford, CT*. 16 June 1968. The program notes that prior to his death in 1967 Walter Maguire chaired the Carillon Committee (formed in 1966) and that he "long felt keenly about the Church's obligation to house the Nestlé carillon which had to be dismantled when the old church was razed in 1956. Drawing upon a background of good business judgement, deep appreciation of music, excellent aesthetic tastes and religious conviction, he directed the Carillon Committee in its work and its regular consultation with the architect, Mr. Wallace K. Harrison, of Harrison & Abramovitz."

[227] Maguire's note with images of Lippold's sculpture is in FPC's archives. The images show Lippold's sculpture in the Whitney Museum of American Art in New York. Maguire's message reads: "The attached suggests lines that might be incorporated into the tower design. WNM"

[228] "Music Spire Is Finished By Copter." *The Hartford Courant,* 20 December 1967. The installation was described as a "delicate, precision-planned hovering maneuver by the helicopter" and "bolting the steel

The Tower was dedicated on June 16, 1968, and Dr. Eugene Carson Blake—general secretary of the World Council of Churches—along with Andre Muller—general manager of the Nestlé Alimentana Co.—spoke, and the program concluded with a 30-minute carillon concert.[229] Others in attendance included Reverend Dr. Campbell and his predecessor, Reverend Dr. George Stewart.

Structural engineers Ammann & Whitney, best known for pioneering bridge design, worked on the Tower with Harrison (the firm was also part of Harrison's team at Lincoln Center).[230] Unlike the original proposal, the new scheme was well-received by the Committee, reflecting the thrusting spires of European Gothic cathedrals and simultaneously "complementing the soaring lines of the adjoining Sanctuary."[231]

The reinforced concrete Tower reaches 260 feet from its 550-ton concrete base; the structure also has heavy Burmese teak wood beams and louvres (which, according to a 1976-77 report by Winthrop P. Moore, should not ever have to be painted: "teak wood work should require <u>no</u> painting, ever").[232] All exposed metal work was galvanized and painted. The base platform, with its paving stones and inscribed tablets, is of a monolithic piece of reinforced concrete. The platform is not connected to the Tower legs nor to the two paved sidewalks giving access, allowing the platform, the legs, and walks to move independently.[233] The Carillon Tower design incorporated openings in the floor of the first (lower) belfry to permit fastenings and operation of hoists and scaffolding for maintenance work, as the floors and roof of the belfries are subject to severe weathering.[234]

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section to the lofty shaft took about one hour to complete… Installation of the carillon bells and other work will not be completed until next spring, when both tower and carillon will be formally dedicated."

[229] "Impressive Carillon to be Heard." *The Hartford Courant*, 15 June 1968.

[230] Ammann & Whitney (founded in 1946 by Othmar Ammann and Charles Whitney) designed in New York City the George Washington Bridge, Williamsburg Bridge, Triborough Bridge, and Verrazano-Narrows Bridge, in addition to bridges throughout the United States and abroad. The firm worked on buildings requiring large spans such as Dulles International Airport, TWA Terminal at JFK International Airport, and the Metropolitan Opera House. According to Billington, David P. *The Tower and the Bridge: The New Art of Structural Engineering.* New Jersey: Princeton University Press, 1983, 21-22: Ammann was known for designing in steel (such as the George Washington Bridge, which was his first completed design, and Verrazano-Narrows Bridge) and is a prime example of a "structural artist."

[231] *Service of Dedication: Maguire Memorial Carillon Tower, First Presbyterian Church. Stamford, CT*. 16 June 1968. Program.

[232] Winthrop P. Moore Maintenance Notes 06/1979: "…the reason why teak is an almost imperishable wood. Grown in the Malay Peninsula (Burma), teak wood is permeated clear through with an oil (sap). This oil impregnates the wood making it waterproof. Since it can't absorb water, it is virtually rot proof. Furthermore, the oil does not evaporate from heat of sun nor from the drying of wind. Hence, it is not as subject to weathering as are most woods." The same report states that the original design called for Philippine Mahogany and would have required three to four initial coats of highest grade spar varnish and subsequent annual varnish. Winthrop P. Moore (who authored books about the maintenance of yachts and motorboats) wrote extensively about the maintenance needs and repairs for FPC throughout the 1970s. He kept detailed records about maintenance for the Sanctuary, Parish Unit, and grounds, including everything from major to minor projects.

[233] Ibid.

[234] Winthrop P. Moore Maintenance Notes 06/1979.

The Carillon Tower has commemorative plaques indicating that the Carillon is in memory of Dr. Edouard Muller and the Tower is in memory of Walter N. Maguire.

As one of his last projects, Dr. Arthur Lynds Bigelow (1910-1967), a widely published and internationally-recognized expert on carillons and University Bellmaster at Princeton University, designed the church's new Carillon and associated mechanism. The program from the dedication service (Appendix 4: Figure 11) states that the Tower and Carillon were:

> …designed together to conform harmoniously with the architecture of the Sanctuary to take advantage of the best site location and to assure optimum performance from a musical standpoint.[235]

This Carillon Tower has a carillon that is a combination of 56 bells from the foundries of Gillet & Johnston (Croydon, England) and Les Fils de Georges Paccard (Annecy-le-Vieux, France).[236] 21 of the original 36 Gillett & Johnston bells are in use, and the additional 35 bells were ordered from Paccard.[237] The carillon requires use of the hand clavier "where proper expression can be given to each note." Twenty of its bells allow for basic tunes to be played by remote control from the organ console. There are three large pealing bells and four that can be used as Westminster Chimes. As the dedication program notes, the carillon integrates the best available knowledge of its time, having been built to specifications written by Dr. Bigelow.

The largest 11 bells are situated in the lower bell chamber, three of which are swinging bells, which is unusual for carillon bells because typically they are stationary. The 45 smaller bells are situated in the upper bell chamber.

The bells are played from the clavier room, which is a teakwood cabin located between the two

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[235] *Service of Dedication: Maguire Memorial Carillon Tower, First Presbyterian Church, Stamford, CT*. 16 June 1968. Program. Additionally, in a letter (presumably to Wallace Harrison) dated April 12, 1965, Maguire suggested that the selected location of the Tower is better than its placement (east of the Parish Unit) due to aesthetic reasons, as the entire Tower could be seen rather than only the upper two-thirds from a certain vantage, and a "view of the whole is desirable." He also stated that: "If the tower had been put up as part of the church when it was originally built, it would have been at a point in the church where the entrance now is. Bell towers connected with a church are almost uniformly located close to the church and not separated by a substantial distance." Other reasons for placement include: "the suggested location gives better access to the tower by the organist and others" and, in relation to the Parish Unit, "if the tower is put in the quadrangle it will release all of the church property to the east for future development without any obstacle to hamper this expansion. Having the area free will permit the Parish House to expand to the east and possibly even to the north in the event that facilities become inadequate. There is a good possibility that this expansion will be needed within the next two or three years. Mr. Mills has worked out some plans for expansion in that direction."

[236] Ibid.

[237] During the decade between construction of the church complex and the Carillon Tower, the original bells were placed in storage, with the smaller bells stored indoors and the larger bells stored in the rear parking lot (bolted to a steel beam where most remained for a decade). Three bells respectively weighing 120, 130, and 140 pounds (C#, C, and B) were stolen, and, according to Barton, "First Presbyterian Church" write-up, were insured and later replaced. New Paccard bells replaced the three stolen bells as well as 12 of other original bells that did not conform to Bigelow's harmony scheme.

bell platforms 75 feet above ground. Remote electrical controls were installed so the lower two octaves can be played from the church organ console during worship services and special occasions. Time mechanisms also allow for selected bells to operate and mark the hours, at which time the carillon sounds the Westminster Chimes melodies.[238] It appears that on a quiet day the bells can be heard 1.5 miles away.[239]

The dedication program also discusses the origin of the use of bells by the Christian Churches noting its history is a bit ambiguous. It notes that by 450 A.D., Irish churches used small handbells and within 100 years of that date large bells were introduced to churches in Europe. Bells served a public function and were used for sounding the time, alarms or calling people to assembly and to worship and prayer. Only in the Middle Ages were the musical properties of bells better developed, and Venice might have been the "first city to claim a set of bells on which church music could be played."[240]

Subsequently in Britain, small sets of bells became customary; each bell had its own rope and bell-ringer. Each bell was numbered and "the set played in many different mathematical sequences. From these, the modern carillon evolved, normally consisting of from two to six octaves." The instrument's quality and adaptability placed it "among the most satisfying of all musical expressions" at the time of the Carillon Tower's dedication in 1968.[241]

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[238] *Service of Dedication*.
[239] FPC Docent Notes, October 2016
[240] Ibid.
[241] Ibid.

Modern Architecture

Like in the rest of America, Stamford's architecture in the 1950s seemed to have been at a turning point stylistically. *The Hartford Courant* reported upon Harrison's revealing of the initial design of FPC in 1953 that:

> Some unusual architectural design has been infiltrating Fairfield County in recent years. The Museum of Modern Art recognizes that many outstanding examples of modern design in homes have been built there… instead of old colonial homes' and gardens' tour, visitors might see what contemporary design can do. And another startling development was announced when the First Presbyterian Church of Stamford disclosed its plan for a new structure… most of the [new churches in Connecticut] have modified accepted forms of architecture, and consequently have provoked no heated discussions. The same will not be said of this Stamford church.[242]

The same article introduces the term "Connecticut Gothic" to describe the new structure and continues that Harrison "merely [carried] out the aim of the old Gothic churches in seeking light, but that with modern materials, he has been able to go farther."[243] New York Times architectural critic Ada Louise Huxtable included FPC in 1959 as one of the *Ten Buildings that Say* Today. She wrote:

> Although modern architecture has reached respectable middle age, it shows no sign of settling down into conservative maturity… [the ten buildings] are remarkable testimony to the continuing vitality and variety of contemporary design, as well as proof that there is considerably more to the modern style than the picture window and glass wall. These buildings represent architecture's latest frontiers.[244]

In FPC, Harrison used modern architectural expression as a means through which religious architecture could be reinterpreted and enhanced in the United States. Wolf Von Eckardt, who was to become the architectural critic for the *Washington Post* a few years later, recognized this when he wrote that Harrison sought to prevent his first church design from looking like:

> … a bank or just another auditorium… neither does one immediately associate it with a church… there is no perpendicular in any direction.[245]

In her book about Marcel Breuer's St. John's Abbey Church in Collegeville, MN, Victoria M. Young interprets Modernism in the context of religious buildings as an architectural style that evolved as architects exhausted the use of steel-and-glass boxes and sought "organic, playful forms that went beyond the rectilinear and entered the realm of expressionism."[246] Harrison

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[242] "A New Church in Stamford." *The Hartford Courant,* 21 October 1953.
[243] Ibid.
[244] Huxtable, Ada Louise. "Ten Buildings That Say Today." *New York Times,* 24 May 1959. Other buildings on the list were, for instance, Mies van der Rohe's Seagram Building in New York and the Mutual Fire Insurance Building in Hartford County, CT (designed by architects Sherwood, Mills & Smith).
[245] Von Eckardt, "A Lay Report on Harrison's Stamford Church", 37.
[246] Young, Victoria M. *Saint John's Abbey Church: Marcel Breuer and the Creation of a Modern Sacred*

was successful in assuring a tradition-minded congregation throughout his creative process, ultimately creating what Von Eckardt describes as having:

> … a brazen stylelessness (it's certainly not modern in the S.O. & M. sense) … it seems to prove that public taste need not be an obstacle to architectural genius if the architect is as sincere and persuasive as Harrison.[247]

Harrison continued to be instrumental in reshaping the built environment of American cities in the middle part of the twentieth century by being the shepherd for unrivalled large scale urban renewal projects and complexes. At the time, advancements in high rise glass curtain walls, pre-fabricated building components, and practical examples of thin-shell construction were eagerly embraced, and Harrison's career "bridges the emergence of the Modern movement in American architecture after World War I, its flourishing at mid-century, and its Post-Modern reaction toward the century's end."[248]

Within Harrison's body of work, FPC occupies a unique place. Not only is it the only church he designed but it also signifies his ability to embrace and integrate new technology, inspire a modern design with a sense of history and create new forms with precast concrete. Harrison's experience in apprenticeships of the Beaux Arts tradition gave him a grounding in neo-classical and neo-Gothic traditions, while his interest in and changes of building technology allowed him to produce new forms of architectural expression, as FPC demonstrates.

Throughout his career Harrison explored innovative structural possibilities. Aside from his collaboration with British engineer Felix Samuely, he worked, for example, with Norwegian born American structural design engineer Fred Severud (1899-1990).[249] Harrison and Severud collaborated on the design of the former U.S. Embassy in Havana (1953).[250] Severud's

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Space. Minneapolis: University of Minnesota Press, 2014, 32-34.

247 Von Eckardt, "A Lay Report on Harrison's Stamford Church", 38.

248 *National Historic Landmark Nomination*, June 22 2017.

249 Weingardt, Richard G. "Fred N. Severud: Cable Roof Pioneer and Monument Builder." *STRUCTURE Magazine*, May 2005, pages 46-48: Severud, upon graduating from the Institute of Technology in Trondheim, Norway, apparently declared that it was his "ambition to become the greatest [structural] engineer in the world." He arrived in America in the early 1920s and worked for an East Coast-based engineering company. He advanced rapidly and by 1928 founded his own firm and what was to become Severud Associates, in New York City. The most significant of its initial commissions focused on designing major housing projects. He wrote extensively on structural engineering, including one of the industry's first comprehensive books called *Apartment Houses*, which was about how to most successfully design, build, and operate apartment projects. Known primarily for brick and masonry projects, high-rise, and large-span construction, he worked on high-profile commissions across the United States. Some of the most well-known projects of his career include: St. Louis' Gateway Arch (designed by Eero Saarinen), New York City's Madison Square Garden—both built during the 1960s—and New York City's Seagram Building (designed by Mies vander Rohe and Philip Johnson), built in 1958. Severud was the structural engineer for the Guggenheim Bandshell, completed in 1969 at New York's Lincoln Center, and for Toronto City Hall, completed in 1965. His structural engineering firm was hired for the Seagram Building, designed by Philip Johnson and constructed in 1958, the same year as FPC's Sanctuary was completed.

250 "Former United States Embassy, Havana, Cuba." Docomomo. Accessed October 03, 2017. http://www.docomomo-us.org/register/former-united-states-embassy-havana-cuba.

association with innovative architects such as Eero Saarinen and Philip Johnson places him in the realm of designing buildings that explored new forms and materials.

Prominent architects of the time were designing churches, synagogues, and religious buildings across the US and abroad, and FPC became one of the first of a group of such widely publicized modern sanctuaries designed by a prominent architect. In the words of *The Hartford Courant* in 1953:

> There is nothing inflexible in church design. Many examples in recent years, including the wonderful chapel at Vence, France, designed by Henri Matisse, venture far from the traditional. So do some new churches in [Connecticut].[251]

Some of the 20th century's most notable places of worship in the United States were constructed in the 1940s-50s: Eliel Saarinen's First Christian Church in Columbus, IN (1940-42, Columbus' first contemporary building, constructed with brick, limestone and concrete); Eliel and Eero Saarinen's Christ Church in Lutheran, Minneapolis (1948-49, composed of concrete, brick, stone, and wood); Frank Lloyd Wright's First Unitarian Meeting House in Shorewood Hills, WI (1947-51, constructed with board-formed concrete walls, stained concrete flooring, stairs, and countertops and heavy timber structural elements); Alden B. Dow's St. John's Episcopal Church in Midland, MI (1949, composed of a sloping roof that simulates hands in prayer; this triangular motif also appears in the glass design and intersecting planes);[252] Philip Johnson's Kneses Tifereth Israel Synagogue at Port Chester, New York (1953-56, composed of precast concrete panels that frame 286 narrow-slit Belgian stained glass windows); Frank Lloyd Wright's Beth Sholom Synagogue, in Elkins Park, PA (1954-59, a glazed three-sided pyramidal tower sitting on a base of reinforced concrete, steel, and glass); and Marcel Breuer's Church of Saint John the Baptist in Collegeville, Minnesota (1958-1961, a modern concrete structure with a large wall of stained glass) and Saint Francis de Sales Church in Muskegon, Michigan (1967, a gray concrete trapezoidal structure) and finally Eero Saarinen's North Christian Church in Columbus, IN (1964, a hexagonal plan church with a soaring spire in its center).

Each of these spaces are in turn different in form and material expression, though all use new materials and structural techniques and seek the advantage of natural light and multicolored glazing inspired by traditional stained glass to create an uplifting and spiritual experience of space. This group established new norms and precedents as FPC had done with its exterior form of folding planes, the use of precast concrete for an ecclesiastical purpose, and with the inclusion of *dalle-de-verre*. FPC set an architectural precedent for Stamford—and all religious structures built in Stamford subsequently were more modern rather than traditional, in both spirit and appearance.[253]

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[251] "A New Church in Stamford." *The Hartford Courant,* 21 October 1953; the chapel designed by Henri Matisse is called the Chapelle du Rosaire de Vence (Chapel of the Rosary), often referred to as the Vence Chapel. Matisse experimented with the use of light, color, and composition and explored stained glass qualities in an attempt to enhance the chapel with a sense of space and spirituality.

[252] Maddex, Diane. *Alden B. Dow: Midwestern Modern*. Midland, MI: Alden B. Dow Home and Studio, 2007, 81 and 214.

[253] *National Historic Landmark Nomination,* June 22 2017.

History of Repairs

Renovation and Repair Work Since Construction

Since the church's construction, there has been a consistent maintenance effort. Renovation and repair work has dealt mostly with recurring issues involving water infiltration, aging infrastructure, concrete (poured-in-place and precast) deterioration due to alkali silica reactions, chloride presence, rebar corrosion, and material failures (particularly sealants and coatings), and glass deterioration. The problems of excessive leakage of the walls and roofs in the Sanctuary were first noted as the Sanctuary neared completion.[254] While an earlier thesis paper does suggest that there does not seem to be evidence that the deterioration of the *dalle de verre* is attributable the structural system,[255] current structural investigations appear to indicate evidence to the contrary.[256]

The Sanctuary's remedial and conservation work was continuously in search of solutions mainly for recurring water infiltration problems. As to be expected, the approaches taken, the materials used and the remedial solutions proposed and implemented have reflected the trends of the time and materials available. They sought primarily to prevent moisture infiltration in the Sanctuary walls, which was noted and thought to be the primary cause for damage to the concrete structure and the *dalle de verre*. The conservation and physical interventions were largely based on visual observations, with the exception of concrete testing for possible alkali reactions, resulting in assumptions about causes and impacts. No other more comprehensive investigation had, up to this point, been undertaken.

Outlined below is a chronological narrative of the repair actions undertaken and the conditions sought to address.

In 1958, the same year that the Sanctuary was dedicated, the acoustical consultants determined that the reverberation time was too high "for satisfactory speech intelligibility particularly when inclement weather or other factors resulted in a small rather than normal

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[254] Winthrop P. Moore Maintenance Notes 03/1979: As the Sanctuary neared completion, excessive leakage of walls and roofs were noted. In an attempt to correct the overall problem, several coats of clear acrylic were applied over the entire building, including the stained glass windows. When this failed to correct the roof leakage, the architect, Wallace Harrison, at his own expense, designed and set in place a Plexiglas cover over the entire roof. It is composed of stainless steel frames with Plexiglas "lights" embedded in Thiokol sealant compound. The hundreds of feet of joints between building frames and the large panels containing the stained glass are caulked with Thiokol. Most of this caulking was removed and replaced about four years after the building was occupied. The cost was split three ways, architect, contractor (Grenadier) and the church.
The original specifications for the Sanctuary identify Thiokol as the caulking material for the joints around the glass panels "where they set in cast concrete wall and roof panels." The compound was called "Del" as manufactured by David E. Long at 220 East 42nd Street in New York City. The same manufacturer was to produce the Del W-97 transparent waterproof coating for the exterior surfaces (to be applied after all precast concrete panels forming walls and roof of church proper have been erected and assembled, and concrete and glass panels set in place).
[255] Bubnash, *Dalle de Verre / Faceted Glass,* 104.
[256] See Appendix 6: Old Structures Engineering Report.

congregation" and, to remediate that condition, the church installed carpeting over the entire floor area, including in the aisles. FPC decided to wait to install any further sound absorbing materials until the effects of the new carpeting could be assessed. Bolt, Beranek & Newman established that hearing conditions were improved from the pulpit due to amplification from the canopy. At this time, no "applied" sound absorbing materials were used in the Sanctuary, and the firm determined that the carpeting beneath the pews "help[ed] control the empty reverberation time characteristic."[257]

In 1959, a year after completing construction, the Buildings and Grounds Committee observed deterioration where the poured-in-place concrete was cast into the narrow joint space (framework) between abutting precast panels covering the connecting anchors and rebars. Harrison hired consultants and they determined that the composition of the concrete was at fault. Under Harrison's direction, the condition was corrected at no expense to the congregation.[258] What analysis was performed and the extent of the deterioration and the types and scope of repairs are unknown.

No major repair projects were identified during the 1960s and only routine maintenance seems to have been executed.

In May 1970, a few maintenance projects were carried out in the Sanctuary: the pews[259] and communion chairs were refinished, the main entrance doors were refinished, the choir room floor and corridor were painted, a gutter was installed outside of the choir room (no gutters were originally installed on the exterior of the Choir Room). Many other areas were also

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[257] Klepper, David L. "First Presbyterian Church, Stamford, Connecticut." *Journal of the Acoustical Society of America,* Vol. 31, No. 7, July 1959. The same article mentions that "the provision of a small chapel elsewhere within the building… has somewhat reduced the need for using this sanctuary with a small congregation… the combination of ministers who are excellent speakers, good interior shaping to reinforce the direct sound, and a pulpit canopy that acts as a natural sound amplifier allows a full church reverberation characteristic… no electronic speech amplification has been employed."

[258] It is possible that the work was performed under the original warranty. The original specifications for the Sanctuary (page 76), include a requirement for a guarantee bond stating that the contractor "shall furnish a bond, acceptable to the Owner, guaranteeing that all roofs will be watertight for a period of twenty (20) years from date of acceptance of the work by the Architects," and that "all workmanship and materials furnished under these specifications, for a period of five (5) years from the date of completion and acceptance, and binding himself to repair and replace, without additional compensation, any defective material or part."

[259] "The First Presbyterian Church", *Commemorative Booklet,* FPC Archives, 1958/1959: The original pews were installed by Joseph Rhodes of Sherman, Connecticut. They are of African mahogany and were originally left untreated in order to be "honest, as in European cathedrals, where the finger marks blending in time make a lasting finish." The pews seat 670 worshippers in the nave, 50 in the balcony, and as many in the choir, for a total of nearly 800 people.

The acoustical firm Bolt, Beranek & Newman recommended pew cushions to control the reverberation time "for uses with a reduced congregation without making the church too dead for liturgical music with the full congregation." Despite this suggestion, the church decided not to use pew cushions. In: Klepper, David L. "First Presbyterian Church, Stamford, Connecticut." *Journal of the Acoustical Society of America,* Vol. 31, No. 7, July 1959.

The pews on the south side of the Sanctuary were apparently stained most likely from water infiltration (and from candle wax).

repainted, including the stairways, corridors, and Sanctuary interior (the narthex interior and the west wall behind the choir were originally painted in "aubergine" and the Sanctuary interior was originally painted in a "plasm gray and cement color"; this was done while the scaffolding was still installed for construction.[260] A similar strategy was apparently utilized in the 1970s Sanctuary restoration to repaint the interior when scaffolding was still standing.)

Winthrop Moore's maintenance notes about the process for refinishing the pews are quite detailed. They describe:

> The backs (seat backs) of all pews, front to end of glass area on the south side, have been refinished as follows: "Machine sand to remove, as much as possible, of the water stains and grime. Where candle wax is observed, scrape off with knife blade before sanding. Use a small rag soaked with mineral spirits (benzene, tohol etc.) to remove wax impregnated in wood grain. Discoloration of the wood will disappear as the volatile solvent evaporates. Follow the machine (orbital) sanding with a light hand sanding with #80 grit oxide paper, with the grain. Brush, with the grain, with hand dust brush, to remove sanding dust. Follow with Turkish toweling or similar absorbent cloth. Finally, wipe with towel wrung out in water. The next step is to apply a wood filler… we have adopted Benwood 'Honey Maple' Interior Stain (Benjamin Moore Co.) as a standard for use on Sanctuary chairs, pews, etc. Application is by brush… having applied the stain as above, it is to be lightly hand sanded… with all surfaces wiped scrupulously clean, the base coat of varnish may be applied. Use top quality exterior spar varnish. This is to provide a water proof coating to protect the wood from possible future water stains. It is to be lightly sanded, wiped with mineral spirits, rag, and recoated with 'rubbed effect' flat varnish. We have used Devoe's flat varnish. Since this dries to a completely flat finish, the pew will assume its original appearance of bare wood, the desired décor effect. It is anticipated that pews thus refinished should last for many years without re-varnishing.[261]

FPC undertook other substantial work in the 1970s; in 1970, the base of the Carillon Tower was extensively landscaped,[262] together with the construction of the Memorial Walk[263] and the plaza area leading into the Sanctuary.[264] Exterior work was carried out on the Sanctuary in 1973—the

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[260] "Aubergine" or eggplant suggests a brownish purple color in the Narthex and in the west wall behind the choir. The rest of the sanctuary was painted a darkish gray. No paint studies were undertaken as part of this report to establish actual colors and locations. But fragments of the original aubergene still exist on the walls.

[261] Winthrop P. Moore *Maintenance Notes*, FPC archives 06/1970

[262] Winthrop P. Moore continues in other notes (June 1979): "…hundreds of trees were planted… often by volunteers… The replacement value of this landscape work would be many tens of thousands of dollars. The Tower landscape work could not be duplicated for under $80,000, as one example. And a similar value exists for the trees on our south boundary. We mention this to point up the value of our grounds property alone. Much of this has come to us as gifts in trust. We are beneficiaries with responsibilities to guard and enhance these values for the benefit of ourselves and for generations to follow."

[263] The Memorial Walk runs along the driveway's sidewalk from Fellowship Hall to the Sanctuary steps. The walk largely reflects today the 1964 installation – it was expanded in 1977 and the stones were reset in 2016 as part of a larger landscape maintenance project.

[264] Moore reported in 06/1979: "The concrete in the Tower structure is definitely of better composition and in much better condition than that of the Sanctuary. There have been no observed distress areas of

entrance steps were enlarged to their current state (this can be seen in a photo from a 1973 brochure for FPC and was done in conjunction with creating a ramp, which changed the arrangement of the plaza entrance). This change and the introduction of a ramp reflected the growing desire for providing adequate accessibility.[265] The landscape architect for FPC at the time was W. Lee Moore from Scarsdale, New York.

In maintenance notes that date to June 1979, Winthrop Moore notes the original intention for the landscape around the base of the tower:

> The base plantings were originally intended to convey the impression of ledge rock, with plantings worked in between the large exposed 'ledges.' The appearance was handsome and complimented the Tower exceptionally well. The rocks were a temptation for some and an invitation to others, as a resting place, for lunch or conversation. For others, a challenge for play. The resulting traffic through the plantings has created costly damage… most distressing and an on-going problem is the damage inflicted when a half dozen active boys converge on the garden to root about in search for a lost baseball, hit up into the area from the Bowl, scene of frequent sand-lot games… In a continuing effort to combat this annual danger, several thousand dollars have been expended over the past five years for replacement plantings. There has been rapid growth of about 20 juniper bushes…

Sound proofing in the Sanctuary was carried out in 1972 and then again in August of 1975 after CBS Laboratory conducted reverberation testing.[266] Speakers were first added under the pews and then Tectum plates (a high frequency absorbing material) were added in the rear of the church to reduce noise; this caused sound to not be heard bouncing at the back (Narthex) and exacerbated the low frequency problem. In a letter to Wallace Harrison dated August 19, 1975, Winthrop Moore wrote that he had "taken the precaution to insulate behind the Tectum panels with Fiberglas" and that before beginning the project, he had commissioned careful reverberation testing by the CBS Laboratory.

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cracking nor of spalling… what will be revealed is a network of hairline cracks over virtually the entire surface of the concrete…"

[265] The end of the 1960s and the beginning of the 1970s saw significant legal and regulatory advances in the facility requirements for handicap accessibility particularly for public institutions. For instance, in 1971 the American National Standards Institute published ANSI 117, which became and continues to be the standard for accessible design across the US.

[266] In October 1974, acoustical consultant Cyril M. Harris visited the church and reported to Wallace Harrison that the "acoustical conditions in the church can, and should, be improved." He offered recommendations for the sound system, such as that the loudspeakers are poorly located (below the pews) and could be incorporated inconspicuously in the chandelier units (but ultimately, he determined that this might not be worth the cost). He also recommended reducing the reverberation time, which would improve the intelligibility of the spoken word but would offer less favorable conditions for the organ music. He recommended that additional absorption could be supplied by carpet underlayment, though also stated that this would not be enough to completely correct the conditions. Lastly, he recommended that acoustical plaster could be applied on all areas at the rear of the church to improve the acoustical conditions, which, would be the single most important corrective measure that could be taken, according to Cyril Harris.

Since the issue was not resolved satisfactorily, in 1990 acoustical engineers were brought in to review the acoustics and improve the lower frequencies; at this point, Masonite panels were installed to cover part of the Tectum in the rear of the church, though the recommendation was to completely cover the Tectum.[267] It was also decided in the 1990s to remove the carpet from the chancel, remove the speakers from beneath the pews, and update the audio system. The consultants also recommended that wood should cover the concrete floor, but this was never executed.

The addition of the Tectum in 1975 affected the appearance of the Sanctuary, though in a letter to Harrison from August 8, 1975, Winthrop P. Moore noted that it was an "improvement as to color, texture, and form." One year later (1976-1977), Harrison supported a redecoration of the narthex and vestibule area, including the addition of a canvas mural by Harrison that is displayed on the north wall of the narthex. Per the letter (Winthrop P. Moore, January 19, 1976), the mural added "a powerful, spiritual impact to this area." Moore indicates in another maintenance report that the lightening of the paint color in the narthex "has enhanced the appearance, improved visibility and renewed interest in the use of the space." [268]

After a severe winter, Harrison and his consultants determined that the structural poured-in-place concrete at the base of the south and east sides of the Sanctuary required remediation. A 1978 maintenance report from Moore stated that in 1976 to 1977 the church carried out:

> … a thorough inspection of the South and Narthex foundation. Large areas of distressed concrete were observed including a section adjacent to the main entrance, where we had previously applied a protective covering of metal lath with cement plaster. Interior cracks were transmitted clear through this coating.

After consulting with Harrison and DeLuca, Moore made the recommendation to retain the engineering consultant Viggo Bonnesen be hired to coordinate restoration. Bonnesen recommended exploring the chemistry of the concrete; he and Moore obtained core samples from six locations in the foundation (the results of this testing was not available for review).[269] Dr. Sidney Diamond from Purdue University tested the cores and found that a chemical reaction occurred within the concrete structure which, in the presence of water, weakened the concrete through expansion, resulting in "distress cracks" clearly visible on the surface areas.[270]

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[267] The Masonite was added by organist Jim Wetherald and it reaches the height of the available ladder.
[268] Winthrop P. Moore *Maintenance Notes*, FPC archives (n.d.)
[269] A record of the results of these tests have not been located to date.
[270] Winthrop P. Moore *Maintenance Notes*, FPC archives, 01/1978 report about Sanctuary Restoration: "The Diamond-Purdue report revealed that a chemical reaction occurred within the concrete structure. In the presence of (water) moisture, an alkaline reaction is set up between the cement and the aggregate. This weakens the concrete through expansion within the body of the concrete, resulting in 'distress cracks,' clearly visible on the surface areas. Such cracking admits water and thus increases the chemical reaction… with this information in hand, we made a report to a special meeting of the Trustees and asked for authorization to immediately undertake an extensive preventive and restoration project… blue prints were prepared by Mr. Bonnesen to delineate the scope and dimensions of the work to be undertaken."

DeLuca started the foundation restoration work on October 12, 1978 excavating with two air hammers a three-foot trench around the sides of the distressed areas of concrete, extending from the chancel end to around the end of the narthex.[271] To improve drainage, a retaining wall was constructed in the trench, which was in turn filled with crushed stone to carry away rainwater.

DeLuca followed that with a "dressing down of the horizontal shelf of the foundation to provide a sloping surface," in the areas of the shingled portion of the chancel and narthex foundation (the portion under the *dalle de verre* was to be treated the following year).[272] A grout coating of concrete was removed and the exposed areas were sandblasted to remove loose material and to prepare for an epoxy coating. The exposed rebars were also cleaned and sandblasted. The liquid epoxy adhesive, Brush-Bond 1001 by Adhesive Engineering Co., a product not available in 1958, was brushed over the foundation's concrete to provide a waterproof seal and bond the new concrete to the foundation; cavities were built up with cement layers to minimize shrinkage. The entire exposed face of the narthex base (except for the North side) was given a ¾" stucco coating of High Early cement, bonded with an epoxy bonding agent according to Moore's maintenance notes from January of 1978.[273]

A month and a half after the completion of the work, Moore observed shrinkage and expansion cracks in the epoxy material at six to ten foot intervals. By mid-summer 1977, the cracks had become larger. Moore reported this to Bonnesen and the Grenadier Company (the construction company that applied the epoxy coatings) to set up remedial measures with Robert Rieux of Adhesives Engineering (who supervised the work). Rieux had the defective material removed at his own expense; this was done for the portion of the above-ground foundation at the south wall.[274]

Dr. Sidney Diamond also produced a report for FPC during the 1980s Sanctuary restoration work in which he performed a chemical analysis of the cast-in-place and precast concrete (a spalled section).

[271] Ibid: "…excavation of a 3-foot trench was undertaken extending from the chancel end (Bedford St.) to and around the end of the Narthex. Using 3 cement block on a poured new forced concrete slab base, a 30" wall was erected in the trench south base, chancel end to front steps. Upon completion, the trench was back filled with compacted crushed stone. Great care was used to protect and support two electrical conduits running alongside the foundation about 18" below grade. These carry circuits from the organ to the Carillon Tower… the exterior of the retaining cement block wall and of the exposed Sanctuary foundation, (to grade level) was coated with waterproofing material (Karnak)… forms were constructed and reinforcing rods laid to provide for the poured concrete slab extending from the foundation over the crushed stone and cement block wall at grade level. Approximately 14 yards of cement was poured in forming the slab."

[272] Ibid.

[273] Winthrop P. Moore *Maintenance Notes*, FPC archives, 1978: "The surface had been extensively chipped and sandblasted to provide a slope of 1" to 12". Special attention was paid to removal of concrete under the copper flashing and this was sandblasted bright. Under supervision of the district manager of the Epoxy Supplier, Robert Rieux, Adhesives Engineering, work proceeded as follows. The two component epoxy, Concresive Floor Fix, 1180 LPL, was mixed together and two parts of special Ottowa sand was added to bring the mixture to a paste like consistency and to bring the co-efficient of expansion closer to that of the substrate, the concrete to which it was applied… Application was done by a Grenadier employee familiar with epoxy work… a good bond to the copper flashing was accomplished."

[274] Ibid: "Mr. Rieux recommended injection, under pressure of liquid epoxy to seal about 8 cracks in the

In his report, Moore states that the same problems had been evident over the past 16 years and that Ammann and Whitney (the structural engineering consultants for Harrison and FPC's Carillon Tower) made several surveys and recommendations for the issue with the Sanctuary, particularly with regard to material selection.[275] Moore also reports a serious problem on the North elevation, where clear acrylic coatings that were applied in 1958 partially failed and the remaining coatings proved "impossible to remove, thus presenting a very unstable surface for treatment."

Separately, a report from September of 1979 by Winthrop Moore and Ralph Layman indicates updates to the Carillon Tower, particularly painting of the stairway cage. The instructions included removing loose paint and rust, washing dirty areas, and coating and painting the entire structure with one full coat of Debevoise CeCo WS-110 Corrosion Resistant Non-Leafing Aluminum Primer. Another report by Winthrop Moore indicates that:

> The base platform of cut paving stone and inscribed tablets [are] subject to frost damage and has already been re-grouted at considerable cost, 1978... The Platform is coated with sealer, applied annually.[276]

In 1981, based on comments from the resident carillonneur and others familiar with the instrument, the I.T. Verdin Co. of Cincinnati was commissioned to perform the first top to bottom repair work of the carillon and its operation in the Tower.[277] Sound isolation material was added to reduce vibration in the bearings and seats of the bell carriages. Two hammers were replaced and all clappers were removed, cleaned, and painted, in addition to other repair work and the installation of a new music rack and pedal springs.[278] Upon this renovation, the

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epoxy covering of the Narthex foundation… with the top shelf of the foundation thus re-exposed, [Moore] proposed the use of cement adhered to the freshly exposed concrete with Brush Bond 1001 (as previously used on the vertical wall areas). This work was performed by DeLuca… it has withstood one weather cycle with no apparent signs of shrinkage cracks or distress."

[275] Ibid: "Several criteria deserve mention as regards material selection and use. The concrete surfaces, south elevations, must be kept waterproof. However, the coating should not set up a vapor barrier. This rules out many materials such as the plastics, clear acrylics and silicones. Cementations grouts of the type we use, will permit water vapor to pass through, thus allowing the surface to breathe. Of equal importance, they must be re-coated at any time, since they erode away, leaving a suitable base for re-coating."

[276] Winthrop Moore, *maintenance notes*, FPC archives (n.d.)

[277] "Maguire Memorial Carillon – Stamford CT." Maguire Memorial Carillon, Waymarking.com. <http://www.waymarking.com/waymarks/WM7HMK>, accessed October 2016: "the action was uneven and rather heavy, particularly in the pedals, with consequent difficulty in controlling the instrument. Accordingly, over a period of two years, several carillon consultants were called in to examine the carillon, and to submit proposals for its improvement."

[278] Ibid: "… isolation material and provision for expansion and contraction of the supporting beams were placed on the smallest 27 bells, effectively eliminating the 'knocking' sound caused by the former rigid clamping to the supporting beams. All recalling springs were replaced, and counter springs were applied to the lower medium and bass bells. All clappers were removed, cleaned, painted, and replaced with renewed lubrication, and all headbolts drawn, inspected, and painted before reinstallation. New neoprene isolation material was also installed for bells 12-29, and all transmission bars were removed, and the bearings cleaned and lubricated. A new umbrella system eliminated leakage and the former friction at that point. At the console, new heavier-pattern adjusters were installed above the music rack, eliminating the necessity of removing the rack when adjusting; all keys and pedals were side bushed with bushing

Carillon was first publicly played by George Matthew, Jr. and Rick Watson on the Sunday before Christmas in 1981.[279]

According to FPC's docent notes, a structural engineer was later employed in 1997 to inspect the developing hairline cracks. The cracks appeared to be more extensive than initially thought, totaling approximately 3,000 linear feet. However, it was determined that these were cosmetic, not structural, faults. The patterns observed were not reflective of the severity of the cracks, but were due to the caulking which attracts dirt.[280]

In the mid-1980s, extensive repairs were undertaken to address the deteriorating *dalle de verre* in the Sanctuary particularly on the south elevation. The replacement (along with subsequent additional remediation attempts undertaken in the years 2003 through 2005) are further discussed in more detail in the next chapter of this report.

By the mid-1980s, the Sanctuary's original organ (identified as an Allen electronic organ), began to require constant repair as its vacuum tubes aged. The Allen organ was replaced in 1991 with a so-called Visser-Rowland mechanical action pipe organ of four manuals, seventy-four ranks, fifty-one stops, and consisting of 4,026 pipes. The replacement for the Allen organ is an Opus 87, conceived by Pieter Visser and built in Houston under the supervision of Patrick Quigley and James Sanborn, then dismantled, packed, and shipped to Stamford.[281] The organ was then reassembled in the Sanctuary, requiring substantial change in the west end of the Sanctuary and the configuration of the chancel—some of which was accomplished to improve the acoustics. The placement of the organ was also changed. The organ console and keyboard no longer sits in an organ pit (beneath the ground floor, as shown on the basement level on the original architectural plans) in the center of the chancel behind the cross; due to the size of the new organ, it is placed closer to the pulpit. The choir, which originally faced the organ from both sides (the seats were placed along the north and south Sanctuary walls) now sits behind the organ console facing the congregation.

The organ (along with its casing) is constructed of various woods, including the Honduras mahogany case and white oak console. The organ console has four manual keyboards with ebony naturals and maple sharps, materials which were selected for their durability and appearance. The façade pipes (the largest of which is 20 feet tall) are flamed copper and polished tin and the *Trumpet En Chamade* is polished copper[282]; the shimmering copper colors of pipes are attained by torching copper after treating it with chemicals.[283] The computerized

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cloth, and all console wood and metal parts were completely refinished. Rear pivot points of the keys were honed and bushed with Teflon, and the first eleven keys, which are extended to the rear for downward connections to the lower bell-chamber, were reinforced, to prevent the former flexing under pressure. A new music rack, long enough to accommodate seven pages, was installed. New pedal springs were installed as well."

279 Ibid.

280 FPC's docent notes, October 2016

281 "Pipe Organ." *Fish Church Conservancy.* More information in the Organ Historical Society Pipe Organ Database (OHS Database ID 7339).

282 Trumpet En Chamade or trompette-en-chamade refers to horizontally mounted pipes that have a strong trumpet like sound.

283 *First Presbyterian Church: Celebrating Our First 150 Years in Stamford*. Pamphlet. FPC Archive.

combination allows the organist to program and instantly change the tonal colors while playing. Topping the 30-foot-high Honduras mahogany pipe case is a so-called *Zimbelstern,* or rotating "bell star."[284]

In 2015, other renovations included replacing the original 1957 oil-fired boilers with a gas-fired heating system and extending new hot water lines to the choir area. In addition, the Parish Unit's roofing was replaced. In 2016, the paved area in front of the main entrance was refurbished—the memorial stones were removed, or replaced, and reinstalled in the new paving. To ensure that each stone was reinstalled in its original location, a "Sidewalk Monument Reference Table" was created and each stone was numbered and described before removal. The scope of work as prepared by D'Andrea Surveying & Engineering specifies to:

> Remove and salvage existing granite sidewalk monuments and reset in new concrete sidewalk panels. [285]

A number of broken granite stones were replaced. The replacements match the original in size, color, and text.

A new air-conditioning system for the Sanctuary was planned in 2016 and completed in August 2017. How the new system will impact its exterior envelop and possibly affect the *dalle de verre* and its matrices has yet to be determined.

In 2017 work was also completed in Fellowship Hall, which included asbestos abatement, upgrades to the kitchen facilities, construction of a new weatherized south window-wall, and construction of ADA compliant bathrooms. Upgrades were also completed in the bathrooms of the Parish Unit, including ADA compliance.

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[284] From Rutherford-Johnson, Tim, Michael Kennedy, and Joyce Bourne Kennedy, eds. *The Oxford Dictionary of Music.* Sixth Edition. Oxford: Oxford University Press, 2012: A toy organ-stop (prevalent in Northern Europe from 1500-1800), comprised of a revolving star near the top of the organ case with a set of tuned or untuned bells attached to a wind-blown driving-wheel behind the case.

From FPC docent notes, October 2016: the rotating bell star is constructed of basswood.

[285] 2016 Renovation plans

Sanctuary Envelope Repair

It was noticed early on that the *dalle de verre* glass was, according to Winthrop Moore, "subject to breakage, mainly from natural causes."[286] Winthrop Moore reported in 1979 that "it was only a matter of time when a piece will disintegrate and require replacement." He mentions that FPC discussed the idea of replacement several years prior, when Gabriel Loire made a scheduled visit. The only documentation about this visit is the maintenance report in which Moore wrote that Loire was prepared to supply replacement pieces, "cut to fit a pattern sent to him in France." Considering cost and time factors, Moore urged the use of local suppliers as an alternative instead. In the appendix of his report Moore goes as far as providing detailed instructions for replacing broken stained glass.[287] Moore specified that:

> It should not be necessary to call for an outside contractor to replace a broken piece of stained glass… the procedure is quite simple and except for areas at considerable height, can be done by a person handy with tools. It is doubtful whether close color matching can be accomplished except at considerable extra expense and time (as for example, working with Gabriel Loire in France). Would a variation in color be noticed in a small replacement piece? If not, write to Carl E. Paulson… Mr. [Paulson] has seen our church and has agreed to make replacement glass at a very modest cost. There must be others nearby who work with stained glass… the replacement glass should be one inch thick and if possible, chipped on the outside edge to form a "facet" (not this treatment in all present glass) which refracts light.[288]

In the mid-1980s, extensive leakage continued in the Sanctuary, particularly in the south and east façades. From a letter, dated May 4, 1987, written by Grant Annable to Bennett

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[286] Winthrop P. Moore *Maintenance Notes*, FPC archives 03/1979: "Because [the glass] is embedded in solid concrete (no gasket or lead or sealant), it fractures in times of wide fluctuations in temperature. This is confined almost 100% to the South elevation of the Sanctuary – the sunny side… repairs are made using silicone sealant which is clear and provides good adhesion. To date, no glass has fractured all the way through to the building interior. Rather, it chips off in irregular shards or layers, always on the outdoor side." The lesser breakage on the original *dalle de verre* on the north elevation would seem – to some extent – to corroborate that statement.

[287] Winthrop P. Moore *Maintenance Notes*, FPC archives 03/1979: "Whereas we have not, as yet, been required to remove and replace an entire piece of glass, that time will come. The procedure we have worked out is as follows: With the aperture cleaned out, place a small sheet of aluminum foil (the heavy grade, as used in freezers) over the opening and press firmly against the cavity edges. This will deform the foil in the exact outline of the opening. With scissors, cut this pattern... We now have the capability to transfer this outline to another material such as a sheet of lead, aluminum or clear plastic. With a bit of trim and fit, our 'plug,' whether of lead, aluminum or plastic, may be inserted in the opening and caulked with a tube of clear silicone, making it at once watertight and secure, while awaiting the delivery of a piece of glass… You have carefully preserved the foil pattern? Good. It may now be sent to the supplier of stained glass, with chips of the broken glass as color guides. The supplier should produce a suitable replacement about 1/8" smaller all around. This may now be set in position in the opening with no difficulty and temporarily held in place with appropriately sized wood splinters, to support it while Thiokol beads of sealant are placed around and under the glass, as a gasket-sealant, indoors and outside. A somewhat neater seal will result from the use of clear silicone, but we do not have much confidence in its adhesive quality. <u>Note</u>: If Thiokol is used, prime the concrete beforehand to improve the bonding of the Thiokol." It is unclear if and how much this procedure was utilized.

[288] Winthrop P. Moore *Maintenance Notes* (n.d.).

Dondlinger, a member of FPC's Building and Maintenance Committee charged with managing the restoration, it appears that FPC had narrowed down to three options the work necessary to solve the problem of leaks to the Sanctuary. The first option identified was carried out and involved the work as proposed by Rohlf Studios for a total of about $825,000. This involved removing and reinstalling new or repaired glass panels into the precast panels in the south façade, re-painting the interior, and caulking the sidewalk and joints.[289] The second of the three options considered was to apply a rubberized coating that had been used in prior years, which had been proven to be ineffective as it would not waterproof the concrete and did not stop leaks into the Sanctuary. The third of the three options considered deferring work on the south elevation until such time as the north wall could also be repaired.[290] This was determined to be risky given the level of leakage that would only become worse over the years.[291] To date, there is no standard or guideline for treatment or repair of *dalle de verre*; rather, work has been carried out on a case-by-case basis.[292]

Another letter, dated April 30, 1987, from Michael William Toto to Ben Dondlinger, reported the findings by Michael Love, a Vice President of Rohlf Studios, of seven different leaks (five in one roof panel area), including a bad leak in a roof supporting (concrete) beam and one small one at another point in the roof. Love also noted that, in addition, the joints around the *dalle de verre* panels in the areas of the leaks, were soft and came apart at the touch.[293] As a result, Eberson & Toto Architects PC, a local Stamford, CT architecture firm, and Viggo Bonnesen & Associates, a local engineering firm, produced drawings for the restoration of the Sanctuary (Appendix 4: Figure 12). A conditions survey by the project's architects remained available for review, and this document outlined three main conservation problems, particularly on the south wall:

1. Cracked and broken *dalle de verre*.
2. Blistering, cracked, and water-stained structural concrete.
3. Moisture infiltration.

In an earlier letter, dated March 3, 1986, Michael A. Love of Rohlf's Studio writes to John Hemsley:

> Unlike today, the making of faceted glass, (1" thick), was constructed using concrete

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[289] According to Winthrop P. Moore's *maintenance notes* (n.d.), the Sanctuary interior was painted at least twice – once in 1970 and then again in 1986 during the major restoration project. The narthex was originally painted in aubergine. Some of the original paint is visible in the balcony and on the west wall behind the choir.

[290] In Winthrop Moore's notes about the Sanctuary Restoration (1976-77), he wrote that there was a serious problem on the north wall elevations, where previously applied (1958) clear acrylic coatings partly failed and the remainder impossible to remove, thus "presenting a very unstable surface for treatment." He continues to say that this "is a classic example of what not to use, since it is non-renewable, and is now a highly objectionable agent standing in the way of needed repairs." The acrylic extends over the glass and having darkened with age has cut out more than 50% of the light and thus darkened the north side glass.

[291] Letter to Ben Dondlinger from Grant Annable. Subj: South Roof Repairs. 4 May 1987.

[292] Bubnash, *Dalle de Verre / Faceted Glass,* 74.

[293] Letter to Ben Dondlinger from Michael William Toto, AIA. Subj: Findings – Roof Condition, South Wall. 30 April 1987.

> which was poured over the heavy iron wire [mesh] that ran throughout each panel. These wires served as a necessary reinforcement for the concrete. This process originated in France and with the European climate, never had any serious repercussions. In the 50's and 60's much of this type of work was imported to religious buildings all over the United States and this is where the problems began. The extreme climate changes caused these panels to contract and expand beyond their structural ability… today in the United States, epoxy matrix is used in place of concrete which supersedes any and all durability tests, as I have previously demonstrated with the first tested sample panel, that was installed in the church in 1983…[294]

Damage to the *dalle de verre* panels in the south and east walls was so extensive that the panels below the roofline were replaced in their entirety by Rohlf's Stained Glass Studio, who photographed and made rubbings of the panels before removal, transported them to the studio, and created reproductions.[295]

According to Peter Rohlf,[296] this replacement process included: erecting scaffolding, both on the interior and exterior, that did not touch the building, photographing the original panels *in situ*, creating rubbings of each panel from the exterior of the building, photographing the panels again in the studio, and reproducing the panels (Appendix 4: Figures 32 and 33). For accurate reproduction of all new glass and for matching color and texture, the replacement panels were assembled on light tables. The new glass was obtained from three different sources: from Blenko in West Virginia (which manufactured 8″x12″ slabs),[297] from Heritage in the Midwest, and from the French glass manufacturer Saint-Gobain. According to Rohlf, the color matching was done with great diligence and accuracy. At this point in time it is not possible to differentiate between the three types of glass and determine their origin.[298] When the new replacement panels were installed within the precast concrete forms (Appendix 4: Figure 34), Sikaplex was used as the sealant according to Rohlf. This was only used on the exterior, as there is no sealant present today on the interior of the panels and only foam strips are visible.

While the precast sections remained unchanged, the new *dalle de verre* panels on the south and east elevation included all panels up to the roof line. The composition of the new panels was changed and the glass was set in an epoxy modified matrix and not concrete as was the case with the original panels. It was determined that, upon removal, the original *dalle de verre* segments were breaking. The original *dalle de verre* panels, as furnished by Loire's studio in Chartres, remain in the north nave walls and in the upper roof parts on all three elevations. The glass and panels in the south nave wall below the roofline (a total of 472 panels) and east

[294] Letter, March 3, 1986, Michael A. Love of Rohlf's Studio, to John Hemsley.
[295] The photographic documentation included an extensive number of color slides now in the collections of FPC.
[296] Phone conversation with Peter Rohlf. 19 December 2016. Present on call: Laura Buchner (BCA), Amanda Gruen (P&P), Theo Prudon (P&P), Peter Rohlf (Rohlf's Studio), and Dorit Zemer (P&P).
[297] Blenko Glass is a West Virginia-based company and was the first to produce *dalles* in the United States (1950s). slab glass products were designed to accommodate customer requests, and the first *dalles* produced. Blenko continues to produce a similar product. Blenko's "early came in various shapes like kidneys, circles, triangles, and stars." Bubnash, *Dalle de Verre / Faceted Glass,* 27-28.
[298] Phone conversation with Peter Rohlf. 19 December 2016.

narthex wall were all replaced in the mid 1980s.

The replacement of the east elevation was undertaken first (in 1986), with the following sequence:

1. Erect scaffolding[299]
2. Photograph panels
3. Create rubbings of glass
4. Color selection[300]
5. Remove panels and caulking
6. Install plexi[301]
7. Sandblast
8. Cleanup
9. Apply Silane
10. Apply STO
11. Recreate new panels
12. Install new panels
13. Caulking
14. Sidewalk joint repair
15. Remove exterior scaffolding
16. Interior work (including painting)
17. Remove interior scaffolding
18. Cleanup

As stated by Rohlf, the replacement glass was closely matched in shape, color and faceting to the originals.[302] The surfaces of the epoxy matrix were covered with sand to suggest a closer resemblance to the texture of the adjacent precast concrete. At the time of this glass replacement the exposed concrete that showed deterioration and rebar corrosion was also repaired. The concrete surfaces of the south elevation of the Sanctuary were sandblasted to remove scaling and deteriorated concrete and to achieve a sound substrate. A new surface was

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[299] In Rohlf's files, there is a lease agreement between Rohlf's Stained & Leaded Art Studios and the New York Ladder Corp. of Long Island City, New York for scaffolding. FPC Archives.

[300] In the project specifications, the summary of work (Section 01010), stipulated that a professional color selector was to make necessary drawings/color chart for replacement of glass. FPC Archives, Project Specifications

[301] Ibid. (Section 01010), requires that clear "plexi" was to fill the openings temporarily in the upper roof sections and plywood panels were to fill the panels in the lower eight feet. The panels were to be set on masking tape and caulked. "Plexi" is an abbreviation for the trade name plexiglass, a polycarbonate glazing product.

[302] Phone conversation with Peter Rohlf, 19 December 2016. The faceting was accomplished by chipping the glass for 20-30% of its surface area. Only the side facing was faceted, the exterior face was left smooth, setting the glass on blocks, and pouring the epoxy in between the glass in two separate pours. i.e. the front halfway, let it cure, then pour the back, which was in effect the exterior face. To achieve this the joints were filled half with sand in the first pour. The epoxy was poured to 1 ¼" so that the panels matched the old in size (epoxy is usually poured closer to ¾" to 7/8"). A perfect cast between the exterior glass and the epoxy was created. The epoxy was manufactured by General Motors and marketed and furnished through Blenko. Epoxy panels do not require reinforcement bars, while concrete *dalle de verre* panels do require reinforcement.

applied to repair the concrete and a cementitious product furnished by the STO Company was utilized. The application included a glass fiber mesh (Appendix 4: Figure 35).[303]

The STO product was applied as a base coat material on the south and east facades. The STO BTS-B is a polymer based ground coat and leveler and was to be used with cementitious materials for added flexibility, according to correspondence between STO Industries' Jan Nogradi (VP Engineering) and Arnold DiGregorio, dated November 23, 1987.[304] This was used on the south wall (in conjunction with the embedded STO mesh). It is unclear whether BTS-B or RFP was used on the east wall. Dow Corning was approved as the sealant in connection with STO materials. The STO aggregate was selected to match the epoxy matrix aggregate of the new replacement *dalle de verre.* While this may have provided a close match at the time, today the appearance is noticeably different: the epoxy surfaces are darker in color than the original concrete still visible on the north elevation).[305]

Rohlf proposed covering the original glass roof panels with a new secondary polycarbonate glazing system in aluminum frames to the design of Rohlf Studio. According to Peter Rohlf, the glazing system was not executed, but the roof was covered with new Plexiglass panels.[306] After the *dalle de verre* replacement panels were installed, some water infiltration was observed. It was determined to be from the STO glass fiber mesh (the original surface applied to the concrete), which had been wrapped around the openings into the reglets affecting the seal. The mesh was cut out in those locations, apparently resolving the leakage.[307] Rohlf Studio provided a written warrantee for the following items[308]:

1. *Dalle de verre panels* – 10-year
2. STO covering – 10-year
3. Sealants – as per manufacturers' warrantees

However, moisture penetration was not entirely resolved and did continue. This led to a third documented envelope waterproofing effort in 2005. Hoffmann Architects were retained and served as the consultants for the Building Envelope Rehabilitation project. The firm had begun investigating the Sanctuary issues as early as 2001, produced a report in 2003, and submitted drawings in 2005. The work was not executed until 2007. Hoffmann identified that where the STO had previously been installed on the south and east elevations, a silicone sealant was subsequently installed around 1995.[309] Additionally, Hoffmann identified that an elastomeric

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[303] STO is a German company that entered the US market in 1979 and pioneered exterior finish and stucco coatings (EIFS) common in Europe prior to that date.
[304] FPC Project Files
[305] Epoxies are "synthetically produced organic resins" that are classified as thermosetting polymers, meaning they "cannot be reshaped under heat or pressure and will remain fully solid once cured." This is accomplished through a two-part system that includes a resin and catalyzing agent ("hardener") that react and provide strength and rigidity. Joost states that, if mixed and applied properly, epoxy should maintain its strength over a great range in temperature and weather. Joost, *Towards the Conservation of Faceted Glass,* 48.
[306] Rohlf interview, December 19 2016
[307] FPC Project Files.
[308] Letter, Michael William Toto, AIA to Grant Annable, November 14, 1986. FPC Project Files
[309] According to BCA's report, this is a possibly "erroneous date since replacement of the sealant with a

coating, called COMAX, was installed on the north façade around 1994. No further information was available regarding this repair and it appears that this coating still exists on the north elevation.[310]

The Hoffmann report acknowledged an alkali-silica reaction was one cause of the substantial concrete cracking. This observation confirmed conditions reported earlier in the 1970s.[311] Hoffmann's proposed scope of work included:

1. Repair of slate roofing and wall shingle systems
2. Replacement of concrete STO coatings at south and east elevations, in addition to repairing cracks with an epoxy gel
3. Colored glass rehabilitation
4. Rehabilitation of elastomeric concrete coatings at north elevation
5. Replacement of roofing secondary glazing system

Hoffmann recommended the replacement of all metal flashings for the slate systems necessary to be effective in keeping water out of the Sanctuary. They specified the removal of the STO coating applied to the concrete at the south and east elevations and the application of an elastomeric coating to keep the concrete dry, following repair of cracks and spalls, to protect against further degradation. Sealant at all joints between concrete sections or concrete and other materials was also to be replaced.[312]

Regarding the *dalle de verre*, Hoffmann reported that damage to the north elevation was

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silicone based material was not recommended in 1987." See further below Appendix 5.

310 No documentation on this project was found in the FPC Files. No information on the product appears to be readily available. Petrographic analysis of cores removed from the north elevation shows the presence of a coating.

311 *Water Infiltration Investigation*. Hoffmann Architects. 8 April 2003: "A report from 1978 indicates tests on the concrete were made that confirmed alkali silica reactivity was occurring within the concrete. This reaction occurs when aggregates of high silica content are used in the concrete mix. Over time, these materials react with water to form a silica gel. As the gel absorbs more water, it swells causing the concrete to crack as the white silica substance weeps out of the concrete. To stop water from reacting with the aggregate, various coating materials have been applied to the concrete… At the south and east elevations of the Church, this coating consists of a decorative aggregate encased in a reinforced acrylic matrix binder. The coating installed in the mid 1980s appears to be a product called Sto Super Lit that was formerly manufactured by the Sto Corporation. Failures are prevalent in this coating system. This deterioration consists of cracks, spalls and delamination from the concrete substrate. Silica gel is visible weeping through cracks in the coating at the foundation wall."

312 *Water Infiltration Investigation*. Hoffmann Architects. 8 April 2003: the report states that "low sloped roof exists above entrances to the Church Sanctuary, the covered passageway at the north side of the nave and the Choir Room at the northeast end of the Church. All of these roofs slope towards the Church Sanctuary. The roof above the entrance to the Narthex is exposed concrete. It appears that the metal flashing that was installed where the roof intersects the slate wall has been removed and replaced with sealant at the joint between the concrete and slate… the roof at the south entrance… is covered with flat seam lead coated copper roofing. The solder at the seams between the copper sections has failed and has been covered with sealant. This sealant has also failed along with the sealant located in the reglet where the metal roofing terminates into the concrete roof slab. The copper flashing at the back of the roof that extends under the slate shingles is beginning to lose its patina and to corrode."

worsening over time and considered replacement of all the concrete and glass panels similar to the replacement undertaken at the south and east elevations. After consulting with Rohlf's Studio and determining the cost, it was decided to take a more conservative approach. Individual units of broken glass would be replaced instead. However, it does not appear that any glass was replaced during this rehabilitation project.

The protective secondary glazing over the *dalle de verre* panels constituting de facto the roof surface were replaced in 2007, concluding the most recent efforts to solve the moisture infiltration issues. The framing of protective glazing is quite visible, however, as the structural pattern of the aluminum frames do not seem to fully align with the pattern of the *dalle de verre* panels when viewed from the ground,[313] and as the dark brown color of the framing is quite conspicuous.

It appears that, generally, the use of *dalle de verre* within a rigid concrete or epoxy system, in combination with exposure to extreme thermal conditions, has posed a fundamental problem for the First Presbyterian Church. Suggested solutions to this problem have included installing a secondary system blocking direct solar exposure – without affecting the entry of daylight – or continue to periodically recast the *dalle de verre* panels on the south and east elevations.

[313] It is likely that the framing members follow the underlying pattern of the *dalle de verre* panels when viewed as an orthogonal projection not accounting for the foreshortening when viewed from the ground.

Determination of Significance

Summary of Significance

The First Presbyterian Church of Stamford is a highly significant building not only because it is a realization of a bold design by a prominent and influential architect, but also because of its innovative and experimental use of modern forms and technologies. Harrison's design for the Sanctuary is exemplary in that it managed to infuse Modern architecture, with its abstract sensibilities, with the expressiveness of traditional Gothic architecture, especially regarding the use of light to enthrall visitors to the Sanctuary.

The only church project Harrison was involved in, First Presbyterian Church is seminal in Harrison's career, both in his estimation, as detailed above, and as an inspiration for his subsequent work, as evidenced in his use of *dalle-de-verre* in the New York Hall of Science built for the 1964 World's Fair.

First Presbyterian is representative of and influential in the history of post WWII suburban architecture. It was also a premier example of the post WWII architectural movement of designing unique and avantgarde places of worship. FPC, which was an early *dalle-de-verre* project in the United States, is also a realization of an important collaboration between a prominent American architect, Wallace K. Harrison, and a prominent French artist, Gabriel Loire, whose work on First Presbyterian was the first of many commissions in the United States. The Sanctuary is also the result of another intercontinental collaboration, between a leading American architect and an innovative British engineer, Felix J. Samuely.

When completed, First Presbyterian Church was immediately recognized as a building of international architectural significance. In 1959, it was featured in a Museum of Modern Art exhibit, titled "Architecture and Imagery: Four New Buildings", along with three other celebrated buildings: the TWA terminal at JFK by Eero Saarinen; the Opera House in Sydney by Jørn Utzon; and the Notre Dame in Royan, France, by Guillame Gillet and Marc Hébrard. Its completion attracted the attention of popular and professional publications, and it was featured in *Life* and *Time* magazines, as well as in *Architectural Forum*. The attention it received popularized *dalle-de-verre* in America, and architects and American stained glass studios were quick to learn and utilize the technique widely.

Today the Church through its programs and policies, maintains its cultural and social significance in the community of Stamford in that it is used and enjoyed not only by its Presbyterian congregants, but by non-Presbyterians and members of the broader community, who appreciate and take advantage of the many civic services FPC provides and hosts. Among the many ways FPC opens its doors to the larger community are cultural and musical events, voting, and educational programs for children.

The following section describes the process by which the above significance was assessed, presents a more detailed discussion of the factors which make First Presbyterian Church a highly significant building, and offers a broader assessment of significance for the Sanctuary and the other components which make up the Church complex.

Assessment of Values & Significance

Typically, the focus in preservation has been on architectural, historical and cultural significance of buildings and sites. The conservation management plan seeks to establish a broader definition of significance and extend it out into the larger community. To achieve that goal the Highland Green Foundation hosted a meeting on November 7, 2016 to discuss the significance of the campus of the First Presbyterian Church and its role in the development of the Stamford community. Attendees included members of the congregation, neighbors, professionals involved in urban and architectural developments in Stamford, historians, and project staff. The various participants offered input regarding the assessment of significance to be included in the Comprehensive Management Plan. The goal was to identify and describe key values which current and previous stakeholders (such as the congregation, staff, local communities, and tourists) have placed on the site over time, and to explain the various ways in which the church is important both in general and in detail for each of the main components, contributing to specific value judgements about the degree of historical, theological, cultural, aesthetic, technological, social, and other types of significance.

This meeting, along with supplementary research, helped identify FPC's values and significance. In talking with community members and carrying out additional research about value (including the overall notion of Outstanding Universal Value and Significance)[314], a hierarchy of value was created to emphasize particular features within the church complex and the degree to which those values contribute to the overall significance of the church. A concept diagram delineating the degree of value which certain spaces carry, and further discussion about resultant policies, can be found in the following section of this Conservation Plan.

Outcomes of Highland Green Foundation Meeting

The discussion of values and significance that took place on November 7, 2016 at the First Presbyterian Church successfully resulted in participants offering insights regarding key components of the church's design, history, and role in the community. Members of the community conveyed certain value judgements about the church, which have been described below.

The consensus was that the experience of the Sanctuary is a vital component of the site's significance. It is the "awe-inspiring"[315] experience of approaching the Sanctuary, entering, and experiencing the "visual surprise" that expresses the language of the day. The Sanctuary was described as not only a place for events, such as marriage and other ceremonies, but a place that offers more at a spiritual level. By many, the Sanctuary was seen as a place to take solace, to re-focus, and as a spiritual home for not only Presbyterians, but to many throughout Stamford. The Sanctuary was described as having an "overwhelming design that once entered, feels accessible."

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[314] This terminology refers to the criteria for significance established for the World Heritage program. See further below for a more detailed discussion.

[315] One participant said that the Sanctuary of the First Presbyterian Church might be the only "awe-inspiring" place in Stamford, using a term common in the 19th century.

Diversity was another topic of discussion at the meeting. It was noted that with a rabbi in residence, inter-faith relations exist within the complex. At the meeting, a participant mentioned that someone unfamiliar with the complex once approached the building and had asked, "may I come into this holy place?" The First Presbyterian Church is unique for this reason. On a typical Sunday, the congregation sees much diversity.

From the topic of diversity, the discussion moved on to accessibility. The complex is experienced as a space that serves as a melting pot for the community, where people come from the greater community to participate in events (such as Scottish Sunday, concerts), including inter-faith events. Fellowship Hall contributes to this, as it provides an excellent place for community use. Since its size and configuration are unique it provides for a variety of opportunities. As described in the meeting, the complex is "civic hardware" for Stamford.

The complex also interweaves the history of the church and the town. The Stamford Historical Wall, situated along Bedford Street, features gravestones that describe important people and events in national and local history within the past 300 years that made contributions to the physical, religious, and cultural growth of Stamford from 1641 to 1941.

First Presbyterian's after-school program and nursery school were also discussed. Since the beginning of the church, there has been an educational component. In 2008, the after-school program "Creative Learning at FPC" was established.

Participants felt that the church should be a nationally recognized tourist attraction. Already, according to one participant, it is one of the four "places to see" in Connecticut. Being within a couple of miles of the train station makes the site is accessible. Another participant mentioned that in 1978, tour buses would come to the church. Another participant said that "no building has surpassed the church" in Stamford" in the last 40 years, in terms of its uniqueness.

Many other topics were discussed during the meeting, ranging from the site's location within the city and availability of open space to liturgy. Comments from participants referred to the church and its "edifice complex"; architectural significance (the church as the "eighth wonder of the world", the result of a challenging holistic design and collaboration between architect, engineers, and contractors, which sets an architectural standard); music (the shape of the Sanctuary, in addition to the acoustics and carillon); and the architect (Wallace Harrison, throughout his career, explored concrete construction)."

The complex was seen as evoking Protestantism in the 1950s, a time of great optimism, and the Sanctuary, in particular, expresses this sentiment. The discussion culminated in a dialogue about how to retain the uniqueness of the First Presbyterian Church and how the site can remain relevant in the 21st Century.

Value

Definition of Value

The concept of "Outstanding Universal Value" (OUV) has been discussed extensively since the beginning of the World Heritage Convention in 1972. Since its initial acceptance, criteria for establishing OUV has continued to evolve and the definition has been given more specifics.[316] Examples of relevant criteria include:

- The site represents a masterpiece of human creative genius[317]
- The site exhibits developments in architecture or technology
- The site is directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic works of outstanding universal significance

OUV generally refers to: cultural and/or natural significance that is so exceptional as to transcend national boundaries and to be of common importance for present and future generations of all humanity. As such, the permanent protection of this site is of highest importance to the international community. A site of OUV meets conditions of integrity/authenticity[318] and has an adequate protection and management system to ensure its safeguarding. Broadly, OUV refers to properties that are exceptional and outstanding from a global perspective (not only at the national/regional levels) and have cultural worth.

Values in this context are physical expressions of communal aspirations, and they contribute to the meaning and the overall significance of the site or building to which they are attributed.

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[316] For the definition of "outstanding universal value" and the criteria for selection, see www.whc.unesco.org/en/criteria as accessed June 30, 2017.
[317] Ibid.: "A masterpiece of human creative genius" should be interpreted as "An outstanding example of a style evolved within a culture, having a high intellectual or symbolic endowment, and a high level or artistic, technical or technological skills."
[318] Ibid. *Operational Guidelines for the Implementation of the World Heritage Convention* (2016), II E: Integrity and/or Authenticity, 79-95. Integrity relates to the 'wholeness and intactness' of the property and how it conveys the values it holds. Integrity can also relate to any threats affecting the property (will the values continue to exist?).

Value Discussion

The text of the outline below was distributed at the above mentioned meeting to provide a starting point for the discussion of the *values* attributed to the First Presbyterian Church.

Architectural Value

I. Sanctuary

The basis for the examination is preserving the spirit (the experience) of the building. This can be accomplished by maintaining authenticity and preserving integrity through recognizing the architectural, historical, and use value; minimizing the loss of historic fabric; and maintaining the intent of Wallace Harrison, specifically including (but not limited to):

a. Preserve elements of the interior—for instance:
    i. Preserve original *dalle de verre* and maintain replaced glass by surveying representative sections and comparing conditions and outcomes.
    ii. Preserve and maintain the precast concrete "space construction" structural system as developed by Samuely and Harrison by surveying representative sections and comparing conditions and outcomes (of both precast and poured-in-place concrete).
    iii. Preserve the original interior features such as pews and branched pendant fixtures in the nave; preserve the original table and pulpit in the chancel.
b. Study the moisture infiltration in the *dalle de verre* walls of the Sanctuary, the structural condition, and the implications of the introduction of climate control in order to preserve the structure and its architectural fabric, and to better support use of the space.
c. Address deterioration and moisture-infiltration issues through understanding building performance and materials, treating typical conditions, and performing the above-mentioned preservation.
d. Review original drawings to understand the design evolution and the original decision-making process in order to establish significance.

II. Choir Room

Maintain the authenticity of and preserve integrity through recognizing values in this particular space through overall space and form, including (but not limited to):

a. Preserve elements of the interior—for instance, the cabinets.

III. Passageway (covered walkway)

Maintain the authenticity of and preserve integrity through recognizing values in this particular space through overall space and form, including (but not limited to):

a. Preserve elements of the interior—for instance, coat racks.
b. Minimize loss of historic fabric—for instance, glazed exterior corridor.

IV. Parish Unit

Maintain authenticity and preserve integrity through recognizing the architectural, historical, and use value; minimizing the loss of historic fabric; and maintaining the intent of Willis Mills.

a. Preserve elements of the Chapel interior—for instance, the original *dalle de verre* skylight (which in this space serves as the trial run for the entire Sanctuary glass) and the stones with incised names of the places where they were collected.
b. Maintain architectural integrity of Fellowship Hall as updates are carried out—for instance, the exposed diagrid structure of the ceiling.
c. Maintain architectural integrity of the Classrooms/Offices/Administration and improve functionality as updates are carried out, specifically including recent renovations.
d. Maintain the overall appearance and architectural integrity of the Corridor as updates are carried out—for instance, the artwork (sculpture) and fragments of stained glass, which are movable but part of the overall integrity of the space.

V. Carillon Tower

Maintain authenticity and preserve integrity through recognizing the architectural, historical, and use value; minimizing the loss of historic fabric; and maintaining the intent of Wallace Harrison, structural engineers Ammann & Whitney, and the carillon's designer Dr. Arthur Lynds Bigelow, specifically including:

a. Preserve and maintain the structural integrity of the poured-in-place system by surveying representative sections and comparing conditions and outcomes.
b. Maintain the architectural and structural integrity of the Tower as repairs are performed.
c. Maintain the Tower as a sculptural work.
d. Preserve the historical and use value of the 56-bell instrument—including 22 bells cast by Gillett and Johnston and 34 bells cast by Paccard in 1967—and its two bell chambers.

VI. Landscape

Maintain the authenticity and preserve the integrity of the landscape through recognizing the historical and use value; minimizing the loss of historic fabric; and maintaining the intent of Wallace Harrison and Bryan J. Lynch, landscape architect, specifically including:

a. Preserve elements of the landscape—for instance, the Stamford Historical Wall and the Church History Walk (which were planned for the site in the 1940s and executed in the 1960s), the Memorial Garden, and the Celtic Cross.

Evidential or Scientific Value

I. Work of prominent American architect and European masters

Maintain the Sanctuary as physical evidence of one of Wallace K. Harrison's greatest accomplishments, and as physical evidence of the collaborative process that took place between Harrison and the French stained-glass artist Gabriel Loire and the prominent British engineer Felix J. Samuely.

II. Experimental and innovative technologies

Maintain the complex as physical evidence of primary experimental and innovative construction technologies, specifically the use of precast concrete and thin-shell construction, and the use of *dalle-de-verre*.

Cultural/Religious/Etc. Value

III. Theology

Recognize the theological history of FPC.

a. Theologically, Rev. Campbell wanted the Sanctuary to convey a Presbyterianism that *"…addressed a God who was as much a part of everyday life as he was a transcendental being."* Harrison suggested "everyday life" in concrete, a vernacular, cost-efficient contemporary building material.

IV. Liturgy

Recognize the liturgical history of the FPC in order to preserve its integrity—including:

a. Preserve the musical experience through recognizing the historical and use value of the pipe organ and carillon.

V. Historical

Identify the historical value of the FPC to preserve its integrity—including:

a. Recognize the social history of the complex.

Social/Community/Use Value

I. Maintain the integrity of community uses through recognizing the historical and use value; maintain the overall concept of the church as an institution, including:
   a. Preserve the integrity of the school, nursery, and afterschool programs.
   b. Preserve the integrity of community programs.

Additional values to keep in mind:

- Recognize contributions of others: keep evidence of contributions, continued use and continuity, demonstrate changes over time.
- Maintain and preserve the structure to its primary period of significance. On the other hand, replacement may serve as a layer that shows intervention and the thought process behind what needed to be done during a certain period of preservation.
- Assess the results of past conservation/remedial projects to understand the performance and conservation issues.
- Develop a remediation and conservation program applicable to FPC and other future remediation projects.

Significance

Definition of Significance

Cultural significance is the term that the conservation community has used to encapsulate the multiple values ascribed to objects, buildings, or landscapes. … these values have been ordered in categories, such as aesthetic, religious, political, economic, and so on. … This identification and ordering of values serves as a vehicle to inform decisions about how best to preserve these values in the physical conservation of the object or place.[319]

Significance Discussion

The below outline was distributed at the above-mentioned meeting to provide a basis to discuss the *significance* of the First Presbyterian Church.

Construction Significance

I. Samuely & Harrison collaborated to develop the "space construction" system of the Sanctuary, which suggests inclined folded plates and is constructed of precast panels.

   a. Today, the system is regarded as reinforced thin shell (due to the seam-ribs). The Sanctuary suggests the central constructional idea of the Gothic cathedral and was experimental in nature from the start. The technology and methodology of construction and materials were cutting edge, particularly the configuration and shape of the Sanctuary.
   b. Harrison said that:

      "the structure is wonderful. We are only beginning to open up an exciting new world of space construction… of domes and rounded, hyperparaboloid frames to span space."[320]
   c. The construction process would be different today: drawings would be much larger and records of any design changes would have been documented much differently. Currently, we don't know why certain design changes were made during the course of construction and we don't know who made them.
   d. Complex procedure of building the panels
   e. Selection of contractors

Design Significance

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[319] Avrami, Erica C., and Randall Mason. *Values and heritage conservation: research report*. Los Angeles: Getty Conservation Institute, 2000, p. 7

[320] Von Eckardt, "A Lay Report on Harrison's Stamford Church", 37-39

I. The Sanctuary involves innovative forms and materials based on a traditional division of interior church design, contributing to the particular spirit of the church.

  a. The church's design evolution is a significant component of the original vision. Harrison utilized the project as an opportunity for exploration and experimentation. The experimentation involves structural form (that which suggests a folded plate) and material. The change to the original *dalle de verre* is an intervention that may serve as an extension of Harrison's unique perception of experimentation and continued use.
  b. The property's high-profile design introduced new large-scale high quality precast and *dalle de verre* insets to American ecclesiastical buildings. The Sanctuary interior continues to provide religious and secular visitors with a unique, deeply moving architectural experience.
  c. It was a challenge to fulfill Harrison's design. In reference to the project, he wrote:

     "…architecture is hard. New methods of construction, new materials and new designs create a multitude of unforeseen problems never met before. The roof of the church still leaks. We have not yet found the correct lighting fixtures. We are not quite satisfied with the design of the pulpit. And yet, on the other hand, there are also happy consequences too of new design: we found that the large scale faceting of the interior provides a variety of reflecting surfaces which increase the diffusion of sound to the extent that no public address system is required for this church which covers a quarter acre of ground…"[321]

II. The FPC complex demonstrates the merging of art and architecture.

  a. *dalle de verre*
     i. FPC was artist Gabriel Loire's first United States commission (also marking Loire's first ecclesiastical commission in the country) and was the most challenging (logistically and technically) in his studio to date. The program marked a turning point for Loire toward greater abstraction in composition, and the wide publicity attending the completion of the Sanctuary quickly popularized the material for its economy and aesthetic impact, leading to subsequent commissions for Loire throughout the country. Harrison went on to feature the material in his New York Hall of Science project.
     ii. Harrison collaborated with both Rev. Campbell and Loire to create the unique abstract iconography; the design was worked out largely through the mail—Harrison and Rev. Campbell determined the theme, Harrison sketched ideas for representational suggestions and abstract patterns, and Loire created the glass.
  b. The Carillon Tower emphasizes Harrison's achievements in crafting iconic sculptural structures. The original design for the Tower was unsatisfactory to Harrison and to the congregation; the current design seems to have been influenced by a work by American sculptor Richard Lippold; Walter Maguire had sent Harrison a published photograph of Lippold's work called *Primordial Figure*, which suggests lines that may have been incorporated into the Tower design.
  c. The Sanctuary also emphasizes Harrison's achievements in crafting iconic sculptural structures—the Sanctuary's basic shape was derived from a modified megaphone.
  d. Harrison wrote about the relationship of art and architecture and said:

[321] Type-written manuscript, Wallace K. Harrison Collection, Avery Library, Columbia University.

"When you've plodded through it all methodically form the beginning—the human needs, the floor plan, the economics, the structure—you still must get an emotional reaction. The answer is to merge art and architecture. At Stamford we did it by bringing in color and the stained glass design. I would have liked to get sculpture, too. I don't mean going out to buy it, but sculpture which grows out of architecture. The future belongs to the integration of architecture, painting, sculpture and landscaping—to what has been called 'total architecture'." [322]

III. Wallace K. Harrison

a. A major American Modern architect, Harrison designed large International Style buildings and was known for those and a few midsize projects. He was a planner, known for holistic designs that were much larger than the Sanctuary. The Sanctuary exemplifies his skill in combining design and construction technology; the Sanctuary is the best known and most influential of his smaller projects; it demonstrates his personal approach to Modern design. Throughout his career, he explored concrete construction.
b. The Sanctuary is an outstanding work by Harrison that is the outcome of a notable partnership between Harrison and Gabriel Loire, a major figure in the adaptation and international diffusion of the glazing systems in the post-World War II era.
c. Harrison created a work that is reminiscent of medieval experiences—it is also the result of an extraordinary integration of modern liturgical, technological, and aesthetic considerations that he developed through analysis and abstraction of a particular type of building tradition.

Architectural Significance

FPC is an example of church architecture in a post-World War II era that demonstrates a modern approach to medieval ecclesiastical concepts. As mentioned above, Harrison's collaboration with others and consequential integration of concepts—including liturgical, technological, and aesthetic—resulted in a unique work of architecture. The Sanctuary sets an architectural standard, and shows that the congregation had the foresight and courage to select Harrison for the project. It has been described as maybe the only "awe-inspiring" space in Stamford.[323]

I. Precast

a. Although not yet widely used as an exposed interior finish in liturgical settings in the United States, concrete had a long precedent in church design in Europe since 1923 and was well-suited to Gothic expression. Harrison looked to precast concrete, a material that he knew well for its economy from prior experience.
    i. Harrison explored a new application of a material/type of architecture–he experimented with precast in other capacities, specifically utilizing the material for low cost housing in Latin America.

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322 Von Eckhardt, "A Lay Report on Harrison's Stamford Church", 40
323 See above discussion of comments made by participants in the community meeting.

b. Understanding the maintenance of this material will help guide a CMP for the church, which can then be applied to other modern buildings with similar systems.

II. *Dalle de verre*

a. Understanding the evolution of the fabrication process and its maintenance will help guide a CMP for the church, which can then in turn be applied to other modern buildings with this type of glass.

III. Carillon Tower

a. The Carillon Tower is a result of the architect and congregation seeking an ideal solution for a tower after rejecting the original plan. Ten years after the Sanctuary was constructed, Harrison was able to create a unique structure and collaborated with several parties, including the Carillon Committee, the congregation, structural engineering firm Ammann & Whitney, and Dr. Arthur Lynds Bigelow, a published authority on carillons and Bell Master at Princeton University, who designed the church's new instrument.

Cultural/Religious Significance

I. Explore the reasons leading to a decision to build a modern church.

a. The suburban complex exemplifies national trends in post-World War II American culture for its close association with Elbert Moore Conover (1885-1952),[324] a leading voice who advocated for church development outside urban centers and who served as a pre-development church building consultant.
b. FPC is an outstanding example of a suburban religious campus built during the post-World War II ecclesiastical building boom that lasted through the 1960s. The rapid growth of the suburbs stimulated the development of new facilities accessible to automobiles with greater up-to-date program space for education and other activities.
c. Acoustics, a priority at FPC due to the emphasis on spoken word and organ music in services (music is central to the worship experience), was the primary requirement of the interior plan and volume (this informed the original scheme more than anything else).
    i. In an interview, Harrison said:
    "…. We wanted the acoustics as near perfect as possible. The acoustical people I brought in, Bolt, Beranek and Newman of M.I.T., didn't want any obstructions to the smooth flow of sound. A square arrangement wouldn't do. We had to modify and re-modify…. Finally we arrived at the shape of an elongated megaphone to spread the sound toward the rear. That determined the shape. The fish symbolism was discovered later. When you are finally done, people will always rationalize."[325]
    ii. Sanctuary

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[324] Conover was a minister who traveled to Europe to study architecture from 1926 to 1932 and influenced the design of Protestant churches. He also wrote books on church design.
[325] Von Eckhardt, "A Lay Report on Harrison's Stamford Church", 39

1. Megaphonic shape
2. Local high school uses the space for chorus
3. The organ installed in 1991 was the largest mechanical-action in New England at the time. This type of organ dates to the 13th century
4. Bells were placed specifically so that the sound would be perfect (Bigelow)[326]

iii. Organist: the organist has been at FPC since 1978

d. Liturgy: FPC was built during a time of great optimism and increased attendance.
e. Diversity
    i. Welcome other religious groups, including a rabbi in residence (additionally, the wall in the chapel and its similarity to that in Jerusalem has been noted); sessions for Muslims/Christians/Jews (theology)
    ii. The Sanctuary feels like a cathedral that is open to all people
    iii. The Historical Wall has gravestones that interweave the history of the church and town
    iv. Not a typical Presbyterian congregation
    v. The architecture contributes to the diversity in Stamford

Community/Use Significance

I. The FPC is an institution in the City of Stamford that serves as a spiritual home to many people.

a. Many members of the congregation and ministry are involved in multiple aspects of the Stamford community and over the years have been influential in enhancing the quality of local life.
b. Events held at the church are popular and contribute greatly to making Stamford a wonderful place in which to live and work; Fellowship Hall, for example, has offered the community a space of unique size and configuration in which to host events such as:
    i. Docomomo
    ii. Scottish Sunday
    iii. Concerts
    iv. Inter-faith events
    v. Marriage Ceremonies
c. The campus provides a beautiful and essential part of Stamford's urban landscape. It offers "land use" value:
    i. The campus provides open space for activities such as picnics on the lawn, and it is the second largest downtown park (second to Scalzi Park) in Stamford
    ii. Outdoor concerts (opportunity for: "melting pots"; invite people inside and engage more people from the greater community)
    iii. Its location within the city is on neutral ground that is centrally located and therefore accessible (it has been pointed out that the location is ideal for a school, which FPC offers); it is accessible by car, bus, walking, biking, etc.
    iv. People want to live nearby because of the space

[326] Barton, "First Presbyterian Church"

d. The FPC offers youth programs, both afterschool and educational. FPC had offered a nursery school or day care since opening, but this has recently been closed. An after-school program called "Creative Learning at FPC" was initiated in 2008.
e. The FPC's Sanctuary is a place to take solace and re-focus.
f. FPC has been part of the urban planning and civic building, it was referred to at the community meeting as "civic hardware"
g. Tourism
    i. The Fish Church is the most unique building in Stamford, and has been since it was constructed.
    ii. It has yet to be nationally recognized, but it is in the top four places to see in Connecticut.

Significance from the National Historic Landmark Nomination[327]

1. First Presbyterian's sanctuary, parish unit and Carillon Tower are eligible under NHL Criterion 4.
2. The property is a singular work by Wallace K. Harrison (1895-1981), a major American Modern architect. Well known for large International Style buildings and complexes that introduced significant, replicable innovations in planning and construction technology to American architecture, the sanctuary is the best known and most influential of his smaller projects which additionally demonstrate his personal approach to Modern design.
3. The Sanctuary (1956) exemplifies Harrison's skill in leading collaborative design, which was a key to his success in projects of all scales. It was the product of a remarkable collaboration between Harrison and Gabriel Loire (1904-1996) a major figure in the revival and international diffusion of the ancient glazing system in the post-World War II era. The close collaboration between the architect and structural engineer Felix James Samuely (1902-1959), Studio Loire, acoustical consultants Bolt Beranek & Newman, and Willis Mills (1907-1995), architect of the attached parish unit, is characteristic of Harrison's successful working relationships throughout his career. The resulting sanctuary (1958), freestanding carillon tower (1968) designed by Harrison and parish unit (1956) are carefully integrated as an ensemble and exemplify Harrison's strength as a master planner.
4. The sanctuary's use of *dalle de verre* stained glass, the largest and most publicized installation in North America at its time, popularized the material during the post-war building boom at mid-century.
5. The sanctuary is an early and widely publicized example of both a thin shell constructed of precast concrete and demonstration of inclined folded plates in a non-industrial American building.
6. Additionally, the suburban complex exemplifies national trends in post-World War II American culture for its close association with Elbert Moore Conover (1885-1952), a leading voice who advocated for church development outside urban centers and who served as a pre-development church building consultant.
7. Though a little less than 50 years old, the soaring carillon brackets Harrison's accomplishments in creating iconic sculptural structures beginning with the Trylon and Perisphere at the 1939 World's Fair and qualifies for listing under Criteria Exception 8 because of its exceptional importance. The property has a high degree of integrity.

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[327] *National Historic Landmark Nomination*, June 22 2017.

Significance Hierarchy

After the gathering of information (detailed in the preceding sections) necessary for a comprehensive understanding of the Church complex, a hierarchy of significance was established and applied to the various spaces within First Presbyterian Church. This resulted in the formulation of levels of significance which provides HGF and the church with parameters for future architectural interventions, preservation efforts and maintenance actions. Three (3) levels are defined as follows:

Level 1

This level, which represents the greatest significance, considers the experience of the entire site, and thus consists of elevations that are of greatest visual value to the visitor's experience. Level 1 includes all elevations of the Sanctuary; the Choir room; the Sacristy; the Covered Walkway as an extension of the Sanctuary's north elevation; the Chapel, its corresponding entryway and the Parish Unit corridor window wall; the Carillon Tower; and portions of the landscape. These spaces have the highest degree of significance, as they make the most significant contribution to the overall experience of the site and buildings and should, as such, be held to the maximum efforts for conservation and to safeguard their original intent and appearance.

Level 2

This level designates a high degree of significance but somewhat lower than Level 1. It considers the experience of secondary spaces within the site and their contribution to the whole. It includes the restrooms and utility room adjacent to the sacristy; Fellowship Hall, and the Parish Unit administrative spaces and classrooms (ground floor and basement). Much of the original configuration of these spaces has already been affected by repairs and alterations that were necessary to allow for the continued, efficient use of its multi-purpose rooms and to meet certain requirements necessitated by administrative and educational needs. Each space in Level 2 has a functional focus, yet still holds architectural and historical value; Level 2 spaces have been, and should continue to be, treated as important fabric. Every effort should be made to maintain as much as possible original intent, volume and material to high standards of conservation.

Level 3

This represents the lowest tier of significance and includes mostly utilitarian and utility spaces within the site. These spaces are not anticipated to be preserved in any particular form and are not held to the standards applied to Level 1 and Level 2. They are considered to be contributing to the experience of the site or affect the spirit of the place as originally intended.

Specific policies based on these levels of intervention are further discussed in the Conservation Policy section of this Conservation Management Plan.

A similar hierarchy for levels of intervention was established for the various elevations. Here the designation presented an interesting challenge for the Sanctuary walls. After several previous envelope restoration attempts, the original *dalle de verre* in its concrete matrix inserts remain only in the sky-facing roof panels and in the wall panels of the north elevation (in addition to the original *dalle de verre* installed in the chapel skylight). The *dalle de verre* in epoxy matrix inserts in the wall panels of the south elevation, in addition to the wall panels of the east elevation (narthex), are replacements. These panels, while quite accurate replicas, are not original and, to some extent, they should be treated with a different degree of significance. While the original *dalle de verre* and concrete panels hold, per definition, a higher degree of significance than the replacement panels, their significance in context of their elevation and their contribution to the architecture should be judged similarly. The significance of the replacement *dalles* is two-fold: first, that they provide an opportunity to experience the Sanctuary as originally intended; second, that they provide an opportunity to create replicas that resemble the original fabric in lieu of not having the original fabric.[328]

The exterior massing of the Sanctuary is significant and is to be preserved regardless of the originality of the glass. The *dalle de verre* is uniquely experienced from the interior of the Sanctuary, and this is the visual impression of being inside a sapphire to which Harrison referred. *Dalle de verre* is generally unexceptional as viewed from the exterior.[329] This interior experience can be preserved, and this has already been demonstrated through the 1980s restoration campaign. The significance hierarchy related to the *dalle de verre* is important when considering recommendations for the conservation of the Sanctuary.

The established hierarchy (Levels 1, 2, and 3) was devised following a complete study of the church complex. The hierarchy of spaces within First Presbyterian Church helps to guide the policies specified in the Conservation Policy section of this Conservation Management Plan. The policies are based on an approach that considers varying degrees of significance within the complex; the hierarchy, and in turn the policy section, recognizes the original design, subsequent changes, and the impact of and need for possible future alterations.

Below are the lists of spaces and architectural features and the various levels of significance assigned to them.

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[328] It can be argued that after 30 years the dalle de verre installed in the 1980s has reached a level of significance in their own right.

[329] This idea is explored in the *Dalle de Verre* section of this report. In her thesis, Bubnash writes that "as viewed from the interior, the *dalles* are usually more exceptional than their exterior appearance would indicate, since they glow as light is diffused through the slabs." This effect is called "halation" and refers to the spreading of light beyond the glass. Bubnash, 23-24.

Exterior

Zone 1

Sanctuary
Choir Room (east and north elevations)
Covered Walkway
Sacristy corridor (south elevation facing the garden)
Parish Unit (south and west elevations; corridor along window-wall: south and west elevations)
Chapel (south and west elevations)
Carillon Tower (all sides)

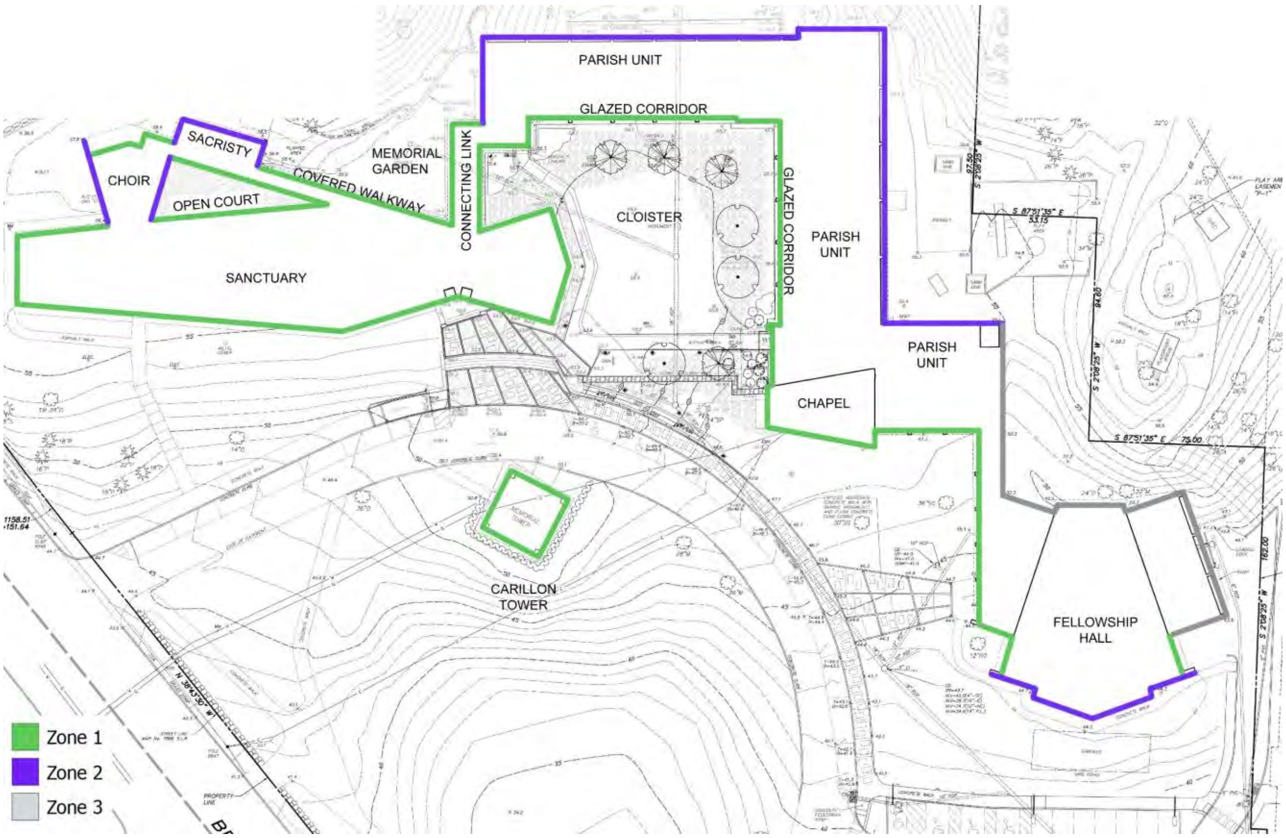
Zone 2

Choir Room (west elevation)
Sacristy (north elevation)
Parish Unit (north, partial east, partial west elevations)
Fellowship Hall (south elevation)

Zone 3

Parish Unit (partial north and partial east elevations)

Exterior Levels of Significance:



Interior

Zone 1

Sanctuary
Choir room
Sacristy (kitchen)
Covered Walkway
Parish Unit corridor (including Chapel entrance)
Chapel
Fellowship Hall: volume and diagrid structure
Carillon Tower

Zone 2

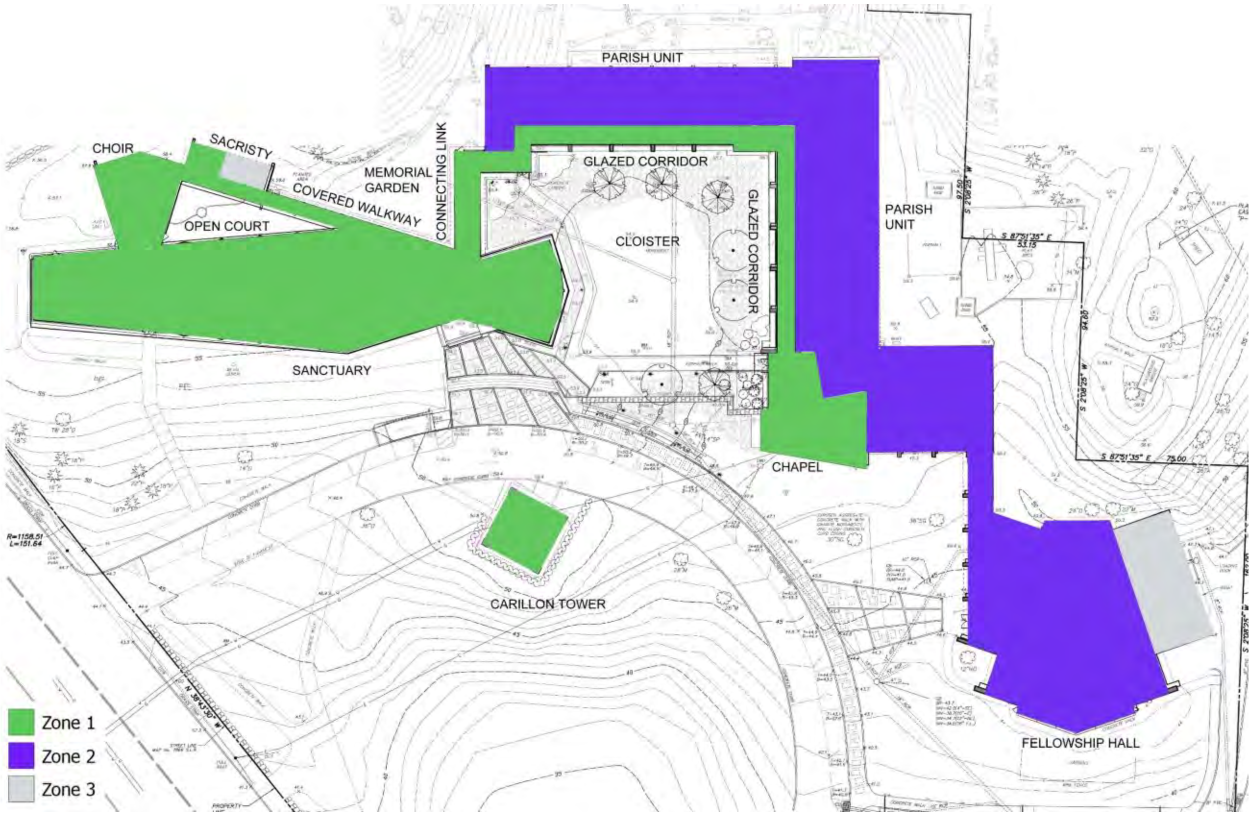
Choir Room
Restrooms & utility (adjacent to sacristy)
Fellowship Hall (excluding the volume and diagrid structure, which are Level 1)
Parish Unit Administrative Space and Classrooms (ground floor and basement)

Zone 3

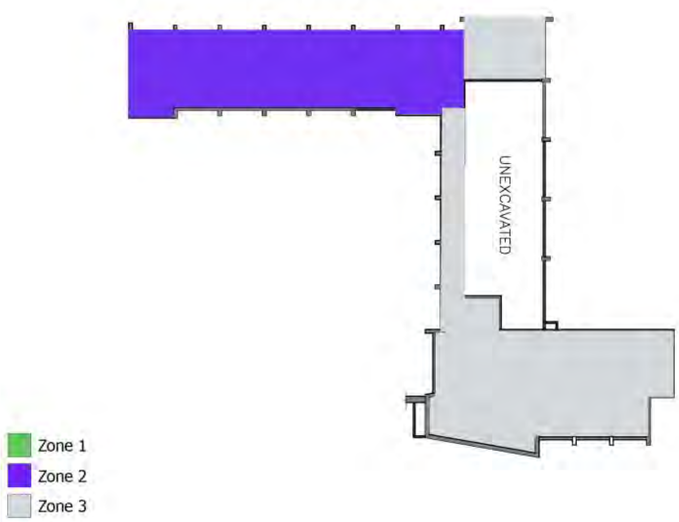
Utility Spaces

Interior Levels of Significance

Ground level



Lower level (Parish Unit)



Landscape

Zone 1

Overall Topography
The Bowl
The "Cloister"
Open Court
Stamford Historical Wall
Memorial Walk

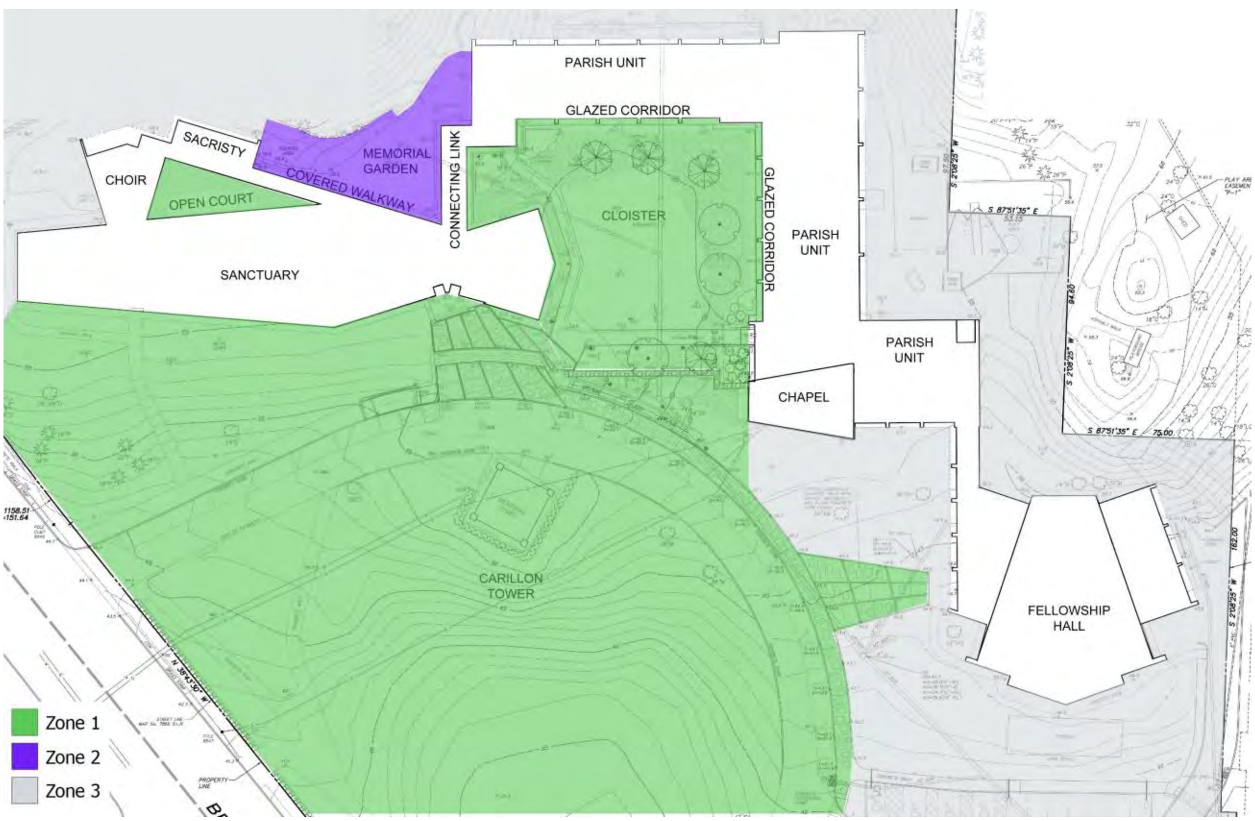
Zone 2

Memorial Garden

Zone 3

Parking Lots
Utility Spaces

Landscape Levels of Significance



Summary of Conditions Surveys

An integral and critical part of a Conservation Plan is the survey and assessment of existing conditions. They provide the base line for all subsequent assessments, recommendations and policies. This section includes brief descriptions of the outcomes of the survey for each discipline. While these surveys were not conducted simultaneously, each took place during the investigation phase of the project. The detailed surveys are included as appendices.

The following surveys are summarized on the subsequent pages:

1. Architectural
2. Conservation
3. Structural
4. Mechanical/electrical/plumbing
5. Aerial photography

Architectural

An investigation of the Sanctuary, the corridor, the Parish Unit, and the Carillon Tower was conducted by Prudon & Partners LLP of New York, New York, during the fall of 2016. The investigation and survey included a number of preliminary steps before the actual site survey was undertaken. They included: a compilation of historic and other related documents, a review of this archival information, cataloguing surviving architectural and other drawings in FPC's archives as well as in Avery Library at Columbia University, the preparation of as-built drawings using the surviving drawings and utilizing the point cloud based data of a laser scanning survey. With these tasks completed a ground-based visual survey of all parts of the church complex was conducted. The ground level acquired information was supplemented with a review of high resolution photographs taken using cameras mounted to a drone (both inside and out). Laboratory testing of selected samples of materials removed from the Sanctuary was conducted by the conservation consultants and provided further insights. Reports by structural and mechanical, electrical and plumbing, as well as the conservation consultants were reviewed. The results of Prudon & Partner's investigation are further expanded upon below and in the Guidelines and Recommendations section of this report and were recorded on various drawings.[330]

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[330] See Appendix 1: Drawings

Conservation

A preliminary investigation of the Sanctuary's building envelope and the *dalle de verre* in the chapel (in the Parish Unit) was conducted by Building Conservation Associates Inc. (BCA) of New York, New York. The investigation included a review of relevant archival information detailing the building construction and previous restoration campaigns as compiled by Prudon & Partners in the initial stages of the project, a ground-based survey of the envelope and its building materials and elements, a review of high resolution photographs taken using cameras mounted to a drone, and laboratory testing of materials. The report is intended to serve as a baseline for planning future conservation efforts at FPC. Specific materials and features examined as part of the survey included: cast-in-place concrete, pre-cast concrete panels, concrete and epoxy *dalle de verre* panels, exterior slate, and waterproofing. The conservation report indicates BCA's preliminary findings (Appendix 5).

Structural

The structural survey of the Sanctuary, Carillon Tower, and Parish Unit was conducted by Old Structures Engineering (OSE) of New York, New York. The investigation included a visual survey of each structure and a preliminary structural analysis of the Sanctuary frame. The goal was to determine if any structural deficiencies existed. Particularly the structure of the Sanctuary was reviewed. It was noted that some of the concrete frames appear to show signs of overstress and excess deflection. This was of concern because it would imply that some of the load was being redistributed to the wall/roof panels. In analyzing the observations, OSE have indicated that a few members are probably overstressed under full design load and the deflection of the structure is significant enough to redistribute a portion of the load to the more rigid non-structural wall/roof panels. This seems to raise the question as to whether and how this is a contributing factor to the failure of the *dalle de verre* panels. In summary OSE's structural report (Appendix 6) indicates:

Sanctuary

1. The Sanctuary showed varying signs of water damage, including peeling paint, efflorescence, minor/superficial cracks, spalling, and larger vertical cracks due to rusted reinforcing bars.
2. Signs of overstress (such as diagonal and horizontal cracks at frame joints and slight out of plane movement) were noted.
3. Cracks were observed along the top of the foundation walls.
4. Crushing failure was observed on the interior foundation wall where the stair to the balcony bears on the wall.

Carillon Tower

1. Cracks were observed along the surface of all the supporting columns (likely caused by typical wearing of concrete).

Parish Unit

1. No signs of significant underlying structural issues were observed.
2. Spalls and cracks have developed around a large penetration for the pipes in the west foundation wall of the boiler room.

Mechanical, electrical and plumbing systems

A preliminary survey of the Sanctuary, Carillon Tower, and Parish Unit was conducted by Bicaluro Associates P.C. of Old Bridge, New Jersey to review, in general. the mechanical, electrical and plumbing systems. The investigation included a visual survey of the systems in each structure in December 2016. In addition, a review of the then proposed Air Conditioning system for the Sanctuary was included. The preliminary report concentrates on identifying the existing mechanical and electrical systems currently installed and recommends a number of upgrades as required. Comments about ventilation and fire alarm systems were also included. The attached mechanical report indicates Bicaluro's preliminary findings (Appendix 7).

Existing Conditions Assessment

The First Presbyterian Church complex has three architectural components: Sanctuary, Parish Unit and the Carillon Tower. This difference between the buildings is not only in the function, but is also reflected in structural design, building construction and material use. The buildings were also constructed at different times: first, the Parish Unit; second, the Sanctuary, and, finally, the Carillon Tower. While the Sanctuary represents an innovative use of precast concrete panel sections with *dalle de verre* decorative infill panels, the freestanding Carillon Tower is mostly a poured-in-place concrete structure with a very large and deep foundation to accommodate lateral wind forces. The Parish Unit, which is attached to the Sanctuary by a covered and enclosed passageway, is a more traditional load bearing masonry structure with concrete floors and built-up roof construction and reflects school construction at the time. The differences in building construction is reflected in the conditions observed.[331]

Process and Methodology

As noted, the surveys used several different inspection methods to compile and document existing conditions. Aside from visual observations from the ground—with or without the use of binoculars—the use of aerial photography (via drone technology), both inside and out, proved to be the most useful, particularly for the Sanctuary, where heights and complexity of form severely limited hands-on access.

The surveys were further complemented by the removal, testing, and analysis of relevant materials to determine composition and deterioration processes and causes.[332] These were deemed necessary to assess the conditions observed and better understand what was causing the noted deterioration and was intended to allow for the formulation of additional testing and research, if deemed necessary, as well as provide direction for better and comprehensive repair materials and processes.

Due to its significance the primary focus of the surveys and testing was the Sanctuary and specifically the issues related to the *dalle de verre* panels.

All conditions were documented both graphically and photographically by the various consultant teams.

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[331] While the original drawings including some structural ones have survived for the Sanctuary and the Parish Unit, there is little original documentation existing for the Carillon Tower.

[332] For a discussion of why, what and where samples removed and the laboratory tests performed, see Appendix 6.

Site

The site is essentially divided in two by the existing church complex. To the south is the largest section, with its curved entrance road from Bedford Street. In the center of this curved grassy area referred to as "The Bowl" is the freestanding Carillon Tower, which sits close to the Sanctuary across the top of the curved road. In the area bounded by the curved road, the entrance to the Sanctuary, and the U-shaped enclosure formed by the Parish Unit and connector, stands a large stone Celtic cross in the center. The layout of this part of the site and landscape have not been significantly altered from its original configuration. Planting material and trees have been changed. Currently several mature as well as more recent trees are existing.

The changes to the site in front of the church complex since the original construction are fourfold: construction of the Carillon Tower and subsequent minor changes around its base, particularly as it relates to the base planting; the paved entrance area into the narthex; the parking area adjacent to Fellowship Hall; and the changes around the base of the Sanctuary to remediate drainage and concrete problems.

After the Sanctuary and the Parish Unit were completed in 1958, ten years passed before the Carillon Tower was built (in 1968). The construction of this reinforced concrete structure and its foundation necessitated the excavation of a considerable pit; however, ultimately, this did not significantly alter the topography, contours and nature of the landscape beyond its immediate location.

As the Sanctuary was built, the entrance in front of the narthex and its main entrance doors were altered from what was in the drawings.[333] During construction the entryway was changed and the sculpture of Christ in Profile was added. Additionally, originally envisioned as a single pathway, paving was added in the 1970s, which connects the entrance pathway to the Parish Unit offices and to a separate entrance to the Parish Unit Chapel and Fellowship Hall. The paved area was altered at the same time to accommodate an accessible ramp and to introduce the Memorial Walk. This area was refurbished and renewed in the summer of 2016 without altering its design or configuration. As a result, the paving and steps are generally in good condition.

The open space in the front "cloister" area is bounded by the curved entrance road, the Sanctuary, and the L-shaped Parish Unit. The landscape of this grassy "cloister" area originally included a number of spruces and three oak trees which were removed in 2013 following a 2012 storm damage.[334] Today the "cloister" holds a Celtic cross in the center and some small trees. The "cloister" grass is bounded at the Parish Unit side by gravel strips along the glazed walls.

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[333] Drawing A-1 dated 9/23/1955 shows part of the entrance area. A set of stairs and a path towards the Parish Unit entrance is shown. No path is indicated towards the chapel and Fellowship Hall entrance. In the sidewalk, MH (manhole) indicates some drainage. It is important to note that all this work is shown with a contract limit line and noted as "extent of contract". More specifically, a separate note on the same drawing states: "school buildings not in this contract". Note the reference to the Parish Unit as "school buildings".
[334] Email from Jane Love of FPC, October 6th 2017

The sale of part of the property along Morgan Street included an area with an original curved parking lot which has since been altered and is rectangular. Since the sale, a slightly smaller lot has been built to the south of Fellowship Hall, which is accessible from the original main driveway. Paving, curbs and planting are recent and in good condition. The parking lot behind and to the north of the Parish Unit is original to the 1958 plan and remains accessible via a driveway from Morgan Street. The area was recently repaved, with parking spots added, and appears to be in good condition.   At the edge of the parking lot, a sunken garden provides daylight to the lower level classrooms. The areaway is surrounded by a fence, and this part of the property is accessible from a stair and entrance door in the Parish Unit. To the east of the classroom wing is a sloped rocky area that provides outdoor space for classrooms and is largely occupied by a playground. Aside from some mature trees the site has no particular features.

The site area behind the Sanctuary and Parish Unit towards the north end of the property consists primarily of a Memorial Garden constructed and landscaped against a substantial rock out cropping. Additional space for memorial plaques was added to the exterior wall of the utility room bordering the Garden in 1982, and another low wall with plaques, along the covered walkway, was added in 2015. The rock outcropping has no particular features, some miscellaneous plant material and a number of mature trees that are partially located on the adjacent property.

To the west of the Sanctuary and the Choir Room, and extending to the property line along Bedford Street, the landscape is mostly undeveloped, with the exception of a small paved area outside the Choir Room.

Sanctuary

General

The Sanctuary structure primarily consists of prefabricated concrete panels leaning into each other; the center panels contain *dalle de verre* and the outer panels are covered with roofing slates. The panels can be divided into wall panels, resting at a slight angle on the footing, and roof panels, which tilt towards each other at a greater angle.

The lower precast sections sit on a poured-in-place perimeter foundation of which an approximately two-foot section extends above grade and serves as a curb.[335] This curb is slightly pitched away from the building; a concrete coating has been applied to the curb and there are stone tiles at the base of the east elevation, and northeast elevation. There is an indication that early deterioration of the concrete base necessitated repair and waterproofing of the foundation walls. It appears that this also included the introduction of a foundation drainage. However, it seems the stone slabs are now covering the earlier drainage system (see Appendix 4, Figure 43). While the gravel over the foundation drain still seems to exist on the west and north sides of the Sanctuary, it appears to be mostly covered by vegetation.[336]

Exterior

The Sanctuary is constructed of precast concrete panels which have different geometrical shapes: triangular, trapezoidal, and parallelograms. The panels all incline inwards, and the lower panels act as wall panels while the upper panels act as roof panels. The solid precast panels at both ends (east and west) are clad in slate shingles, while the central panels contain *dalle de verre*. The shingles on the roof panels are smaller in size and more regular compared to the shingles on the wall panels, which appear more random in size and pattern. The triangular panels incorporating *dalle de verre*, in addition to their inward inclination, also incline toward and away from each other, forming a folded appearance and creating ridges and valleys. *Dalle de verre* portholes are also present in the *dalle de verre* wall panels, as well as in the solid precast roof panels. The *dalle de verre* panels forming the roof are covered by aluminum framed protective glazing. All precast panels are connected by reinforced cast-in-place concrete ribs. There are no scuppers or gutters at the roofline, and any water collecting at the roof flows directly from the upper panels onto the wall panels. Metal flashings, stainless steel, and lead coated copper strips are inserted between the different planes. The whole structure sits on a reinforced concrete base raised above the ground plane.

Conditions observed at the South façade:

This façade includes 28 triangular precast wall and roof panels, which incorporate *dalle de verre* panels. The flanking wall and roof panels are solid and covered in slate shingles. The south façade has undergone several revisions, including the cutting of a reglet at the roof line;

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[335] All footings are noted to be on rock. See drawing S-1 prepared by Edwards & Hjorth and dated September 23, 1955. FPC Archives

[336] During the installation of the new air conditioning system for the Sanctuary a section along the north wall of the narthex was excavated exposing a perforated pipe.

additionally, the original concrete matrix *dalle de verre* inset panels were completely replaced in the 1980s with epoxy matrix *dalle de verre* panels with an added surface exterior aggregate to simulate a concrete finish. The exposed concrete elements have been covered with a waterproof coating that is failing in many places.

There are two entrances on the south façade. The main entrance from the driveway consists of two wood doors that are separated vertically and enclosed by a sculptural concrete canopy (Christ in profile), which visually forms a cross. The roof slab of the canopy inclines toward the wall of the Sanctuary. In observation surveys and in the drone images, no drain is evident over the canopy (see Appendix 4 Figure 25). Concrete steps lead from the driveway to the main entrance and the original cornerstone is set into the supporting wall of the landing. There is a secondary entrance on the western end of this façade.

Below follows a summary of the conditions encountered.

Concrete: There is a substantial amount of biological growth on the south façade, particularly at the valleys between the precast panels, and in the seams between the precast panels and the cast-in-place ribs where it is able to accumulate. Hairline cracks are visible in the concrete throughout, both in the precast panels and in the cast-in-place elements in between the precast as well as in the concrete base. Numerous and deep cracks are apparent at the entrance stairs, particularly at the low wall with the embedded cornerstone to the right of the landing. The protective topcoat, applied during an earlier repair campaign, is peeling in several locations, particularly at the base of the Sanctuary and at some of the concrete ribs (cast-in-place concrete) where other forms of water damage are apparent, and a few ferrous stains are seen in the cast-in-place concrete ribs.

Slate shingles: The slate shingles are generally in good condition. A few wall panel slates are supported by exposed metal brackets indicating repairs and several wall panel slates are loose or lifted from the surface. There are a few ferrous stains visible, and many currently cracked or broken slates, some of which have apparently been repaired. There are only a few instances of bio-growth on slates.

Dalle de verre panels: Efflorescence is apparent on the epoxy matrix at the wall and roof panels, and there is one instance of patching visible. Several of the *dalles* are cracked in almost every precast wall panel, in addition to at least one cracked *dalle* in a precast roof panel. There are a few panels where the texture created by the surface aggregates on the epoxy have washed off and leave the epoxy matrix exposed. Condensation is apparent under some of the protective glazing over the roof panels. Sealant joints between the *dalle de verre* panels and the precast sections do not show any significant failures, but small local failures are likely to exist given that most are a decade old.

Roofing and flashing: The stainless-steel flashing at the roof ridges in between the *Dalle-de-Verre* roof panels ends abruptly. At the joints between the slate-clad roof panels, and the wall panels at the valleys, water damage—consisting of significant biological growth and some peeling of the topcoat—is evident. The Hoffman report from 2005 states that flashing is missing at the roof canopy above the double doors of the main entrance. Drone photos seem to confirm this (See Appendix 4, Figure 25)

The south elevation has no gutters or drains of any sort allowing water to run unimpeded over the entire surface. Because of the folds in the exterior wall, water runoff concentrates into the valleys in the folds where also the majority of biological growth and staining tends to occur.

Entrances to the Sanctuary: The secondary wood door at the western end, which has a simple concrete enclosure, has abandoned electrical conduits on both sides of the doorway, the cementitious top coat on the east side of the enclosure is delaminating, and the exterior plywood of this door is also delaminating. The main entry doors appear to be replacements and look to be in general good condition.

Conditions observed at the North façade:

The north façade is largely identical to the south elevation and includes 28 triangular precast wall and roof panels which incorporate *dalle de verre* panels. The walls flanking the *dalle de verre* sections as well as the related roof panels are covered with slate shingles. The *dalle de verre* panels at the north façade have the original concrete matrix and date from the 1950s.

The north elevation proper is intersected by the choir room and a covered glazed walkway that create a small triangular shaped open court (created by the intersection of the north elevation of the Sanctuary, the east elevation of the choir room, and the covered corridor). This façade has several exit doors: one at the western end that leads out of the organ room (Sanctuary to exterior), another two that lead to the choir room (Sanctuary to choir room), and double doors at the eastern end (Sanctuary's narthex to the covered passageway). The latter two doors are original wood with concrete enclosures, bridging the angle between the inclined sanctuary walls and the vertical doors. The door from the organ space is a metal replacement. It is also enclosed by a concrete canopy.

In the covered walkway and in the choir room, where the north façade forms an interior wall, the north façade is covered in veneered plywood. Where the north wall abuts the covered passageway, there is an open but largely unused 'garderobe' that is an original feature and has a fixed wooden coat hanging system. At the east end of the façade at the narthex end, there are two large lead coated copper grills that are connected via ductwork to the mechanical room underneath the narthex. All plywood millwork, including the ceiling of the covered walkway, is in good condition.[337]

There has been less intervention in this façade compared to the south and east façades. The most recent work on this façade was the application of a waterproof coating in 1995.[338]

Concrete: Biological growth is apparent mostly at the concrete base and at the cast-in-place concrete ribs, especially at the roof line, at the valleys, and at the seams between the cast-in-place and precast elements. Horizontal cracks exist mostly at the cast-in-place base. The top coat is peeling (mostly at the base) and at the ribs of the roof line, and some additional peeling

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[337] According to an email from Jane Love, dated 10/6/2017, the ceiling of the covered walkway along the north elevation was lowered in Fall of 2015 to accommodate A/C ducts. Original plywood ceiling panels and water-damaged plywood cladding of the Sanctuary façade were replaced at that time due to water damage.

[338] From the existing documentation, it is not clear whether this elevation was re-caulked during the mid-2000s repair campaign.

exists at the vertical cast-in-place ribs. A few cementitious patches exist on the cast-in-place elements, where samples were taken. In January 2017, three additional core samples were taken from the base, the precast panel, and the cast-in-place rib, and the core holes were patched.

Slate shingles: The slate shingles are generally in good condition. Differing degrees of bio growth exist along the whole façade. The grills have stained the slates below. A few wall panel slates are supported by exposed metal brackets indicating prior repairs. A number of wall panel slates are loose or lifted from the surface. There are a few ferrous stains visible, in addition to several cracked or broken slates.

Dalle de verre panels: There is minor efflorescence evident on a few roof panels and at least one instance of patching. There are cracked *dalles* in most wall panels and in some roof panels, as well as cracks in a few of the *dalle de verre* portholes. Not all cracking is easily visible from the exterior. Some condensation is evident at the roof panels beneath the protective glazing.

Entrances to the Sanctuary: At the concrete enclosure of the entrance (metal door) at the west end of the elevation giving access to the space behind the organ, there is bio growth and cracking. There is some deterioration of the wood doors to the covered walkway and to the choir room. Additionally, there is missing and deteriorated hardware at the doors from the narthex to the covered walkway.

Roofing and flashing: The metal flashing at the ridges between the precast *dalle de verre* panels terminates abruptly. At the valley joints between the roof and wall panels there is substantial bio growth. There are blocked scuppers at the roof of the covered walkway, and at the roof of the choir room. A downspout on the east elevation of the choir room spills into the enclosed triangular shaped courtyard.

The north elevation of the Sanctuary has, like the south, no gutters or drains of any sort allowing water to run unimpeded over the entire surface. Because of the folds in the exterior wall, water runoff concentrates in the valleys in the folds where also the majority of biological growth and staining tends to occur. The discoloration is more severe on the north than on the south, probably because of the different exposure and because this elevation has seen less repair work over time.

Conditions observed at the East Façade:

The east façade has eight wall and roof panels with *dalle de verre* inserts, flanked by slate-shingles covering solid precast panels. The original concrete matrix *dalle de verre* wall panels were replaced with epoxy matrix panels in the 1980s, with an aggregate applied to the surface to better match the concrete. Along the base, large tiles pitch water away from the foundation wall, a configuration similar to the one found along the south and west elevations. A concrete edge or curb suggests a wall below as noted in earlier reports and confirmed on the north elevation's narthex end.

Concrete: There are horizontal cracks at the base and at different locations along the exposed concrete panels. These cracking patterns, which are also found to run through the precast panels as well as the cast-in-place ribs, appear to be largely limited to the surface coating but deeper cracks are also evident in some places where the coating has peeled away. Vertical cracks run along the seams between the precast panels and the concrete ribs. Biological growth is apparent at the base, at the concrete ribs, and on the face of the precast panels.

Dalle de verre panels: Efflorescence is apparent in the roof panel *dalle de verre* and cracking of individual glass pieces is evident in the four central wall panels, conditions similar to the south elevation. Sealant joints between the precast panels and the *dalle de verre* infill panels appear to be generally sound, although localized failures may exist.

Roofing and flashing: No downspouts, scuppers, or gutters exist at this elevation as was the case elsewhere. As a result, water runoff tends to collect in the valleys between the precast panels and water damage conditions are found to be more severe at valley joints between the roof and wall panels.

Conditions observed at the West Façade:

The west façade is comprised of two inclined precast panels and clad in large, irregularly sized and patterned slate shingles. There are two large metal grills. Low vegetation borders the base, which probably covers the foundation drainage that was constructed in the 1980s.

At the concrete base, cracking was observed similar to the cracks observed on the east and south elevations, in addition to bio growth. The cementitious topcoat is peeling in some locations. The slate shingles are generally in good condition. There are some exposed metal supports and some ferrous staining on the shingles. The metal grills have stained onto the shingles below.

Interior

The interior, on the ground floor and above, can be divided into roughly four distinct spaces: nave, chancel, narthex, and balcony. The nave has a seating capacity of approximately 500 and tapers toward the chancel at the west. The nave is bounded at the eastern end by the narthex and connected at the north to the choir room and sacristy beyond. The raised Chancel includes the original pulpit (altered) and lectern, as well an organ that replaced the original.

The nave has a polished concrete floor underneath the rows of pews, which are original to the building. In the main aisle and the two side aisles, the floor is covered with carpet. Underneath the floor is a hypocaust heating system that is supplied with air from a central duct running in a trench beneath the center aisle. Along the perimeter on the north and the south side, a continuous raised grill provides the warm air supplied underneath the floor. The walls and ceiling are formed by the precast panels, which in the center are filled with the *dalle de verre* infill panels. At either end, the precast panels are solid. While at the chancel and nave the backside of the precast panels is exposed, toward the narthex the surfaces have been covered with a natural fiber sheet material, probably Tectum, which in turn has been partially covered with a material called Masonite. Both applications have, presumably, been made to adjust acoustical properties. The original suspended light fixtures exist intact and remain functional. The original wood chairs and pews, each of a different length, are in generally good condition.[339]

The chancel, which is raised several steps above the nave level, includes the base of the original pulpit (the top sounding board has been removed) and lectern, as well an organ. The steps and floor of the chancel have been replaced with large scale ceramic tiles with the installation of the organ. A historic millstone is embedded in the floor. The current organ is a replacement of the one originally installed. The organ fills almost the entire west end of the chancel. There is a central pit under the organ. This area was significantly altered in 1991 to accommodate the new organ; this involved a different placement of the organ (the organ keyboard no longer sits in an organ pit, which was originally beneath the ground floor and drawn at the basement level on the architectural plans). Due to the size of the new organ, it is now situated closer to the pulpit. Also, the choir originally faced the organ (the seats were facing inward and were situated along the north and south walls) and now faces the congregation. Behind the organ casing are two additional levels containing organ-related functions and old sound chambers containing 12 organ pipes; in these spaces, the interior partitions are of exposed cement blocks.

To the east of the Nave, separated by a wooden partition and doors, is the Narthex. This space is entered from the outside at the south side. On the north side, a set of double doors lead to the glass enclosed connection to the Parish Unit and the corridor running alongside the north elevation. Along the south wall, the concrete stair with its sloped side overhead (along the south wall) is clad in millwork and leads up to the balcony with additional 50 person capacity. The balcony floor is a concrete slab. The balcony, which opens up into the nave has a suspended ceiling above.

Below the stair to the balcony, a door and staircase leads from the Narthex down to the fan room in the basement level. Across, on the north side of the Narthex, a door leads into the vent room, which houses ducts coming up from the fan room and connect to the central duct running underneath the floor of the nave.

The floor is a concrete slab covered partially in carpet and vinyl. The walls and ceiling are comprised of the precast panels, which at the east end have *dalle de verre* infill panels. The north and south side are solid panels.

Conditions in the Nave:

The polished concrete floor of the nave shows several cracks in the concrete slab. They represent two types: an almost continuous crack running east-west at either side of the center aisle and occasional cracks running north-south in between or under the pews at both sides of the center aisle. It can be surmised that the east-west cracks are occurring at the edges of the supply and return trench as shown in the various original architectural and mechanical drawings.[340] The cracking in the other direction occurs somewhat less frequently and is most likely also related to the subfloor heating system connecting the center supply and return to the

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[339] Several of the original pews have been removed

[340] Drawing A-4 dated September 23, 1955 shows in Section A-A the extent and configuration of the trench. Drawing S-1 details the structural slab configuration and drawing H-1 details the mechanical layout. The details on A-4, S-1 and H-1 are not identical, but conceptually the same.

grills along the north and south wall. These cracks are more intermittent but consistent in their location and direction.[341] The floor is otherwise in reasonably good condition.

Conditions observed at the south elevation (Nave):

The south elevation consists of the original precast panels with the *dalle de verre* panels that were replaced in the 1980s. The *dalle de verre* was placed in an epoxy matrix. For the other wall sections of this elevation, which are interrupted by glazing, different materials have been used. Toward the east end (the Narthex) and adjacent to the balcony, a Tectum product was applied to the interior for acoustical purposes.[342] The lower section of that wall surface has subsequently been covered with painted Masonite (up to approximately 12 feet). Overall, the Tectum appears to be in good condition where visible, except for water stains on the south side. In some lower sections, the Masonite appears to be bulging suggesting water infiltration behind the material.

The central portion of this elevation is taken up by the *dalle de verre* panels set in the precast panels. As noted, the infill panels are replacements, while the precast panels date to the original construction. The infill panels are set in a simple rabbet in the precast. In the 1980s installation, the infill panels were cushioned and set against a compressible foam strip that is now not only visible on the inside, but appears to be pulling out in some instances. The foam material probably served as backer rod material filling the joint behind the sealant, which forms the exterior barrier. There seems to be no indication of displacement of the panels themselves. The conditions observed were documented graphically and photographically.[343]

The replacement infill panels were fabricated using new glass set in an epoxy, rather than concrete, matrix.[344] The glass furnished by various manufacturers is approximately one inch thick. The matrix appears to be largely intact, though minor deterioration (fine cracks) in the epoxy matrix are evident. The precast panels were joined by a poured in place concrete tying the separate sections together. The inside face of all the concrete was been re-painted a darker gray possibly to mask discolorations and water staining during the Sanctuary restoration campaign in the mid 1980s (at least part of the interior, evident in the narthex, was originally painted a dark aubergine). At several locations, the paint has begun to peel at intersections of two precast panels. In addition, in several locations the surface concrete has begun to deteriorate and efflorescence has appeared streaking down. In one or two instances, a dark brown infill material appears to be exposed.

Winthrop Moore wrote of the above-mentioned efflorescence in a maintenance report:

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341 Drawing A-9 also dated September 23, 1955 shows a section through the edge of the floor with the raised curb and continuous grill. In addition, it shows subfloor voids. The same is detailed in drawing H-1 where the so-called "airfloor" system is shown. The perimeter grille is designated "discharge grille".

342 This would seem to be a later addition, The Finish Schedule as shown on drawing A-14 shows for the narthex and nave only cement as floor finish and nothing for any other surface. A-9 shows the exterior wall details but gives no other information about finish except for a notation of 'precast'.

343 Aerial photography provided a detailed view of conditions in the upper parts of the nave. Because of their size and detail only a few have been included in the text.

344 There is some indication that the glass panels are anchored into the concrete with an anchor identified as a stainless steel spring clip according to a sketch titled "Window Installation Detail". The sketch was submitted (presumably to the architects) and dated 6/16/86. Rohlf's Studios papers now in the FPC Archives.

> Efflorescence, the flaking of paint, inside walls of the Sanctuary, is the result of moisture in the concrete which loosens the paint film, due to a buildup of lime and other elements, carried to the surface of the concrete by the dissolving action of the water. This action is apparent to the viewer as white patches on the dark columns of the building, usually from the turn of the roof to about half way to the floor. Correction of the problem is, of course, to stop the leakage in the joint sealants. Rupture of the side bonds of the Thiokol. In rare instances, cracks in the "cap" covering the juncture of panels, permits water entry. Such leakage is difficult to trace to source and it is important to observe the terminus or starting point from which the water shows on the surface, during periods of heavy rain... to repair (inside) wall areas damaged by falling paint simply remove, with wire brush, loose concrete to expose a firm base that can support paint. Whereas good teaching requires neutralizing the powdery lime deposits with a dilute acid wash, we have omitted this in past years with good results. The big problem is that several pews must be removed, to make way for the 40' ladder, for each column area to be treated.[345]

Most of the damage noted occurs in the glass and related concrete areas. Efflorescence is apparent on the concrete cast-in-place ribs as well as on the concrete base and on the *dalle de verre* panels; additionally, the *dalle de verre* panels include many shattered, cracked and spalling individual glass pieces, and there is a hole in at least one of the glass pieces.[346] Ultimately, at least six different conditions can be noted, which in order of increasing severity are[347]:

1. Some localized efflorescence
2. Peeling paint with some efflorescence
3. Minor efflorescence in the glass
4. Major efflorescence in the glass
5. Shattering of the glass
6. Cracks in concrete

While hands on investigations were limited by overall accessibility, the more severe damage seems to be primarily limited to the lower sections of the panels, though there is significant damage at the roof line. Efflorescence and peeling paint were noted higher up, and, to varying degrees, the glass has begun to fracture. In general, these fractures seem to be most frequent on the lower part of the wall and appear particularly severe for the darker colored glass, such as in the purple tones. In many instances, a white and fine powdered efflorescence seems to be primarily bleeding out of the joints between the glass and epoxy matrix.[348]

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[345] Winthrop Moore, *maintenance notes*, (n.d.)

[346] OSE, the structural engineering consultant is of the opinion that secondary stresses contribute to the damage: "We believe that some of the damage to panels is based on secondary stresses imposed on the panel by the frame. This does not mean that the panels are required for structural safety: if they are removed, the frame will carry all loads, but will move more than it does now." Donald Friedman in e-mail exchange to Theodore Prudon, 6-26-2017

[347] These conditions are noted on the drawings. See Appendix 1.

[348] For a more detailed discussion of the *dalle de verre* conditions, see Appendix 5: BCA Conservation Survey.

Additional conditions observed at the south elevation include water stains and atmospheric soil on the concrete (in some cases, the top-coat is flaking or peeling off, and this is especially the case at the concrete surrounds of both entrances; Appendix 4: Figure 13); the skylight panels, which are original panels set in concrete matrix, are covered on the interior with an original metal wire mesh and attached to the structure by metal anchors, which are often displaced (Appendix 4: Figure 14); the painting of the concrete is inconsistent, with some elements exposed, and above the roof level all concrete is exposed; the concrete members suffer from spalls, cracks, and ferrous stains; there are water stains on the acoustic panels in the rear as noted; and at some of the epoxy panels, the compressible foam strips with which they were installed appear to be loose.

Conditions observed at the west elevation (Nave):

The interior of the wall toward the chancel (west elevation) appears as the backside of the precast panels and has been painted. No deterioration seems to exist or is directly apparent on this elevation. The remainder of the space is largely taken up by the organ.

Conditions observed at the north elevation (Nave):

The north elevation is of similar construction as the south, with the exception that the *dalle de verre* infill panels date to the original construction. The infill panels are the original glass set in a concrete matrix, which is reinforced with thin rebars. The panels are anchored to the precast with metal (probably lead) clips that are visible on the inside. Here the fracturing of glass is significant, but of a lesser degree than as noted on the south elevation.[349] As on the south side, efflorescence is seen and here has accumulated at the base of the wall and on the curb containing the continuous perimeter grill.

Water stains and atmospheric soiling exist on the concrete, with flaking and peeling of the top coat, in addition to some ferrous stains and inconsistent paint.

Efflorescence is apparent on the concrete ribs, on the *dalle de verre* panels, and on the individual pieces of glass. Cracking and spalling is apparent in all concrete elements in addition to numerous instances of cracking and spalling on individual glass pieces.

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[349] OSE, the structural engineering consultant is of the opinion that secondary stresses contribute to the damage: "We believe that some of the damage to panels is based on secondary stresses imposed on the panel by the frame. This does not mean that the panels are required for structural safety: if they are removed, the frame will carry all loads, but will move more than it does now." Donald Friedman in e-mail exchange to Theodore Prudon, 6-26-2017

Conditions observed at the east elevation (Narthex):

The floor of the narthex, which is a continuation of the nave, is in good condition and shows no serious cracking. Directly under the floor is the fan room from which the trench noted in the nave originates. As a result, the cracking seen in the nave does not occur here. The north and south walls are solid and show the interior side (backside) of the precast panels. No significant deterioration was noted on these elevations within the narthex.

The east wall of the narthex consists of the precast panels with the *dalle de verre* infill sections. The glass does not show the degree of deterioration observed on both south and north elevations of the nave. However, where the panels abut vertically, an efflorescence streaking pattern that was observed on the south elevation also occurs here. In addition, the paint and concrete have begun to peel and separate, indicating a similar brown infill material.

The narthex also includes the stair towards the balcony (cracks appear at the top of the concrete stairs), the main entrance doors and the doors to the connecting link with the Parish unit and corridor to the north of the sanctuary nave. In addition, a door below the balcony stair gives access to the stair down to the fan room. Horizontal and vertical cracks were observed along the interior of the south foundation wall along these stairs.[350] All interior millwork for doors and stair has a natural varnish finish and appears to be in a fair condition and does not show excessive wear or water damage.

Choir Room

The choir room, which is reached through two doors from the chancel, has a concrete slab floor, walls are plaster on concrete blocks and a large window wall facing north. The roof is pitched over wood construction. The interior floor is re-painted cement and the ceiling is original natural finish plywood. The windows are the original natural wood windows and similar in detail and construction to others found in the complex.[351] A door in this wall gives access a small unused outdoor area. An additional glazed door exists in the west elevation. Millwork cabinets separate the main volume of the choir room from an access corridor along the east wall. The cabinets are original and have a natural plywood finish and do not reach the ceiling leaving the interior volume intact. Original light fixtures are surface-mounted to the ceiling.

The overall condition of the interior of the choir room is fair, which takes into consideration the water damage at the walls adjoining the Sanctuary. The original wood cabinets remain in use and are in fair condition. A wood shelf has been added over the floor grill along the north windows.

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[350] OSE attribute these cracks to "crushing failure where the base of the stair to the balcony bears on the wall". Structural Engineer's Report, Appendix 7

[351] The Specifications for the Sanctuary indicate that: all exterior and interior door frames and trim shall be of white oak Select Grade, plain sawn. All exterior roof facias, boarding T. & G. ceiling material, exposed structural members of wood and glass wall assemblies and other trim and finish of same shall be B or Btr. Grade of Western White Cedar. All other interior wood finish shall be Cabinet Grade White birch for all exposed work, either solid or birch faced plywood of same grade where indicated. Doors manufactured by W.D. Crooks and Sons of Williamsport, PA (or equal as approved) select white oak."

Sacristy

The sacristy area envelope consists of a concrete slab floor like the choir room and a bituminous roofing over wood construction with metal gravel stop. The walls are of plastered and painted or exposed concrete blocks with the original window wall. The interior consists of a re-painted cement floor and the original natural plywood ceiling. Adjacent to the Sacristy restrooms are functional and walls have been re-tiled. The corridor has the original natural wood window wall, with original casement windows in the kitchen and bathrooms. Much of the original millwork, in good condition, still adorns the kitchen.

The overall condition of the Sacristy (kitchen), restrooms, and utility room, is good. However, there is water damage in the utility room in addition to water damage to the wood window wall in the glazed corridor. At the door to the covered walkway the transom has been sealed with plywood and new hardware has been installed. Storm windows are possibly missing (removed and not replaced) in the bathrooms and kitchen. In the utility room, the original natural wood louvres are blocked with galvanized metal sheets and new plaster board covers the ceiling.

Covered Walkway (Passageway)

The enclosure of the covered walkway consists of a concrete slab floor and bituminous roofing over wood construction. The wood of the window walls is varnished African mahogany.[352] The interior consists of a re-painted cement floor and mostly original natural plywood ceiling.[353] The glazed walls are original and consist of natural wood window walls, single pane, and a coursed fieldstone wall. The plywood along the Sanctuary wall has been replaced.[354] The windows are natural on the interior and painted on the exterior. There are steel hopper-type windows at the base.

The overall condition of the covered passageway is good but maintenance items exist. There are instances of peeling paint, exposed aggregate at the concrete base of the window wall, corroded window screens, some of which are broken. There is also peeling and flaking paint at some areas of window wall. There is water damage where the walkway meets the Sanctuary walls and at the vestibule to the Parish Unit. Water damage is also observed at the wood window wall, which also has one cracked glass pane.

Some of the hopper-style windows are inoperable. There is damaged and/or missing hardware in the original narthex doors and a few cracks along the original cement floor. Other observations include some wood patching in the door to the vestibule.

Parish Unit

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[352] From Winthrop Moore's *maintenance notes* (n.d.): "…all wood trim, Sanctuary to Chapel, is African mahogany. For economy, portions of the window frames have been painted. Doors, window frames, etc choir to office are mostly varnished and require annual attention."

[353] Some ceiling panels have been replaced where the ceiling was lowered to accommodate new ductwork in the fall of 2015. The wood wall panels along the north façade, which had suffered water damage, were replaced at the same time. From email by Jane Love, October, 6, 2017

Exterior

The Parish Unit is a two-story L-shaped structure that is attached to the Sanctuary by a glass enclosed covered walkway. The L shaped structure is roughly comprised of a north and east wing, which together with the covered walkway to the west form the boundaries of the open "cloister". Because of the topographic contours of the site, the south and west elevations are one story, while the north elevation is two stories. The Chapel and Fellowship Hall are on the east wing of the L-shape.

The envelope of the Parish Unit basement consists of a concrete block foundation (above grade) and coursed rubble stone facing walls (according to the construction drawings: 9″ stone facing, 1″ parging, 8″ concrete block); the concrete blocks are exposed or painted and the window walls are made of African mahogany over a concrete block base. The floor is concrete slab flooring and there is a composite roof system with concrete roof slab over open web steel joists, and a built-up bituminous inverted pitched flat roof with central drains (originally with pebble cover but now without).

The building is generally well maintained but some issues remain. Regarding the overall condition of the Parish Unit envelope, several issues were observed: There are cracks in the concrete base of the window walls that appear in the south and north elevations of the north wing, and in the west elevation of the east wing. There are several occurrences of peeling paint on the wood windows of the north and west elevations within the north wing.

All exterior entry doors in the various locations have been replaced with new ADA compliant wood doors.

Other conditions observed during the survey, include some replacement concrete blocks on the southern exterior wall of the furnace room[355]; exposed aggregate in the concrete that occurs at the base of the western wall of the chapel; cracks in the concrete eve occur at the south elevation of the north wing and at the east elevation of the east wing; some exposed and rusted re-bars show on the north elevation of the north wing and west elevation of the east wing; deteriorated or missing caulking all along the north wing, and on both sides of the east wing; efflorescence on the west elevation of the east wing and the north elevation of the north wing; stucco coating over the concrete along the south elevation of the north wing and at the west elevation of the east wing; spalling of the concrete base at the south elevation of the north wing; broken window screens at south elevation of north wing and rusted screens at the north elevation of the north wing; several instances of cracks in the concrete blocks were observed at the north elevation of the north wing and at the east elevation of the east wing; paint stains on concrete blocks on the east elevation of the east wing.

Interior

General

[355] A section of the wall was opened and resealed for the installation of a new heating unit in Fall of 2015

The interior of the Parish Unit can be separated into several components: the utility rooms in the basement level of the east wing, the two levels of the north wing (classrooms and offices), and the ground level of the east wing (classrooms, lounge, Chapel and Fellowship Hall).

The interior of the utility rooms in the east wing includes a cement floor, concrete slab ceiling, painted and exposed concrete and concrete block walls, and steep steel stairs that lead from the furnace room to corridor #114. There are painted concrete treads in steel brackets in stair #119.[356]

The Parish Unit ground floor interior (north and east wing) has typically vinyl tiles in the corridors and classrooms with carpet in the offices and lounge. The ceilings consist of original or replacement suspended acoustic tiles and skylights in the east wing classrooms. The walls are painted concrete blocks or concrete blocks with plaster and there are some drywall sub-divisions in addition to coursed rubble stone piers. The windows are the original painted wood window walls over built-in base and grill, with steel hopper-style windows at the base. In the classrooms some interior mullions have been added to the window walls. The classrooms and offices have original base cabinetry. The lounge was altered and the wood paneling on the fireplace wall was replaced with drywall with some moldings.[357]

The overall condition of the ground floor interior of the Parish Unit is good. The classrooms and office base windows have been sealed with Plexiglas. The air conditioning window units at the base of the window walls in classrooms and offices have been sealed with plywood and other materials. There are some damaged original vinyl tiles throughout. The offices in the north wing were recently altered and ADA compliant bathrooms were added.

The east wing of the Parish Unit ground floor interior has vinyl floors throughout, with carpet in the library and junior high classroom. New ceramic tiles have been installed in the kitchen and men's bathroom, while mosaic tiles have been installed in the women's bathroom as part of an overall bathroom renovation. The ceiling has acoustic tiles, with concrete in the bathrooms and storage area, plaster board in the kitchen, and a new suspended ceiling in the lounge, which slopes up to clear the top of the window. The walls are painted concrete blocks with plaster and coursed rubble stone. There is stone and plaster facing on the chapel wall and plywood along the corridor, with a recessed display wall. The windows are full height painted wood window walls with new store-front windows in the lounge.

The east wing is overall in good condition. However, there are some damaged vinyl tiles throughout and some stains in the original ceiling tiles. The lounge and kitchen were recently renovated, including the installation of new exit doors.

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[356] Refer to drawings of Parish Unit in Appendix 1 for room numbers

[357] Original construction drawings and photo of interior of lounge (FPC *commemorative booklet*, 1958/1959) indicate that wall had wood paneling, and that fireplace hearth, header and pillars were of slate

Chapel

The envelope of the chapel consists of a concrete foundation; the walls are concrete and 6" (according to construction drawings) coursed rubble. The floor is concrete slab and the roof consists of a concrete slab, insulation, and built-up roof finish (steep pitch); there is also translucent corrugated plastic roofing sheets installed over the *dalle de verre* skylight[358]. Lead coated copper is on the west side of the roof. The chapel envelope is overall in good condition. No water infiltration was observed.

On the wall directly outside the chapel, in the corridor, is a memorial wall with stone fragments from various European and mid-eastern sites.[359]

The interior of the chapel consists of a stone (slate) tile floor with a wood step up to the "chancel" at the east end of the space. There are some grills in the floor and the original small organ pit has been covered. The ceiling over the chancel area is a sloped *dalle de verre* sky light with wood ribs that receives direct day light. Corrugated plastic roofing covers the skylight. There are surface mounted acoustic tiles and ceiling fans installed. The walls are painted rough plaster and coursed rubble at the east end; there is a decorative wood screen with dark backing at the west end in the rear of the chapel. The sconces along the north and south wall are new but in original locations. Apart from some soiling on the original ceiling, the interior is in good condition.

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[358] Not clear whether this is the original corrugated plastic

[359] For details about this wall, see description of Parish Unit (page 25)

Fellowship Hall

The exterior envelope of Fellowship Hall is in general of the same construction as other sections of the Parish Unit and consists of a concrete block above-grade foundation and coursed rubble stone facing walls (9″ stone, 1″ parging, 8″ concrete block back up), in addition, in some locations, the concrete block has been exposed or painted. The wood of the south facing window wall was African mahogany with single pane glass sitting atop a concrete/concrete block base. The window wall has been replaced with new assembly of thermally broken aluminum frames with insulated glazing units. The pattern of the window frame subdivision and its random multi-colored glass accent panels has been mostly maintained, though the colors and composition have been slightly altered.

Also on the south-east end, set back, the south facing wall of the furnace room has pierced blocks. The floors are concrete slabs and the flat composite roof system consists of a concrete roof slab over open web steel joists and a built-up bituminous concave flat roof with central drains (it appears originally the roof had a pebble cover).[360]

Fellowship Hall was undergoing renovation during the survey and access was limited. Renovation consisted of: new flooring; the south facing window-wall was weatherized and altered; The kitchen was enhanced and upgraded; the bathrooms were reconfigured. In general, the space maintained its overall volume and features, particularly its original and unusual structural ceiling configuration. Interior finishes were renewed but the wood paneling in the hall was maintained. Outside Fellowship Hall, in the corridor, an ADA compliant restroom was inserted into an existing storage room and original plywood wall paneling was removed and replaced with a more contemporary version.

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[360] From Winthrop Moore's *maintenance notes* (n.d.): "…to the uninitiated, a flat roof may be a puzzlement. Many are constructed to hold and retain rain water. It serves as cheap insulation to cool the area in summer and reduce heat loss in winter. Our roofs are concave, to direct water centrally, it is drained off through interior drains. Except for the corridor, office to choir where, several years ago, we installed copper scuppers to control and direct runoff directly to the ground.

The roofs are laid on poured concrete, except for the office to choir corridor. First a layer of insulation in panel sheet form is laid down. Hot tar is swabbed over this insulation and a layer of felt membrane material rolled over the tar. Several layers, tarred in between are added. This membrane covers copper flashing on each side. As the top dressing of tar is applied, small pebbles are spread over the entire area. As the hot tar cools and solidifies, the pebbles are anchored to the membrane and may be walked upon…"

Carillon Tower

The Carillon Tower consists structurally of four inclined concrete legs with square footprints, in addition to three (3) connecting concrete struts (connecting rings) along its height. Four smaller inclined concrete legs are supported on the second strut (ring). Their square plan is rotated 45 degrees to the base plan. A stainless-steel cross caps this structure at the top. The tower has two belfries and concrete slabs support the lower and the upper one. Between the two belfries is the enclosed clavier room. A spiral precast concrete stairwell leads to the lower belfry, and metal ladders lead to the upper levels. The precast concrete staircase is enclosed in a cylindrical metal grill to the height of the lower strut and the whole staircase is enclosed by a teak wood screen; this same teak wood is also used to form screens that partially enclose the upper and lower belfries with a decorative pattern.

At the ground level, there are square concrete pavers with inserts of larger granite memorial plates and surrounding box hedges. The stair platform consists of a circular concrete slab with concrete curb at the center of the granite paving.

The stairway with its metal grill enclosure[361] is structurally formed by identical precast treads with cylindrical core elements, stacked to create the ascending spiral. There are no landings, and the stairs are supported by eight (8) galvanized steel hanger rods with turnbuckles. The hangers are attached to the eight (8) vertical teak wood supports that enclose the metal grill, and hang from the concrete slab of the lower belfry. The balustrades are galvanized and painted metal rods, one connected to each precast tread. Metal tubular handle bars connect the balustrades. The metal grill consists of vertical painted and galvanized metal rods connected by horizontal plates, which enclose the staircase to the height of the lowest concrete strut (ring). A gate on the south side of the enclosure enables access to the stairway. Metal hooks for supporting rappelling equipment for maintenance of the stairs are attached to the bottom of the lower belfry floor slab.

The teak wood screen enveloping the staircase consists of eight (8) vertical structural elements, inclined outwards and inwards. Horizontal wood rings connect the vertical elements. The wood elements are connected by galvanized metal gusset plates and bolts on the interior. The connections are concealed by wood plugs on the exterior.

The lower belfry level has a concrete slab floor with a cementitious top coating. The ceiling is also a concrete slab. The exterior walls are an open pattern of teak wood elements; the interior walls consist of woven wire mesh in metal frames. Bell support consists of heavy galvanized and painted metal profiles. The enclosing metal grill of the staircase reaches this level and a steel gate opens from the enclosure onto the belfry. A chain-link fence wraps the metal grill and gate and a metal ladder climbs up to the carillon room.

The carillon room has a wood floor and its ceiling consists of drywall. The exterior walls are wood and the interior walls are drywall. The metal door is situated within a metal frame and the space has floor to ceiling double casement windows with wood security bars. There is also an air conditioning window unit. The lights are fluorescent and utility wall fixtures.

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[361] From Winthrop Moore's *maintenance notes* (n.d.): "…the entire metal cage and stair structure from ground level to top of stairs and door enclosure to be primed and painted… paint entire structure with 1 full coat of Debevoise CeCo WS-110 Corrosion Resistant Non-Leafing Aluminum Primer."

The carillon is the instrument as installed originally. Metal wires connect to the bells of the belfries above and below. A metal ladder leads to a hatch door to the upper belfry

The upper belfry level has a concrete slab floor and concrete slab ceiling. The exterior walls are an open pattern of teak wood elements and the interior walls are woven wire mesh in metal frames. The exterior light is a utility wall sconce. Bell supports consist of painted galvanized steel profiles, and heavy timber planks. A metal ladder leads to a hatch door to the roof. The roof is a flat concrete slab that is exposed to the elements, with no railing. A construction of two (2) horizontal painted wide flanges support the bell construction below.

The Carillon Tower is, generally, in good condition. However, the following conditions were observed: there are consistent vertical cracks along the whole height of the structure (the concrete legs).[362] Cracks have been previously repaired with filling material and painted. The concrete struts (rings connecting the concrete legs) are in good condition, though biological growth throughout was noted. There are some cracks and efflorescence at the floor slab of the spiral stairs. The precast stairs are in general good condition despite a few ferrous stains, occasional spalling (some of it deep and in one instance exposing rebars). There is also some efflorescence evident in the central core and on the underside of the stairs. Corrosion of the balusters is apparent, especially at connections to the treads. Peeling paint exists at the balusters and hand rail. There is also some corrosion at the gusset plates supporting the metal stair hangers.

The metal grill enclosure elements show corrosion; there is also corrosion at the gate to the stairs, especially at the escutcheon. There is missing and broken hardware and the gate doesn’t close properly.

The teak wood screen is in general good condition. It looks untreated and there are many instances of biological growth.

On the lower belfry, the top coat is flaking and peeling from the concrete floor and there are cracks and efflorescence in the concrete ceiling slab. The gate to the lower belfry shows corrosion, especially at the escutcheon, and the gate doesn’t close properly. There are a few instances of corrosion in the bell support structural members.

The clavier room is in general good condition. There is some corrosion at the metal door and door frame, and the room needs constant cleaning because small animals occasionally get trapped in the structure.

The upper belfry is in general good condition. There are some cracks, efflorescence and ferrous stains in the ceiling slab and the hatch-door to the roof is hard to close.

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[362] See also Appendix 7 for structural engineering report on the tower.

Protective Designations

First Presbyterian Church is a property of national and international significance. Legal recognition and protection has been granted at the state level, and legal recognition and protection at the national level are under consideration.

Connecticut State Register

First Presbyterian Church has been designated under Connecticut's State Register of Historic Places, a listing and collection of structures and sites that characterize the historical development of the state.

National Historic Landmark Nomination (Pending)

The National Historic Landmark designation is under consideration. The nomination was accepted initially on September 16, 2014 by Dr. Alexandra Lord, Branch Chief, National Historic Landmarks Program, U.S. Department of the Interior. This nomination has to be credited as an important basis for understanding the building construction history and for establishing the significance of the site.[363] The latest submission, as of the time of writing of this report, is from June 22 2017.

[363] The *National Historic Landmark Nomination* referenced here is dated June 22 2017.

Principles of Conservation

The purpose of this section of the Conservation Management Plan is to provide an appropriate general framework for decision-making regarding conservation, improvements, repair, and maintenance of the First Presbyterian Church by employing an approach that strives to acknowledge and enhance the structure's significance in all identified aspects. This is accomplished by recognizing the original design, subsequent important changes, and the impact of future changes. If not preserved properly, the danger is that original features and details will vanish or be covered over in time, thereby diminishing our ability to experience, appreciate, and understand how the design and experience of the church complex was intended and continues to operate. To encourage and achieve appropriate stewardship, the conservation policies outlined here are framed specifically to:

1. Define features that embody the character and quality of the church complex, including its structures and landscape, to preserve the entire site by minimizing the loss of historic fabric
2. Guide essential modifications and repairs to be harmonious with the church complex, which will in turn improve the efficiency of its intended uses
3. Identify features that unfavorably affect the church complex and that require modification or repair
4. Provide appropriate methodology for the replacement of deteriorated historic fabric
5. Emphasize the necessity for the management and continuity of conservation guidelines

General Conservation Policies and Principles[364]

1. The stated significance contained in this Conservation Management Plan shall guide future preservation undertakings.

2. The recommended policies discussed in this Conservation Management Plan provide direction for future work.

3. The recommended policies regarding protecting, maintaining, and improving the church complex are meant to foster and establish an ongoing program that helps to conserve the church complex as a whole and in its constituent parts.

4. The original drawings and related original documents shall be maintained and properly preserved to provide original design and construction documentation for future reference.[365] This will assist in clarifying the historic fabric and helps in determining the appropriateness of future decisions regarding protecting, maintaining, and improving the church complex.

5. The policies in this Conservation Management Plan shall be reviewed at regular intervals. It is recommended that the CMP shall be reviewed and updated again in five years from the date of publication, followed by review every ten years thereafter.

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[364] Peter Inskip and Stephen Gee: *Louis I. Kahn and the Yale Center for British Art: A Conservation Plan* (New Haven, CT: Yale University Press, 2012) is one of the sources that provided guidance for the general policies discussed in this section of the Conservation Management Plan.
[365] A detailed catalogue of remaining and current drawings was prepared for that very purpose.

Policies Related to Conservation Issues

6. Temporary or short term (removable) alterations to the First Presbyterian Church must be carefully considered, whether in the form of physical projects or usage, to maintain the highest degree of cultural value; modifying the space, even temporarily, based on "reversibility" (for example: temporary signage) can negatively impact a visitor's experience and perception of the church's cultural significance. Temporary alterations also often, unintentionally, become long-term or permanent.

7. As modifications and repairs are performed at the First Presbyterian Church, the significance of the building shall be upheld by respecting and considering national and international conservation principles. For instance, as modifications and repairs are proposed, consider the level of intervention on a scale of minor, moderate, and major work; minor involves cleaning and repair, moderate involves cleaning, repair, and some replacement of materials, and major involves larger in-kind replacements where materials are severely deteriorated

8. Conservation work shall be characteristic of the best conservation practices (quality of work to be supported through the involvement of appropriate specialists and trades). Alterations are acceptable where technical advances, expert advice, design quality, adequate resources, and meticulous construction can be combined to create facilities that will improve function and reinforce the significance of the church complex provided that the work is planned in the context of an overall scheme and not taken piecemeal on an ad-hoc basis.[366]

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[366] Inskip and Gee: *Louis I. Kahn and the Yale Center for British Art: A Conservation Plan*, 87.

Policies Related to the Place as a Whole

9. To maintain the experience of the Sanctuary as designed by Wallace K. Harrison of Harrison & Abramovitz Architects

> 9a. The appearance and experience of the Sanctuary interior shall be maintained with the highest degree of significance

10. To maintain the experience of the Parish Unit as designed by Willis Mills of Sherwood, Mills & Smith in collaboration with Harrison & Abramovitz Architects

> 10a. The appearance and experience of the Parish Unit shall be maintained with a high degree of significance, though as one that is only secondary to the Sanctuary; the Parish Unit was designed to complement the Sanctuary

11. To maintain the experience of the Carillon Tower as designed by Wallace K. Harrison

> 11a. The appearance and experience of the Carillon Tower shall be maintained with the highest degree of significance, as it was designed as a sculptural work of art by Wallace K. Harrison

12. To maintain the experience of the landscape on the south side as designed by Bryan J. Lynch

Policies Related to the Sanctuary

To maintain the Sanctuary as a space for worship and music as designed for the First Presbyterian Church by Wallace K. Harrison, specific policies should be recognized:

13. To conserve the spirit of the building, as conceived by the architect, which provides religious and secular visitors with a unique architectural experience; the spirit is expressed and reflected in the exterior and in the interior

14. To regard the Sanctuary as a system of 152 exposed precast concrete units connected by poured in place concrete, forming what Harrison and British structural engineer Felix J. Samuely referred to at the time as "space construction"; these are irregular triangular, trapezoidal, and parallelogram panels leaning into each other and that constitute both the wall and roof of the Sanctuary

> 14a. To maintain the legibility of the volume and its primary elements from both the exterior and the interior
>
> 14b. To maintain colored and colorful glazing (*dalle de verre*) that highlights the interior

15. To consider the central idea and its visual and structural concept that the Sanctuary was without comparison from the start, specifically referring to the technology and methodology of construction and materials that resulted in a particular configuration and shape

Exterior

16. To maintain the Sanctuary's design and structural integrity, by preserving:

> 16a. The appearance of the above-mentioned precast concrete panels and poured in place concrete as viewed from the exterior
>
> 16b. The appearance of the original and replacement *dalle de verre* panels as viewed from the exterior on the north, east, and south elevations
>
> 16c. The appearance and character of the slate shingles on the wall and roof panels
>
> 16d. The entryway plaza (which was rehabilitated in the 1970s and refurbished in 2016)
>
> 16e. The original concrete entryway sculptural canopy (Christ in Profile)
>
> 16f. The wood doors (some of which have been refinished or replaced)
>
> 16g. The granite cornerstone (originally installed at the former church structure at 90 Broad Street and reinstalled at the new Sanctuary in 1957)

17. To maintain the Sanctuary's visual, design and structural integrity, by resolving issues through improving:

> 17a. The damaged original and replacement *dalle de verre* panels

17b. The foundation walls and reinforced concrete base

17c. The aluminum framing system installed upon the *dalle de verre* roof panels

17d. The water management of the exterior walls

Interior (including Sanctuary, Chancel, Organ, Narthex, and Balcony)

18. To maintain the Sanctuary's visual, design and structural integrity, by preserving:

18a. The Sanctuary's innovative forms and materials reflecting a traditional interior division of church architecture; the legibility of the internal organization of the building in this division

18b. The appearance of the precast concrete panels and poured in place concrete and their surfaces as viewed from the interior, including the cast in place concrete stairs along the south elevation in the narthex, leading to a balcony that spans the width of the Sanctuary, and the balcony's original concrete slab floor

18c. The appearance of the original and replacement *dalle de verre* panels as viewed from the interior on the north, east, and south elevations

18d. The appearance of the original branched pendant light fixtures (as designed by Harrison) suspended in the nave

18e. The original elements in the chancel, including table, pulpit (as modified), and millstone embedded in the floor before the communion table

18f. The prominence and appearance of the wooden cross and the related appearance of the chancel; the chancel was significantly altered in 1991 to accommodate a new organ (see 18h), which resulted in a change in legibility of the space (the organ was originally set behind conduits and was less prominent); the new configuration should be maintained

18g. The pews, designed by Harrison and installed by Joseph Rhodes, were originally left untreated (natural wood) and were subsequently refinished (varnished) to mimic its original appearance. All future pew maintenance shall follow the procedure as researched and specified in the Conservation Management Plan's Physical Evidence section to maintain a natural wood like appearance

18h. The acoustical integrity of the Sanctuary, including the Opus 87 Visser-Rowland mechanical action pipe organ (installed in 1991 to replace the original Allen organ) is critical; future acoustical improvements and updates shall be held to the highest acoustical standards

18i. The 16-foot canvas mural of the crucified Jesus, created by Harrison and installed during the 1970s redecoration of the narthex

18j. The mobile suspended in the narthex, titled "Fishers of Men and Women," which echoes the imagery of fish in the *dalle de verre* (an addition dating to 1994)

18k. The original wood doors, including: wood doors (with original hardware) between the nave and narthex, the two original wood doors from the Sanctuary to the choir room, the original wood door in the narthex to the fan room, the original wood door in the narthex to the storage room, and the original wood doors (excluding hardware) from the narthex to the covered passageway

18l. The original wood screen and doors separating the Nave from the Narthex

19: To maintain the Sanctuary's structural and design integrity, by resolving issues related to:

19a. The damaged original and replacement *dalle de verre* panels

19b. The damaged original precast concrete panels

19c. The damaged exterior stairs and landing outside the main entrance to the Sanctuary

19d. The air conditioning system

Policies Related to the Choir Room

To maintain the choir room as conceived by the architect, specific policies should be recognized:

20: To regard the multi-purpose space as a rehearsal space for the choir, meeting room, storage, and a connection between the Sanctuary and the Sacristy and Corridor

> 20a. As such, to reallocate space only as necessary, which is acceptable so long as the organization of the space remains within the original intended use of the Choir Room; original features such as the wood cabinets should not be changed, but movable features (such as loose furniture) may be reconfigured

21: To recognize that the overall form of the Choir Room plays an important part in the massing of the complex and reflects the design intentions for the Sanctuary, narthex, Fellowship Hall, and Harrison's designs for the pews, fixtures and the pulpit

Exterior

22: To maintain the Choir Room's design material and structural integrity, by preserving exterior elements such as:

> 22a. The concrete block walls (stucco) and window walls
>
> 22b. The terrace on the north side of the Choir Room with cement slab flooring; the rear wall is set back deeply with the overhanging eave creating a sheltered porch
>
> 22c. The original wood door that provides access to the enclosed triangular open space formed between the Sanctuary, Corridor, and Choir Room, in addition to the original wood doors (with glass panels) from the Choir Room to the rear terrace

Interior

23: To maintain the Choir Room's design, material and structural integrity, by preserving interior elements such as:

> 23a. The cement floors (re-painted), including concrete steps
>
> 23b. The original natural plywood ceiling
>
> 23c. The concrete block and plaster walls
>
> 23d. The original natural wood windows and original wood window walls
>
> 23e. The original wood cabinetry and related millwork

24: To maintain the Choir Room's design, material and structural integrity, by resolving issues related to:

24a. The water damage at walls adjoining the Sanctuary; no gutters were originally installed on the exterior of the Choir Room, but gutters were added later

Policies Related to the Covered Walkway (Passageway)

To maintain the covered walkway as conceived by the architect, which serves as a link between the Sanctuary, Choir Room and the Parish Unit, outside the Sanctuary, access to the Sacristy, and as an additional architectural element of the elevation to the Sanctuary, specific policies should be recognized:

25: To conserve the covered walkway, the space should be recognized as two sections: Corridor (identified as C106 on the plans) and Connecting Link (W100 to W102 on the plans); the Corridor section which provides access to the Sacristy (C101 to C105)

Corridor Exterior

26: To maintain the Corridor's design, material and structural integrity, by preserving:

26a.The corridor, as viewed from the exterior, as an extension of the Sanctuary's North elevation. The precast concrete panel sections and *dalle de verre* infill panels of the north elevation and the massing of the Sanctuary can be seen from the rear of the church complex due to the transparency of the corridor

26b. The legibility of the internal space and its apparent purpose as viewed from the exterior and spaces beyond

26c. The original painted African mahogany window walls

26d. The original exposed concrete slab flooring

26e. The original wood built-up roofing

27: To maintain the Corridor's design, material and structural integrity, by repairing:

27a. The instances of failing paint

Corridor Interior

28: To maintain the Corridor's design, material and structural integrity, by preserving:

28a. The corridor, as experienced from the interior, as an extension of the Sanctuary's North elevation; the precast concrete panels and *dalle de verre* infill panels can be seen from the interior of the corridor due to the transparency of the corridor

28b. The original natural African mahogany window walls

28c. The original natural finished veneer plywood ceiling

28d. Accessibility to the Sacristy (as shown on plans as C101 to C105) and its materials, including the original natural wood window walls, original casement windows in the kitchen and restrooms, original natural wood built-ins in the kitchen, concrete block (exposed and with plaster) walls, and (re-painted) concrete floor including steps.

28e. The original wood door separating the corridor leading to the choir from the remainder of the covered walkway.

29: To maintain the Corridor's design, material and structural integrity, by repairing:

29a. Cracks throughout the original concrete floor

29b. Corroded window screens

29c. Water damage in the utility room

29d. Water damage to wood window wall

Connecting Link Exterior

30: To maintain the Connecting Link's design, material and structural integrity, by preserving:

30a. The connecting link, as experienced from the exterior, as an extension of the Sanctuary's North elevation; the precast concrete panel sections and *dalle de verre* infill panels can be seen from the west side of the connecting link (the entrance to the Parish Unit) due to the transparency of the connecting link

30b. The original natural wood window walls and natural built-up roofing

31: To maintain the Connecting Link's design, material structural and integrity, by repairing:

31a. Flaking and peeling paint at exterior of window wall

Connecting Link Interior

32: To maintain the Connecting Link's design, material and structural integrity, by preserving:

32a. The connecting link, as experienced from the interior, as an extension of the Sanctuary's North elevation; the precast concrete panel sections and *dalle de verre* infill panels can be seen from the interior of the connecting link due to the transparency of the connecting link

32b. The original wood door to the Open Court, which provides access to the enclosed triangular open space between the Sanctuary, Corridor, and Choir Room

32c. The original wood door to the Memorial Garden, which provides access to the open space to the north of the Sanctuary

32d. Certain elements of the interior, including the original coat racks and related millwork installed along the south wall of the corridor, which also forms the Sanctuary's North elevation

32e. The plywood millwork (replaced) along the north Sanctuary elevation, and the replaced wood ceiling panels

33: To maintain the Connecting Link's design, material and structural integrity, by repairing:

33a. Cracks throughout the original concrete floor

33b. Some original but inoperable hopper-style windows

33c. Water damage at the vestibule to the Parish Unit

33d. Water damage where the connecting link meets the Sanctuary wall

33e. Cracked glass pane

33f. Damaged and missing hardware in the original narthex door

Policies Related to the Parish Unit

To maintain the Parish Unit as a low fieldstone and glass structure designed for administrative, school, educational and community needs by architect Willis Mills of the architecture firm Sherwood, Mills & Smith, and as a space designed before and in coordination with (and ancillary in design to) Wallace Harrison's Sanctuary, specific policies should be recognized:

34: To conserve the Parish Unit, the space should be recognized for its core sections: Office and Church School Building (identified on plans as rooms 101 to 120 and 203 to 258), Corridor (shown on plans as rooms 111, 114, 201, and 230), Chapel (marked on plan as room 239), and Fellowship Hall (numbered on plan as room 253)

35: To reallocate space only as necessary to serve current needs, which is acceptable if the organization and general subdivision of the space remains within the original intended uses of the Parish Unit, and to improve functionality as updates are carried out (including recent 2016-2017 renovations); however, a careful and cautious approach to any change or future subdivision of the existing offices, classrooms, meeting rooms, and other spaces should be taken to assure that the character of the interior is upheld, as the organization of the Parish Unit is of fundamental significance to and representative of Mills' design and should be respected

36: To recognize that Mills developed plans for a potential but not executed expansion of the Parish Unit to the rear of the existing structure[367]

Office and Church School Building Exterior

37: To maintain the exterior's design, material and structural integrity, by preserving:

> 37a. The Parish Unit as a meandering plan form that frames the Sanctuary (beginning at the wood and glass corridor that connects the structure with the Sanctuary and culminating at Fellowship Hall)
>
> 37b. The wall materials, including exposed and occasionally painted concrete blocks and rubble stone facing
>
> 37c. The composite roof system, consisting of concrete slabs (pitched inward and with a membrane roof originally covered with pebbles) with centrally located drains, translucent corrugated plastic sheets (Corrulux)[368] over the stained glass skylight in the chapel, and domed skylights in the east facing classrooms

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[367] The Carillon Tower was built in its existing location partly to avoid building in free space near the Parish Unit in anticipation of possible future expansion. In April 12, 1965 Walter Maguire wrote in a letter (presumably to Wallace Harrison): "…there is a good possibility that this expansion will be needed within the next two or three years. Mr. Mills has worked out some plans for expansion in that direction." FPC Archives

[368] Corrulux is the tradename of a product identified in the original specifications and in the 1950s marketed as a 'translucent structural panel".

Office and Church School Building Interior

38: To maintain the interior's structural and design integrity, by preserving:

38a. The ground floor wall materials, consisting of concrete blocks with painted plaster (some of which have already been changed)

38b. The built-in furniture and millwork designed by Mills

38c. The ground floor fireplace in the lounge. It's surrounds already significantly altered. (Room #229, labeled "Lounge" in the Parish Unit Ground floor plan)[369]

38d. Accessibility to the classrooms, offices, and other spaces such as staircases and activity rooms (library, youth center, lounge)

38e. The original wood doors with glass insets into the classrooms and offices

39: To maintain the interior's design, materiality and structural integrity, through the general maintenance of:

39a. The ground floor and basement suspended acoustic ceiling tiles

39b. The basement concrete block wall – painted (corridor), plastered (classrooms), and exposed concrete block (utility)

39c. The interior millwork

Corridor Exterior

40: To maintain the exterior's design, material and structural integrity, by preserving:

40a. The overall legibility of the Corridor as experienced from the exterior and as the section of the Parish Unit framing the Sanctuary (beginning at the wood and glass corridor that connects the structure with the Sanctuary and culminating at the chapel); meaning, the layout, appearance and transparency of the interior spaces as seen from the exterior of the structure

40b. The window systems (window walls), with African mahogany framing resting on concrete blocks

40c. The embedded stained glass medallions (removed from the windows of the earlier and demolished sanctuary)

41: To maintain the exterior's design, materiality and structural integrity, through the upkeep of:

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[369] Original construction drawings and photos of the lounge interior appearing in the FPC *commemorative booklet*, dated 1958/1959, indicate wood paneling on the fireplace wall and slate hearth, header and pillars for the fireplace

41a. The existing wood window walls

41b. The existing stone piers

41c. The new, ADA compliant, wood and glass exit doors[370]

Corridor Interior

42: To maintain the interior's design, materiality and structural integrity, by preserving:

42a. The overall legibility of the Corridor as experienced from the interior and as the section of the Parish Unit framing the Sanctuary (beginning at the wood and glass corridor that connects the structure with the Sanctuary and culminating at the chapel); this includes the appearance of original doors, which are still remaining and are located at the entrances to the classrooms and offices

42b. Its accessibility to existing offices, classrooms, meeting rooms, and other spaces

42c. The window systems (window walls), with African mahogany framing resting on concrete blocks

42d. The embedded glass medallions (removed from the windows of the earlier and demolished sanctuary)

42e. The interior millwork

Chapel

43: To maintain the chapel's design, materiality and structural integrity, by preserving:

43a. The overall space and form of the chapel, which reflects the spirit of the Sanctuary, narthex, Fellowship Hall, Choir Room, and Harrison's designs for the pews and the pulpit

43b. Wood screen at the west wall

43c. The skylight of wood ribs and original *dalle de verre* (which was the earliest installed stained glass in the church complex)

43d. The original entry doors, consisting of wood double doors with small cross cut outs lit from behind by the glass corridors and with its wood grill above and single wood access door

43e. The original lighting locations (which have new fixtures installed)

44: To maintain the chapel's design, materiality and structural integrity, through the upkeep of:

[370] All sets of double doors exiting out of the Parish Unit have been replaced with new ADA compliant wood glazed doors and have been outfitted with necessary exit hardware.

44a. The surface mounted acoustic ceiling tiles

44b. The slate floor tiles

Fellowship Hall Exterior

45: To maintain the exterior's design, materiality and structural integrity, by preserving:

45a. The overall space and form of Fellowship Hall, which reflects the spirit of the Sanctuary, narthex, Choir Room, chapel, and Harrison's designs for the pews and the pulpit

45b. The concrete block and stone faced walls

45c. The distinctive wide flange beam roof structure

45d. The slate roof

46: To maintain the exterior's design, materiality and structural integrity, through the upkeep of:

46a. The wall of clear glass, colored glass insets and wood framing designed by Mills, which has been replaced with new thermally broken aluminum frame with insulated glass (similar to the original in design, inset with panels of rose, amber, and turquoise glass[371]); this wall now has deeper mullions and muntins to accommodate the thicker insulated glass units

Fellowship Hall Interior[372]

47: To maintain the interior's structural and design integrity, by preserving:

47a. The Hall as a multi-purpose space (originally used during construction of the Sanctuary as a temporary setting for worship and continued use as a community space). As such, to reallocate space only as necessary, which is acceptable if the organization of the space remains within the original intended use of Fellowship Hall; to maintain architectural and design integrity as updates are carried out. (The 2016-2017 intervention harmed the original integrity of the hall by replacing the south window wall and some of the original finishes.)

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[371] Note: The pattern of colored glass panel insets is reminiscent of the original pattern, but is not identical

[372] The policies reflect the renovated conditions, A survey of Fellowship Hall was conducted after recent renovations (2016-2017), and the following policies have been developed in response to the observed alterations.

47b. The walls, including concrete blocks, original veneer plywood wall panels, and wall of clear glass with above-mentioned inset panels; (note: however, the replacement inset panels are not exact replicas of the original glass)

47c. The ceiling, including original star-beam/diagrid structure (updated paint); the exposed structural elements form the Gothic symbol of hands touching in prayer. The overall space and the ceiling are of utmost significance in Fellowship Hall, and should be treated as such

48: To maintain the interior's structural and design integrity, through the upkeep of:

48a. The overall form of the original stage

48b. The replacement wood paneling in the corridor connecting Fellowship Hall to the Parish Unit; these panels are different in size and configuration than the originals. They are meant to be reminiscent of the original panels in terms of material and color

Policies Related to the Carillon Tower

To maintain the Carillon Tower, as conceived by Wallace K. Harrison and structural engineers Ammann & Whitney and built to specifications by Dr. Arthur Lynds Bigelow to house the carillon, which serves as a sculptural work of art that enhances the experience of the Sanctuary and provides religious and secular visitors with a unique architectural and musical experience, specific policies should be recognized:

49: To maintain the Carillon Tower, the structure should be recognized for its sculptural design and structural design integrity, by preserving:

49a. The Tower as a design and structure that showcases Harrison's achievements in crafting iconic sculptural identities

49b. Its structural form expressed in its concrete components: poured in place concrete legs with square footprints, three connecting concrete struts, four smaller inclined concrete legs that are supported on the second strut, and concrete slabs that support the lower and upper belfries

49c. The spiral precast concrete stairwell that leads from the ground up to the lower belfry, consisting of identical precast treads with cylindrical core elements, stacked to create the ascending spiral

49d. The cylindrical metal grill, consisting of vertical painted and galvanized metal rods connected by horizontal plates that encloses the concrete staircase

49e. The teak wood screen stair enclosure and the teak wood enclosure for the belfries, and the galvanized metal gusset plates and bolts on the interior and wood plugs on the exterior that connect the teak wood elements

49f. The square concrete pavers at the base with inserts of larger granite memorial plates

49g. The upper and lower belfries, composed of concrete slab floors and open patterned teak wood walls (the belfries have woven wire mesh in metal frames on the interior)

49h. The carillon-player room, consisting of wood floor, wood exterior walls, and an original carillon instrument

49i. The carillon of 56 bells (a combination of 21 original Gillet & Johnston bells and 35 1960s Paccard bells). Twenty of the bells allow for basic tunes to be played by remote control from the organ console in the Sanctuary

49j. The remote electrical controls that allow the lower two octaves to be played from the church organ console during worship services and special occasions; the time mechanisms that allow for selected bells to operate and mark the hours

49k. The base, with its landscaping dating to the 1970s, including plantings (which were originally intended to convey the impression of ledge rock, according to Winthrop P. Moore's maintenance notes)

Policies Related to the Landscape

To maintain the landscape as an open space that provides an appropriate setting to the complex in general and the Sanctuary and Carillon Tower in specific and is a beautiful and essential part of Stamford's urban fabric, as designed originally by Bryan J. Lynch, specific policies should be recognized:

50: To respect the original landscape and its relationship to the building, the grounds should be recognized for its core components: the Bowl, the open 'cloister' area framed by the Sanctuary and the Parish Unit Corridor, the Memorial Garden, the Stamford Historical Wall, the Memorial Walk, and the triangular Open Court bordered by the north elevation of the Sanctuary and the south elevation of the Corridor and Connecting Link

The Bowl

51: To maintain the Bowl's landscape design integrity, by preserving:

> 51a. The open space as a dramatic sloping lawn that projects a natural, pastoral public image as viewed from Bedford Street
>
> 51b. The minimal plantings (early images indicate minimal landscaping and not much more than foundation plantings), including only a small number of trees and shrubs (during the first several years post-construction, a substantial number of evergreen trees and shrubs were planted as memorial gifts by church members) for the complex to remain visible

Open Cloister

52: To maintain the Open Cloister's design integrity, by preserving:

> 52a. The grassy area as a U-shaped enclosure that allows direct views of the Sanctuary's east elevation and the Parish Unit Corridor
>
> 52b. The Celtic Cross, made of Barre granite, in the center of the space
>
> 52c. The paving with its two sidewalks leading from the curved driveway to the Parish Unit running respectively south and east (altered in 2016 for ADA compliance)
>
> 52d. Minimal plantings; (the existing plant selections were inspired by the religious symbolism for each as well as how they relate to the pre-existing plant palette)

Memorial Garden

53: To maintain the Memorial Garden's landscape design integrity, by preserving:

> 53a. The integration with a natural ledge outcropping, which was one of the main features of the landscape that Harrison utilized to determine the layout of the church complex

53b. The space as designated originally by the Trustees of the church as a final resting place for the ashes of members of the church and their families

53c. The space as a buffer between the church complex and the adjacent high-rise apartments beyond (to the north)

53d. The minor additions of shrubs

53e. The original wall for memorial plaques (the supporting wall across the door from the walkway)

53f. The addition of two walls for memorial plaques; the first of which was built in 1982 (this is the exterior wall of the utility room), and the second of which was built in 2015 (this is a straight wall parallel to the covered walkway)

54: To maintain the Memorial Garden's design integrity, by resolving issues related to:

54a. Landscaping and planting

Stamford Historical Wall

55: To maintain the Stamford Historical Wall's design, content and cultural integrity, by preserving:

55a. The feature as a part of the landscape that runs along the Bedford Street edge of the main lawn, as conceived of by Rev. Dr. George Stewart in the 1940s

55b. The feature as a continuation of DeLuca Construction's work at the church

55c. The 72 inset granite tablets with lettering that interweave the history of the church and town, including the tablets from its original construction in 1964 and two additional stones that were added in 1978 at the 20th anniversary of the Sanctuary

Memorial Walk

56: To maintain the Memorial Walk's design and cultural integrity, by preserving:

56a: the feature as part of the landscape that runs along the driveway's sidewalk from Fellowship Hall to the Sanctuary steps, conceived of by Rev. Dr. George Stewart in the 1940s in consultation with Protestant church historian Roland Herbert Bainton

56b: the feature as a continuation of DeLuca Construction's work at the church

56c: the 106 inset tablet stones of Barre granite incised with the names and dates of biblical figures, theologians, politicians, and others; *the Walk was expanded in 1977 and the stones were reset, and a few replaced, in 2016 as part of a larger landscape maintenance project*

Triangular Open Court

57: To maintain the Open Court's design integrity, by preserving:

57a. The space as designed by Wallace Harrison

57b. The integration of open space within enclosed building units

Parking

58: To maintain the parking lot's design integrity, by:

58a. Recognizing the design intent that the original curved parking lot (located on land that was sold in 2015 and subsequently redeveloped) was purposely integrated into the overall site plan, and recovering the overall unity of the existing parking lot and its relationship within the landscape

Guidelines and Recommendations

This section of the Conservation Management Plan is prepared to provide guidelines and recommendations that are the results of architectural, conservation, structural, and mechanical research and surveys. To assure that decisions concerning repair and conservation respect the significance of the First Presbyterian Church complex, the following serves as a guide to the interventions and maintenance, both short- and long-term.

The below recommendations have been specified to aid HGF and the congregation in planning, fundraising, and implementing the long-term conservation of the Sanctuary and adjoining buildings.

The following recommendations reflect the superior significance assigned to the Sanctuary building in general, and specifically to the *dalle-de-verre* panels which are of the utmost significance to the experience of the Sanctuary. This most significant component is also the most problematic in terms of its physical condition, and was found to be the most in need of remediation.

Hence, the following recommendations are concerned mostly with the maintenance and repair of the structure of the Sanctuary, and with the maintenance and repair of the *dalle-de-verre* panels. Recommendations for the rest of the complex are dealt with only in general (not prescriptive) terms in the previous policy section.

Architectural

Guideline 1: Water Management

History of Water Management at First Presbyterian Church

The original drawings for the Sanctuary, choir room, and corridor (and connecting link) involve little planning for water management letting water spill off sides and roofs freely. The original roof plan and details (shown on drawings A-5 & A-11, Appendix 2) show interior roof drains for the flat roof of the sacristy avoiding the need for external gutters and downspouts, but no drains or gutters for the roofs of the choir or for the covered walkway. The plans for the Parish Unit and Fellowship Hall include measures for water management similar to the sacristy—the flat roofs are pitched inward and interior drains collect water. The chapel roof and Fellowship Hall roof are pitched and the water from those roofs collects into the drains of the flat roofs. At some point between construction and prior to 1970, gutters and downspouts were installed over the corridor and along the Choir room roof.

The structure of the Sanctuary consists of precast panels and cast-in-place concrete connecting ribs and cast-in-place concrete footing. The precast panels all incline toward the central axis of the structure, forming wall and roof panels. The flanking panels to the east and west are protected with slate shingles, but the central panels containing the *dalle de verre* are exposed to the elements and prone to water infiltration. Since construction, the Sanctuary exterior has undergone several campaigns of waterproof coating in attempts to mitigate water damage.

Other problem areas are the *dalle de verre* skylights at the roof of the sanctuary. Protective secondary polycarbonate glazing was installed during construction over these skylights. In 2005, this original glazing was replaced with new protective glazing in aluminum frames with inadequate or no ventilation resulting at times the occurrence of condensation, and maybe overheating of the panels.

Despite the existence of gutters and drains from the choir roof, water damage is evident at the choir room interior on the walls adjacent to the Sanctuary (Appendix 4: Figure 15), directly under the junction of the pitched roof of the choir room and the inclined wall of the Sanctuary.

The Sanctuary's interior shows evidence of extensive water damage. In the south, north, and east elevations, there is damage in the form of efflorescence, peeling paint, different degrees of concrete spalling, rebar corrosion, flaking, and cracking of glass *dalles*. Water damage on the interior is evident throughout the inclined precast panels, but appears to be especially severe on the cast-in-place ribs along the roof line and at the ribs connecting the precast panels, as well as at the cast-in-place concrete base (Appendix 4: Figures 16 and 17). Water infiltration is also apparent at the interior of both entrances at the south façade, resulting in flaking and peeling paint, mold stains, cracking, and spalling concrete (Appendix 4: Figures 18 and 19).

Wet conditions and efflorescence exist at the interior of the foundation wall along the stairs to the fan room (Appendix 4: Figure 20), indicating water infiltration from the main entrance landing above. The landing and stairs are cracked at various locations (Appendix 4: Figure 21).

The aerial photos show condensation under the protective glazing over the *dalle de verre* skylights (Appendix 4: Figure 22). The condition at the the roof panels appear to be less severe than the condition of the slanted walls, but the congregants report that fragments of glass occasionally fall into the space from the skylight panels, despite the wire mesh under the skylight *dalle de verre* panels.[373]

Water infiltration from the roof is not cause for concern in the corridor. There is, however, some infiltration at the walls where the corridor roof meets the north wall of the Sanctuary (Appendix 4: Figure 23). The glass of the window wall is single pane, and there is no climate control in the corridor as a result the water damage may be attributed to condensation (Appendix 4: Figure 24).

Winthrop Moore's maintenance papers, dating from the 1970s, already indicate repairs to the Parish Unit roof. The current roof looks to be quite new and appears to be in good condition. Minimal ponding seems to occur – which is not entirely surprising given the shallow pitch. However, no water infiltration was identified in the Parish Unit. Some of the window walls seem to require re-caulking and re-sealing.

Recommendations for Water Management:

1: The existing gutters and downspouts at the choir room roof should be surveyed, cleaned and fixed, where necessary. The cause of water infiltration particularly at the intersection of Sanctuary and Choir Room roofs – a shallow-slope roof meeting a slate roof – should be improved.

2: The existing protective glazing at the roof level for the skylight *dalle de verre* panels is to be replaced with a new system of protective glazing. The new protective glazing should minimize the greenhouse effect caused by secondary glazing, be better ventilated (without causing leaking) to avoid condensation and be better color matched so as to reduce the currently existing contrast.[374]

3: For the Sanctuary, a system that better diverts most of the water from the exterior surfaces is recommended. This should include some system of collecting and guiding the water through limited sections and gutters along the roof line and downspouts to carry the water to the ground. However, this recommendation is not without its conflicts both visually and technically. For instance, one of the problems is the structure of the Sanctuary—the roofline above the wall panels is not continuous but jagged and includes several ridges and valleys. It may require designing several shorter and carefully located sections that are minimally visually disruptive. It would result also in a number of downspouts that need to be gathered and diverted at the base. Options for the design of gutters and downspouts should be considered carefully, as they will interfere with the integrity of the Sanctuary's façades.

4: Additional waterproofing should be considered for the exposed concrete elements since the testing identified the exposed concrete as quite porous, a condition further aggravated by the

[373] Although no specific reference was identified, it is assumed that the *dalle de verre* panels for building code purposes were interpreted as skylights requiring the wire mesh.

[374] Some comments have been made about how the framing does not match the design of the underlying *dalle de verre* panels. They do match but the foreshortening only creates that impression.

slope of the panels. The currently existing waterproof coating on the exterior of the sanctuary is degrading. New options for water proof coating should be carefully researched and considered and re-application needs to be included in a more regular maintenance program.

5: The concrete slab outside the main south entrance slab should be more comprehensively surveyed to determine the cause of cracking and water infiltration to the foundation wall below[375].

6: The debris over the main entrance canopy at the south should be cleared (Appendix 4: Figure 25) and the cause of water infiltration should be determined and repaired. Aerial photos seem to show that the canopy over the south-west entrance still has the original lead flashing installed (Appendix 4: Figure 26). This flashing should be repaired or replaced, and any other cause of water infiltration at the south-west entrance should be determined and repaired.

Guideline 2: *Dalle de Verre*

Several probable causes have been identified for the continued deterioration of the *dalle de verre*: environmental stresses, water migration, glass 'disease' and secondary structural stresses. The lack of adequate water management guidelines for the Sanctuary and its exposed *dalle de verre* from its inception has necessitated several waterproofing campaigns to mitigate water damage since the original construction. The *dalle de verre,* on the north elevation and in the chapel, is of the highest significance, as this *dalle de verre* is original in design and construction. The *dalle de verre* on the south elevation and the east elevation is replacement *dalle de verre* dating from the 1980s and should be seen to have a lesser degree of significance. The *dalle de verre* on the south and east are anticipated to be too seriously deteriorated for conservation.

The overall experience of the glass framed enclosure from the interior of the Sanctuary should be preserved to the greatest extent possible.

Recommendations for the Dalle de Verre:

6: Additional research is called for to determine the exact nature and causes of the observed cracking, including: consultation with glass experts; lab testing of the epoxy matrix; additional environmental monitoring; deflection monitoring

7: Additional research is necessary to determine the best possible solution for the stabilization and conservation of the *dalle-de-verre* panels of the north façade (in the original concrete matrix).

8: The damaged *dalle de verre* that cannot be conserved should be replicated as closely as possible in form, color and extent of fracturing. This concerns mostly the south and east facades below the roofline. These facades exhibit significant damage and do not date from the time of the original construction of the building. The preferred matrix and methods for replication of the panels are to be thoroughly considered and tested.

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[375] Survey by the structural engineers suggests crushing failure where the balcony stairs bear on the foundation wall. See Appendix 7

9: Secondary glazing is to be considered for the north elevation of the Sanctuary (including wall and roof panels), as the *dalle de verre* is original to construction and therefore should be preserved. The secondary glazing should be properly ventilated so as to avoid condensation.

10: Secondary glazing is recommended for the roof panels of the south and east elevations of the Sanctuary replacing existing glazing to be better ventilated and be less obtrusive.

11: Secondary glazing for the *dalle de verre* for the south and east elevation is to be explored. The technical design is to avoid or reduce environmental stresses using current glass system technologies. The visually least obtrusive options should be explored. The connection between the wall and roof panels should be given particular attention and be integral to any improvement of water management. While visible this intervention would fundamentally not affect the overall massing of the structure, and would also protect the experience of the *dalle de verre* from the interior. Appropriate mock-ups will be required in coordination with environmental monitoring to assess impact and effectiveness.

12. All solutions should be tested for appearance and resilience with mock-ups and accelerated weathering tests

Guideline 3: *Structure*[376]

In the analysis of the structural framing of the Sanctuary it was determined that secondary stresses are present in the system due to some observed deflections. These stresses may, to some extent, be transferred on to the infill panels possibly affecting glazing.

Recommendations for the structure:

11: Explore ways to reinforce the replacement infill panels so as to minimize the introduction of secondary stresses affecting the infill panels and its glass.

12: Repair all cracking in concrete in Sanctuary, Carillon Tower and Parish Unit.[377]

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[376] See also further below in the Structural Guidelines section for recommendations.
[377] Ibid. for more detailed descriptions of areas to be addressed.

Conservation

The attached report by Building Conservation Associates (BCA) has offered guidelines for conservation and repair that are prioritized, in general, by three categories based on their urgency. It is to be noted that potential life safety issues were identified as of the date of the report and that some overlap exists between the three categories. They are:

1. Potential life safety issues, water proofing, and loss of material integrity
2. Diminished material performance
3. Aesthetic (restoration treatment)

Recommendations for the pre-cast and cast-in-place concrete:

Based on BCA's observations and related testing the following recommendations were made:

1: Remove all exterior coatings.

2: Remove efflorescence with poultice materials.

3: Remove deteriorated concrete. Clean of rust, prepare, and coat exposed rebar and provide cementitious patches.

4: Rout out and fill cementitious cracks and crack repairs.

5: Remove and replace existing concrete patches that exhibit deterioration or do not match adjacent original concrete.

6: Provide new breathable silane type waterproofing coating. Testing is required to determine if one product is suitable to all surfaces and can be applied to all elevations to simplify future maintenance. In its application, provide protection of the glass or methods to keep the coating from affecting the appearance of the glass.

7: Further review and assessment of the cracks between the cast-in-place concrete framework and the pre-cast panels is required by the engineer.[378]

9: Perform additional investigation and appropriate mockups in advance of finalizing treatments, involving stripping coatings from areas of concrete on the north, east, and south elevations to evaluate the layers and appearance of underlying materials; testing paint; and performing additional petrographic analysis on additional cores.[379]

Recommendations for the original dalle de verre:

BCA recommends two different approaches for the *dalle de verre,* based on the location of the panels, the conditions existing, the previous interventions, and the visitor experience with the

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[378] See Appendix 7 Old Structures Engineering Structural Survey

[379] See Appendix 6 BCA Conservation Survey for outcome of specific testing

artwork and the building: the original concrete *dalle de verre* in the north façade and skyward facing panels should be conserved *in situ*. It is to be noted that this aims to reduce the rate of deterioration not to fully eliminate the process.[380]

The conservation process for the north elevation and the roof panels involves the following steps:

10: Clean the existing material.

10a: Remove the existing coatings from the exterior concrete matrix.

10b: Clean the interior and exterior concrete matrix material.

10c: Carefully clean existing salts and dirt from the interior glass surfaces.

10d: Carefully remove dirt and biological growth from exterior glass surfaces.

10e: Remove efflorescence from concrete with poultice cleaners.

10f: Remove all coatings and residue from the *dalle de verre* and the pre-cast concrete panels under the existing protective glazing.

11: Stabilize glass.

11a: Stabilize crizzling surfaces with glass silk and a reversible consolidant or with other appropriate method[381]

11b: Replace isolated glass *dalles* too deteriorated for stabilization with new glass matching the shape, color and degree of fracturing of the original as closely as possible.

11c: Replace the few missing *dalles* with new matching original, where information about the color of the original glass is available.[382]

11d: Remove existing inappropriate patching material, provide new patches or replace *dalles* with new matching the original depending on the extent of underlying damage.

12: Install protective glazing.

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[380] The glass apparently is experiencing what is called crizzling for which there appears to be no known method of halting the process of deterioration today. See Appendix 5 for the specific test results and conclusions.

[381] As noted this process has been used, apparently successfully, on European examples. No applications are known to exist in the United States. Additional testing and mockup applications would be required to test its applicability.

[382] Most missing *dalles* are individual pieces of which the shapes are known. Color and degree of fracturing will most likely require some thoughtful interpretation because documentary evidence is unlikely to exist.

12a: Replace existing glazing at roof panels with new protective glazing of appropriate visual and technical design.[383]

12b: Install protective glazing on the exterior north façade. This requires proper ventilation to prevent interior condensation, high light transmittance and low reflectance, and a large framework tracing the pre-cast concrete panels; not covering the *dalle de verre* panels or affecting the light transmission is desired to the greatest extent possible. A low-profile design to reduce the potential for shadows on the *dalle de verre* is recommended.

13: Repair concrete matrix.

13a: Repair cracks that allow light penetration or threaten to destabilize glass.

13b: Remove existing inappropriate patch material and provide new patch repairs at spalls and losses.

14: Environmental monitoring.

14a: Install equipment to monitor the air and surface temperatures as well as the relative humidity on the interior and exterior facades on different elevations.

Recommendations for the replacement dalle de verre:

15: Replace epoxy *dalle de verre*.

15a: Provide new *dalle de verre* panels matching the appearance of the original glass and matrix material.[384]

Recommendations for slate and waterproofing:

16: Further assess the existing conditions of the various flashing materials and provide new flashings if necessary.[385]

17: Clean all slate free of general soiling and biological growth using a biocide.

18: Replace loose, missing, and deteriorated slate with new slate matching the original.

19: Replace all exterior sealant between the pre-cast concrete panels and at the perimeter of the original *dalle de verre* panels following the removal of concrete coatings.

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[383] See also the discussion above in the section Guidelines and recommendations: Architectural, Guideline 2: *Dalle de verre*, 168-169.
[384] The appropriate type of matrix material needs to be established. See discussions of history of *dalle de verre* above in: Description of Site, Thematic History, Dalle de Verre, 59-65 and in: Physical Evidence, Sanctuary Envelop Repair, 104-110.
Use existing original cartoons to the greatest extent possible
[385] See also section Guidelines and Recommendations, Architectural: Guideline 1: Water Management, 166-168.

20: Remove planting directly adjacent to footing in north courtyard.

21: Install drainage system to separate the building and landscape at the west and north elevations, including in the courtyard, to direct water away from building.

22: Redirect downspouts.

Recommendations for the dalle de verre of the chapel:

23: Clean the skyward facing surfaces of the *dalle de verre* panels to remove heavy dust.

24: Perform a finishes analysis of the wood framework to identify the original color of the wood for future repainting campaigns.

25: Redirect exterior drainage away from the base of the building.

26: After the interior masonry at the base of the wall has sufficiently dried, remove efflorescence with a poultice cleaner.

Recommendations for additional research, probes, and tests/mock-ups:

27: Archival Research.

> 27a: The Ateliers Loire, the stained-glass studio begun by Gabriel Loire, remains in operation, although Gabriel Loire passed away in 1996. Reviewing records pertaining to the original materials utilized for the panel construction may prove informative if still available.[386]

28: Probes, Tests and Mockups.

> 28a: Remove a typical concrete *dalle de verre* panel on the north facade to determine and document its configuration and detail as built.
>
> 28b: Remove a typical epoxy *dalle de verre* panel on the east or south facade to confirm and assess its configuration and detail as built.
>
> 28c: Strip samples of all coatings from representative areas of concrete on the north, east, and south elevation to evaluate the effectiveness of proposed methods and materials and to assess the condition and appearance of underlying substrates.
>
> 28d: Perform additional petrographic analysis.
>
> 28e: Perform RILEM testing on original concrete *dalle de verre* panels to better understand range of porosities in advance of selecting a paint stripping system.[387]

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[386] See figures 44-46 in appendix 4 for existing mockups from Studio Loire

[387] RILEM is the European equivalent of ASTM. The test is RLEM II.4 and involves a low pressure method of assessing absorption and porosity *in situ* by using simple test tubes mounted against the surface.

28f: Mock-up glass silk fabric stabilization and/or other proposed glass stabilization methods to determine the extent of crizzling that can be stabilized and the visual impact of the treatment.

28g: Mock-up replacement of significantly cracked glass *dalles*.

29: Larger Scale Mock-ups.

29a: Explore repair, replacement and conservation options through large scale mock-ups that can be monitored and assessed over time, to determine suitability, efficacy and appearance. For example, as noted above, design and install a new protective glazing system mock-up and perform glass stabilization work at the corresponding interior *dalle de verre* panels to further evaluate the protection system and the aesthetic qualities of the stabilization treatments as observed by the design team and the church congregation.

29b: Monitor the temperature, relative humidity, and assess impact and behavior of the mock-up installations on the interior environment and the existing and newly installed materials at the mock-up location.[388]

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[388] A particular concern would be the interaction of the replacement *dalle de verre* and its matrix in its exposed and protected configuration with protective glazing.

Structural

Old Structures Engineering's investigation and visual inspection and assessment of the Sanctuary, Carillon Tower, and Parish Unit did not identify any significant structural issues and did not indicate any areas of concern.

The analysis was largely focused on the Sanctuary. It was noted: "…the deflection of the structure is significant enough to redistribute a portion of the load to the more rigid non-structural wall/roof panels."[389]

The report continues: "The compressive and shear stresses from the inadvertent loading may be a factor in the observed cracks and deterioration in the panels."

Old Structures Engineering recommendations include:

1: For the Sanctuary, the new decorative infill panels are to be made in glass fiber reinforced concrete to be able to resist additional loads.[390]

2: For the Sanctuary, all concrete cracks are to be repaired and filled.

3: For the Carillon Tower, the concrete cracks are to be repaired and appropriate waterproofing to be applied to minimize moisture absorption and prevent future rust jacking.

4: For the Parish Unit, foundation damage is to be repaired, concrete patched and waterproofing to be applied.

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389 Letter from Don Friedman and Mona Abdelfatah to Theodore Prudon dated June 21, 2017.
390 Email from Donald Friedman to Theodore Prudon on June 26, 2017: "… it's not feasible to keep the panels from stiffening the frame. To do so would require expansion joints the full perimeter of where each panel meets the frame, as well as some form of pin or clip detail where each panel meets each bordering member. These will be difficult to design and construct so that they will perform properly and, more importantly, will change the appearance and nature of the distinguishing architectural features of the building. If we don't do this, then we have to accept that secondary stresses from frame movement will exist. The only way to handle those stresses is to make the panels stronger."

Mechanical, Electrical and Plumbing

Bicaluro Associates' investigation and survey of the Sanctuary, Carillon Tower, and Parish Unit resulted in an identification and assessment of the existing mechanical and electrical systems. Most of the recommendations are general in nature and can be implemented over time.[391]

One specific task was related to the review of the air conditioning system proposed for the Sanctuary.[392]

Bicaluro's recommendations include:

1: For the existing hot water system, a general recommendation was made that the existing load could be reduced significantly – approximately 25% - by changing the windows, adding wall insulation, and improved ventilation method, and by limiting infiltration (outside air).[393]

2: For the proposed air conditioning system, it was suggested to verify that the fire smoke dampers if installed are in compliance with IMC section 607.5.6 requirements; whether the IECC is applicable for this application or not; list efficiency of proposed equipment on the drawings; reducing temperature setbacks for night or unoccupied periods to minimize plenum condensation or thermal mass effect of the floor.

3: For the proposed air conditioning system, it was also recommended to review air temperatures for new and existing air handling unit in relation to the underfloor application to reduce risk of condensation and mold growth.

4: For the proposed air conditioning system, it was suggested that the electrical panel be 400 amps not 600 amps as shown on the referenced drawings.

5: Specific recommendation with regards to operation of the system with respect to the organ are included in the consultant's report.

6: Since the current design for the ventilation system with constant air supply is not in compliance with ASHRAE Standard 62.1 and IECC requirements, a demand control ventilation approach is recommended to minimize energy use for spaces with large occupancy as the Sanctuary or Fellowship Hall.

7: Regarding the plumbing system, the consultants recommend keeping the existing cold water service and distribution; file, obtain approval and install backflow preventer in the domestic water line.

---

[391] See Appendix 8 Bicaluro Associates Mechanical, Electrical and Plumbing Systems Condition Report, January 30, 2017

[392] The review of the system was based on a set of drawings and specifications titled First Presbyterian Church Air Conditioning Modifications prepared by JP Engineering and dated March 4, 2016. No further communication about the design took place and it is not what actions, if any, were taken.

[393] Changing the existing single glazing for corridors and passage ways would significantly alter the visual appearance (reflections) and given the size of the glazing be costly. This is fundamentally what was done at the south elevation of Fellowship Hall.

8: Replace the existing hot water system with storage tank with high efficiency.

9: Create a separate room for the gas meter; ventilate as required directly to outdoors.

10: Update the current electrical system panel installation, since the original electrical service for the church building was initially installed in the mid 1950's and has not been significantly upgraded within the last years.

11: Upgrade/modify the fire alarm system as required.[394]

[394] As of Fall 2017, the fire alarm system is being upgraded at great cost

Next Steps

Further Research and *dalle de verre* Material Assessment

The documentation, survey, testing and analysis conducted with regards to *dalle de vere*, concrete and precast concrete construction of the sanctuary has led to a considerable insight into the existing deterioration processes and repair and conservation treatments available and are reflected in the recommendation section. However, much of general recommendations are generic instructions without actual laboratory or field data or field test applications. Some of the treatments noted are experimental and given the earlier history of repairs, interventions and replacement, a continued scientific investigation is recommended. This would clarify the stipulated policies or recommendations and provide a sound basis for their execution.

Expanded Project Research

While during the preparation of the CMP, a number of *dalle de verre* and Gabriel Loire projects where studies and work was undertaken, were identified and reviewed, others continue to come up both in the US and Europe. Experiences and conditions appear to vary widely and none seem to present the complexity of the First Presbyterian Church. In addition, conservation research being conducted, particularly in Europe, appears to be largely experimental and seems short on field application and testing. Little or no replication appears to have occurred. Continued compilation of information is warranted.

However, due to the combination of a lack of comparable research and project documentation and the questions raised by the surveys and scientific analysis of the *dalle de verre* materials at First Presbyterian, further scientific analysis is warranted. That analysis can be defined as follows:

Glass Analysis

According to the documentary research the glass used in the dalle de verre in the sanctuary is, at least. from four different sources: the 1950s glass provided by the Loire studio on the north elevation and three American sources (ie Blenko, Heritage Glass and Saint Gobain) identified for the 1980s replacement for the south elevation. For the south elevation the location of which source of glass is where is unknown. A more comprehensive laboratory analysis of select samples of glass and efflorescence related to the glass is to be conducted. A testing protocol is to be formulated identifying location and number of samples and tests to be performed.

In addition to the examination and analysis of the glass deterioration, the conservation treatments recommended are European in origin and represent laboratory experimentation. Examining the treatments in a laboratory context and a field sample is prudent and necessary.

In addition to the laboratory tests and examinations consulting with others that are expert in glass deterioration or glass disease and ‘crizzliing’ is to be undertaken to better understand and asses the conditions noted.

Matrix Analysis

In the case of First Presbyterian both concrete and epoxy matrices were used for the *dalle de verre*. Where concrete is common European method, the use of epoxies is later and predominantly American development. In considering conservation treatment for the concrete matrix of the original installation and needing to formulate a matrix for the south elevation, a better understanding of the interaction between matrix and glass is warranted before selecting a replacement material. A testing methodology and protocol remains is to be prepared.

Concrete Analysis

Early reports identified the presence of ASR (alkali-silica reaction) in the concrete. The current petrographic analysis needs to be expanded to establish the variations in the concrete and the presence and extent of ASR. Number and locations of cores to be established.

Over the years the concrete including the precast, poured in place and *dalle de verre* concrete matrix, has been covered with various waterproofing and surface coatings. Before any subsequent treatments are applied, the earlier ones need to be removed and the underlying substrate needs to be examined as to its condition before new applications are formulated. Sample removals are to be conducted and new applications are to be tested. Scope and protocol is to be prepared.

Environmental Monitoring

The environmental conditions are to be more closely examined in relation to the *dalle de verre.* Surface temperatures and relative humidity on the exterior and interior surface should be monitored. Monitoring over an extended period of time is to be done and is recommended. Specific plan for location, types of monitors, data loggers and data analysis and interpretation is to be developed.

Architectural Interventions and Secondary Glazing

Aside from the further scientific examination and analysis of component materials and treatment, two possible improvements to the exterior envelop are to be studied in more detail. They are management of rain water externally and the installation of secondary glazing. These interventions need to be taken into account when considering the scientific and test data. Three specific actions are to be undertaken:

Water infiltration has been an on-going issue for the exterior envelop of the sanctuary particularly for the precast panel connections, the joints between the precast and the *dalle de verre* panels and the interface between the glass and the matrix itself. Detailed on-site testing on a representative section is to be conducted together with a comprehensive survey of particular joints.

With rain water running uninterruptedly over the slanted surfaces of the exterior walls, water is able to penetrate at all locations. Channeling and directing water would alleviate the environmental stress on the exterior walls, in general, and the *dalle de verre*, in particular.

Design proposals for the installation of gutters and downspouts need to be developed and their visual impact to be assessed.

From the inception the *dalle de verre* panels located at the very top of the sanctuary have been covered with secondary glazing panels. The panels currently existing were replaced in the mid 2000s. Extending the wall areas covered is to be considered. Their impact is to be assessed visually and physically and should represent the latest glass and glazing technology in design and technology. Design proposals are to be prepared.

Implementation of Conservation and Repair Strategies

With the completion of the above testing and research agenda and the assessment of its outcomes, detailed implementation plans and specification plans are to be prepared. Those plans are to contain comprehensive quality control procedures to assure the proper application of specified conservation treatments and repair technologies. The implementation can be in phases if necessary.

Appendices

Appendix 1	DRAWINGS OF EXISTING CONDITIONS
Appendix 2	ORIGINAL CONSTRUCTION DRAWINGS
Appendix 3	SELECT DRONE SURVEY IMAGES
Appendix 4	ILLUSTRATIONS
Appendix 5	BIBLIOGRAPHY
Appendix 6	BUILDING CONSERVATION ASSOCIATES CONSERVATION REPORT
Appendix 7	OLD STRUCTURES ENGINEERING STRUCTURAL REPORT
Appendix 8	BICALURO ASSOCIATES MECHANICAL, ELECTRICAL AND PLUMBING SYSTEMS CONDITION REPORT SURVEY

Appendix 1 Drawings

The attached drawings largely represent the conditions existing in the winter of 2016. The drawings were prepared using the results of a scan survey for the Sanctuary and updating the original drawings for the Parish Unit and the Carillon Tower. When utilizing the drawings for design and construction the data is to be further verified in the field at that time.

List of Attached Drawings

T-100.00	SITE PLAN AND LIST OF DRAWINGS
A-100.00	SANCTUARY. GROUND FLOOR PLAN
A-101.00	SANCTUARY. BALCONY AND BASEMENT DETAILS
A-102.00	SANCTUARY. ROOF PLAN
A-103.00	SANCTUARY. NORTH AND SOUTH ELEVATIONS
A-104.00	SANCTUARY. LONGITUDINAL SECTION FACING NORTH; PLANS OF TONE GENERATING CHAMBER & SOUND CHAMBER
A-105.00	SANCTUARY. LONGITUDINAL SECTION FACING SOUTH
A-106.00	SANCTUARY. WEST ELEVATION AND CROSS SECTIONS
A-107.00	SANCTUARY. EAST ELEVATION AND WALL PANELS
A-200.00	SANCTUARY. ROOF PLAN – PANELS
A-201.00	SANCTUARY. NORTH ELEVATION – WALL PANELS
A-202.00	SANCTUARY. SOUTH ELEVATION – WALL PANELS
A-203.00	SANCTUARY. NORTH ELEVATION. ORTHOGONAL DWGS. LOWER DALLE DE VERRE PANELS
A-204.00	SANCTUARY. SOUTH ELEVATION. ORTHOGONAL DWGS. UPPER DALLE DE VERRE PANELS
A-205.00	SANCTUARY. SOUTH ELEVATION. ORTHOGONAL DWGS. LOWER DALLE DE VERRE PANELS
A-206.00	SANCTUARY. SOUTH ELEVATION. ORTHOGONAL DWGS. UPPER DALLE DE VERRE PANELS
A-207.00	SANCTUARY. EAST ELEVATION. ORTHOGONAL DWGS. DALLE DE VERRE PANELS
A-300.00	CARILLON TOWER. GROUND FLOOR PLAN, EAST AND NORTH ELEVATIONS
A-301.00	CARILLON TOWER. UPPER FLOOR PLAN, WEST AND SOUTH ELEVATIONS
A-400.00	PARISH HOUSE. BASEMENT PLAN
A-401.00	PARISH HOUSE. GROUND FLOOR PLAN
A-402.00	PARISH HOUSE. FELLOWSHIP HALL GROUND FLOOR PLAN
A-403.00	PARISH HOUSE. ROOF PLAN
A-404.00	PARISH HOUSE. FELLOWSHIP HALL ROOF PLAN
A-410.00	PARISH HOUSE. ELEVATIONS A, B, C, D, E
A-411.00	PARISH HOUSE. ELEVATION F; COVERED WALKWAY. ELEVATIONS I, II, IV

List of Attached Conditions Survey Drawings

A-103c	CONDITIONS SURVEY. SANCTUARY. NORTH AND SOUTH ELEVATIONS
A-104c	CONDITIONS SURVEY. SANCTUARY. LONGITUDINAL SECTION FACING NORTH
A-105c	CONDITIONS SURVEY. SANCTUARY. LONGITUDINAL SECTION FACING SOUTH
A-106c	CONDITIONS SURVEY. SANCTUARY. WEST ELEVATION AND CROSS SECTIONS
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A-201c	CONDITIONS SURVEY. SANCTUARY. NORTH ELEVATION – WALL PANELS
A-202c	CONDITIONS SURVEY. SANCTUARY. SOUTH ELEVATION – WALL PANELS
A-203c	CONDITIONS SURVEY. SANCTUARY. NORTH ELEVATION INTERIOR
A-204c	CONDITIONS SURVEY. SANCTUARY. SOUTH ELEVATION INTERIOR
A-410c	CONDITIONS SURVEY. PARISH HOUSE. ELEVATIONS A, B, C, D, E
A-411c	CONDITIONS SURVEY. PARISH HOUSE. ELEVATION F; COVERED WALKWAY ELEVATIONS

LIST OF DRAWINGS

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A-200.00 - SANCTUARY. ROOF PLAN - PANELS
A-201.00 - SANCTUARY. NORTH ELEVATION - WALL PANELS EXTERIOR
A-202.00 - SANCTUARY. SOUTH ELEVATION - WALL PANELS EXTERIOR
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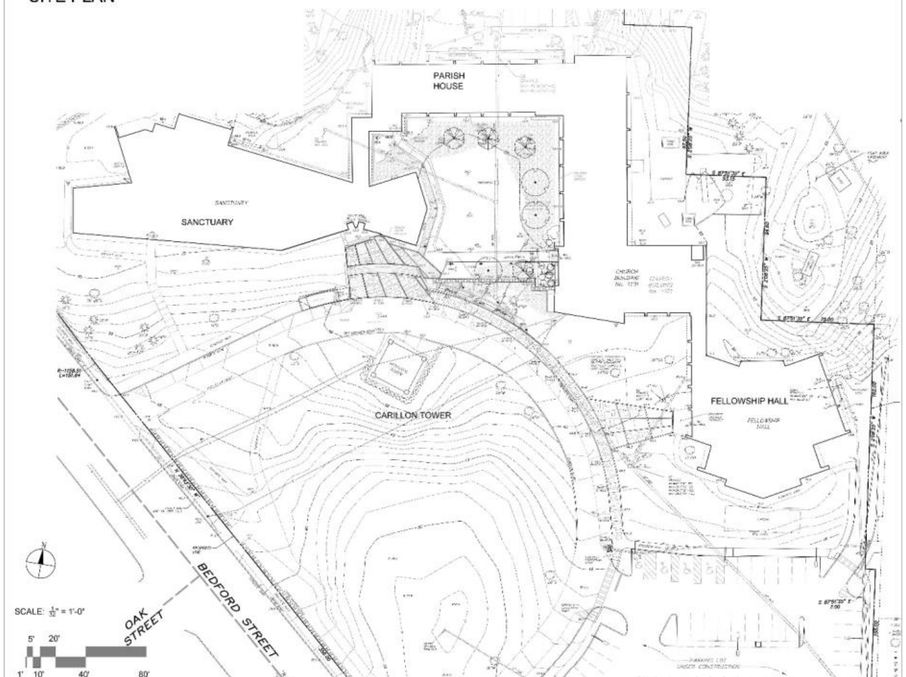
A-411.00 - PARISH HOUSE. ELEVATION F AND COVERED WALKWAY ELEVATIONS

SITE PLAN



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No.	Date	Revision

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1101 Bedford Street
Stamford, Connecticut

Drawing Title
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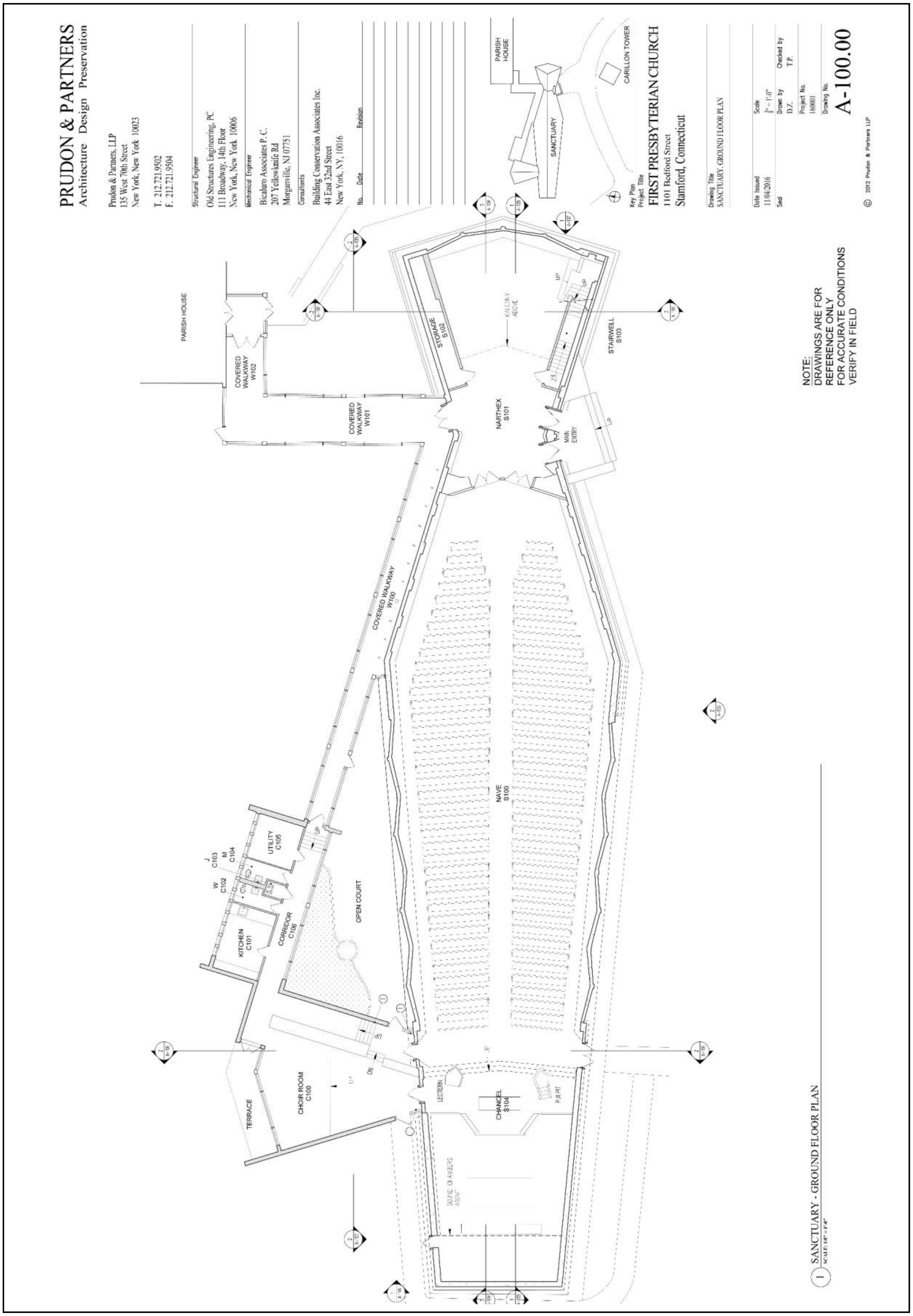
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PARISH HOUSE
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COVERED WALKWAY W101
STORAGE S102
NARTHEX S101
STAIRWELL S103
MAIN ENTRY
COVERED WALKWAY W100
NAVE S100
UTILITY C105
W C102
J C103
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OPEN COURT
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CHOIR ROOM C100
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CHANCEL S104
PULPIT
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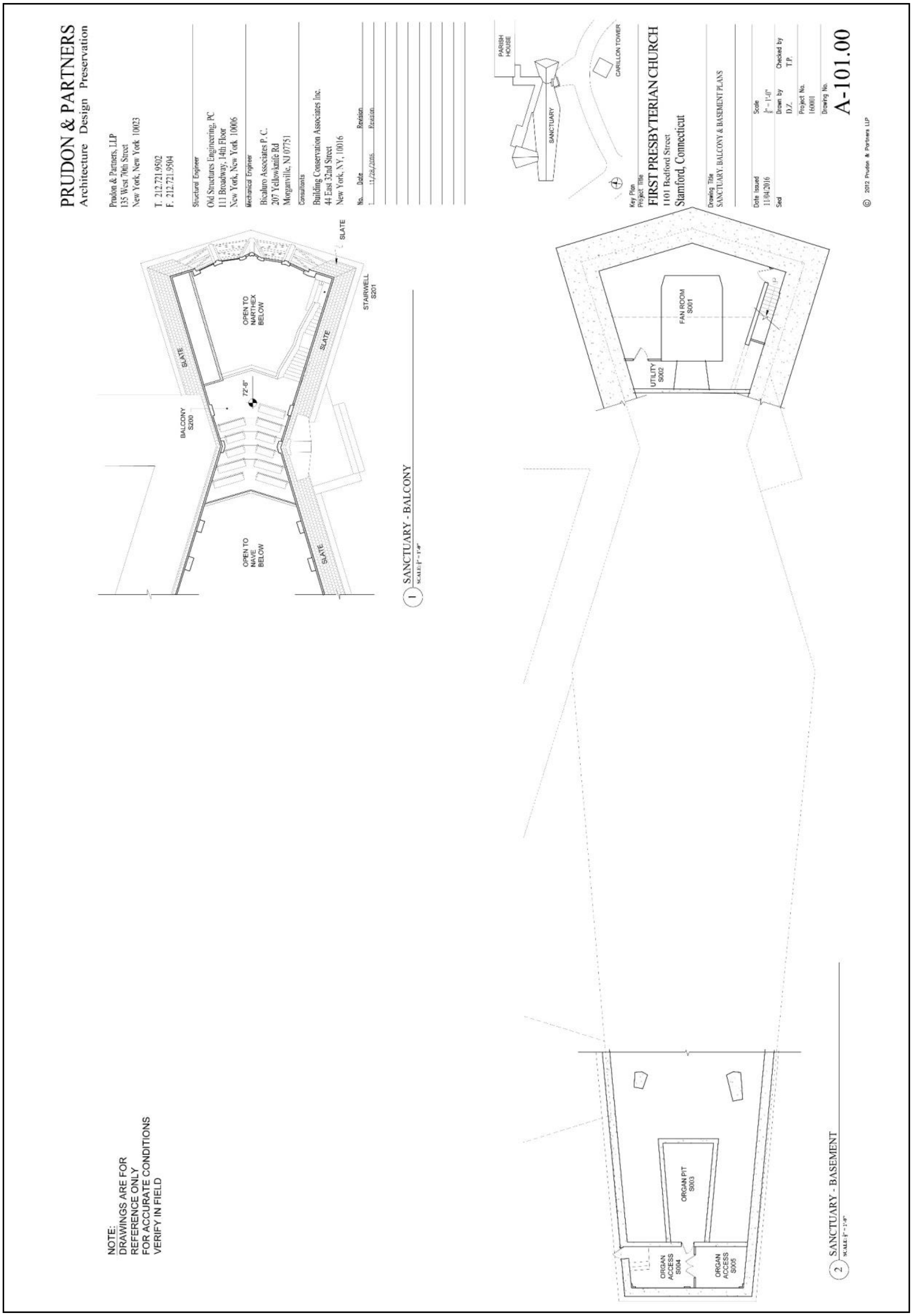
1 SANCTUARY - GROUND FLOOR PLAN



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OPEN TO NARTHEX BELOW
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BALCONY S200
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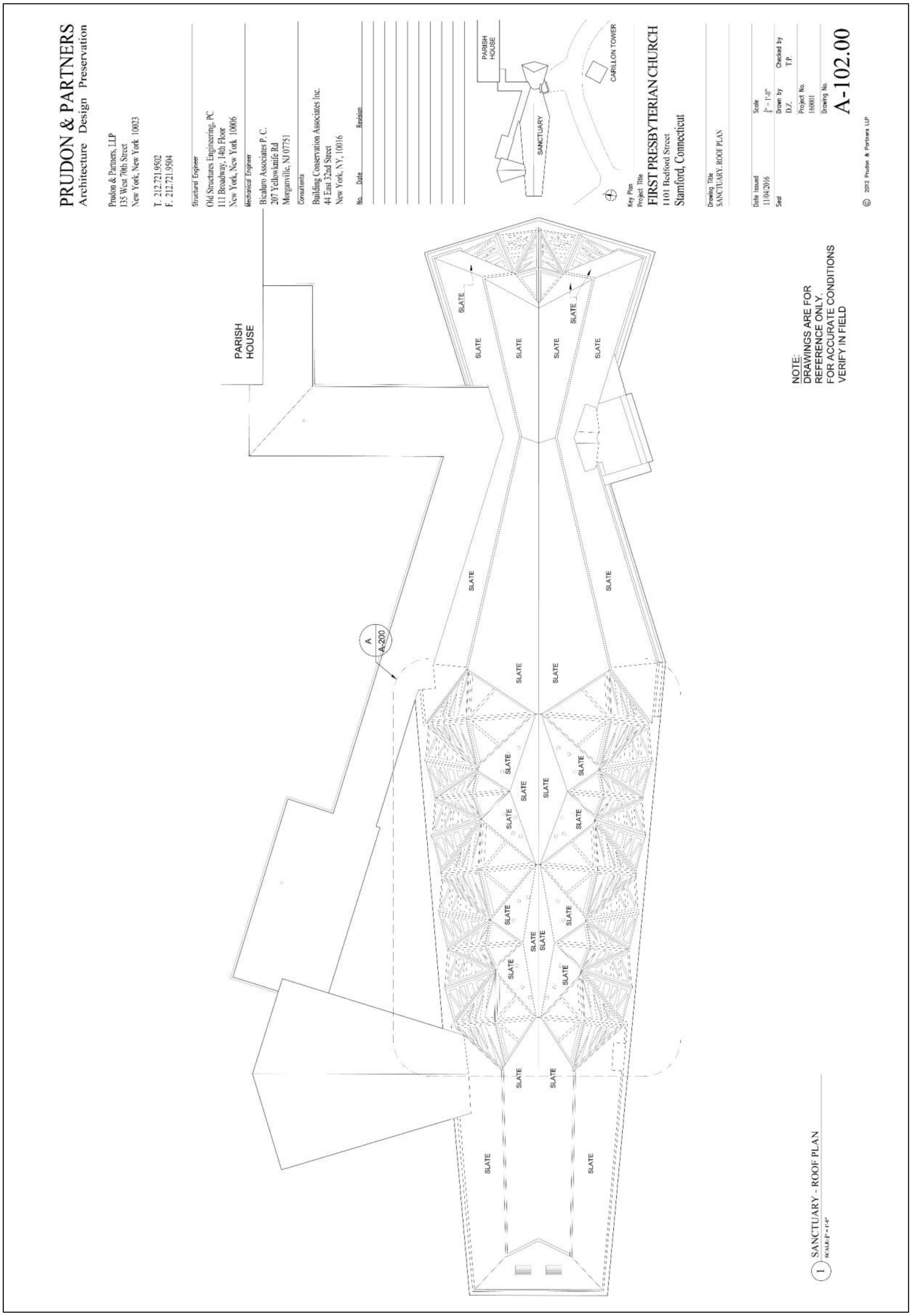
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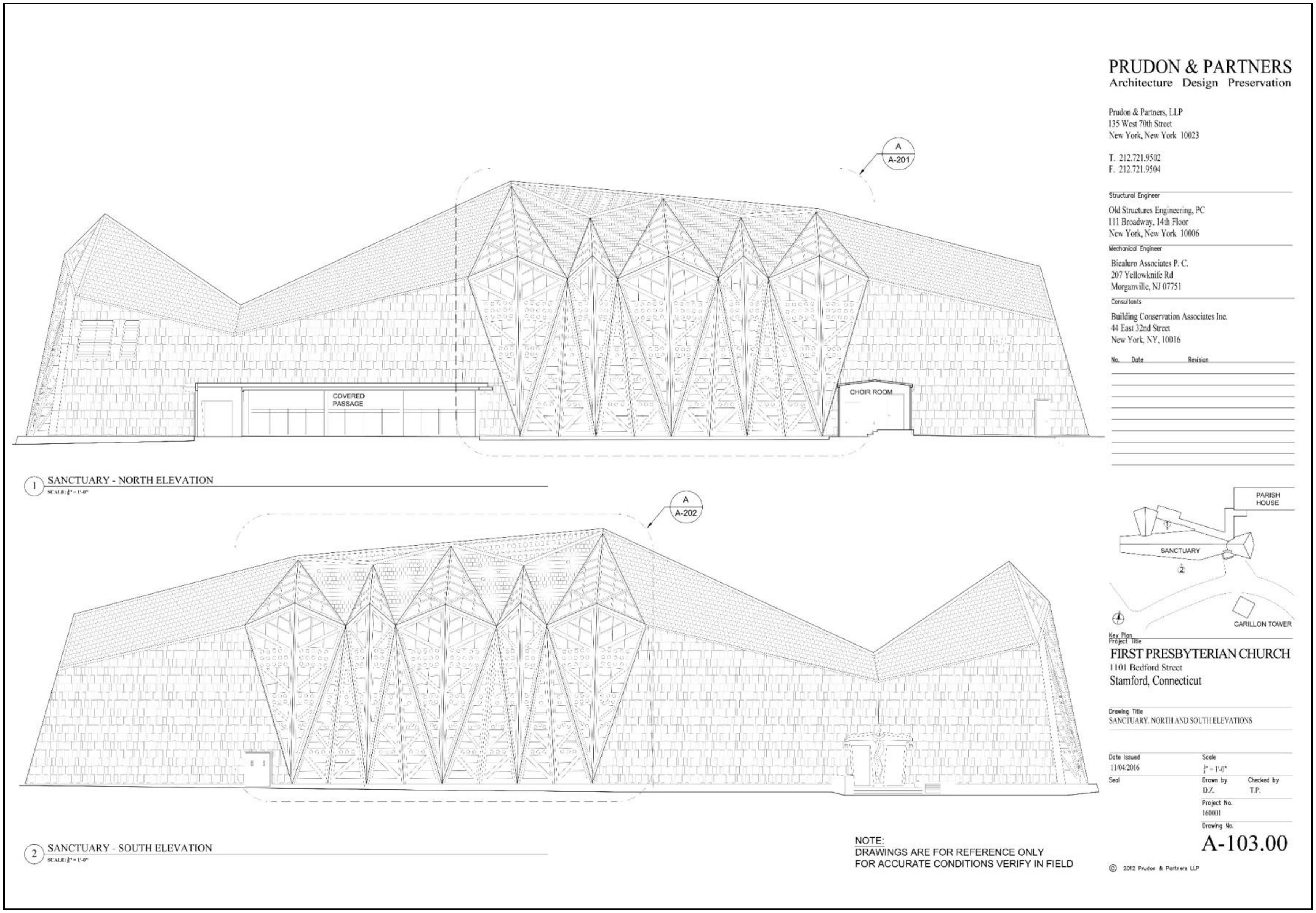
1 SANCTUARY - ROOF PLAN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PARISH HOUSE
SANCTUARY
CARILLON TOWER
Key Plan
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
SANCTUARY, NORTH AND SOUTH ELEVATIONS
Date Issued
11/04/2016
Scale
= 1'-0"
Seal
Drawn by
D.Z.
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T.P.
Project No.
160001
Drawing No.
A-103.00
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A
A-201
COVERED PASSAGE
CHOIR ROOM
1 SANCTUARY - NORTH ELEVATION
A
A-202
2 SANCTUARY - SOUTH ELEVATION
NOTE:
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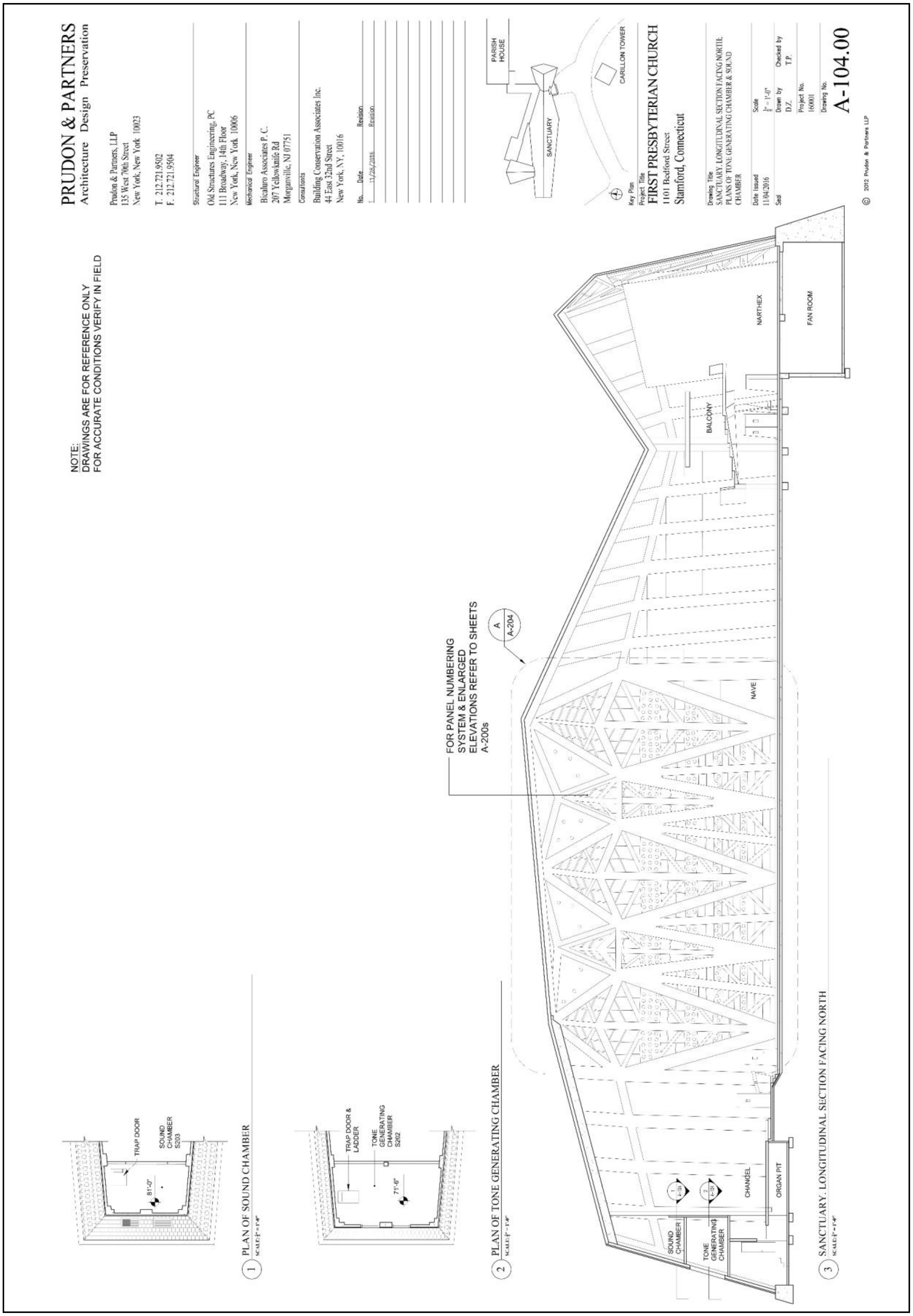

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1 11/28/2016 Revision
PARISH HOUSE
SANCTUARY
CARILLON TOWER
Key Plan
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
SANCTUARY. LONGITUDINAL SECTION FACING NORTH; PLANS OF TONE GENERATING CHAMBER & SOUND CHAMBER
Date Issued
11/04/2016
Scale
Seal
Drawn by
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Checked by
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Project No.
160001
Drawing No.
A-104.00
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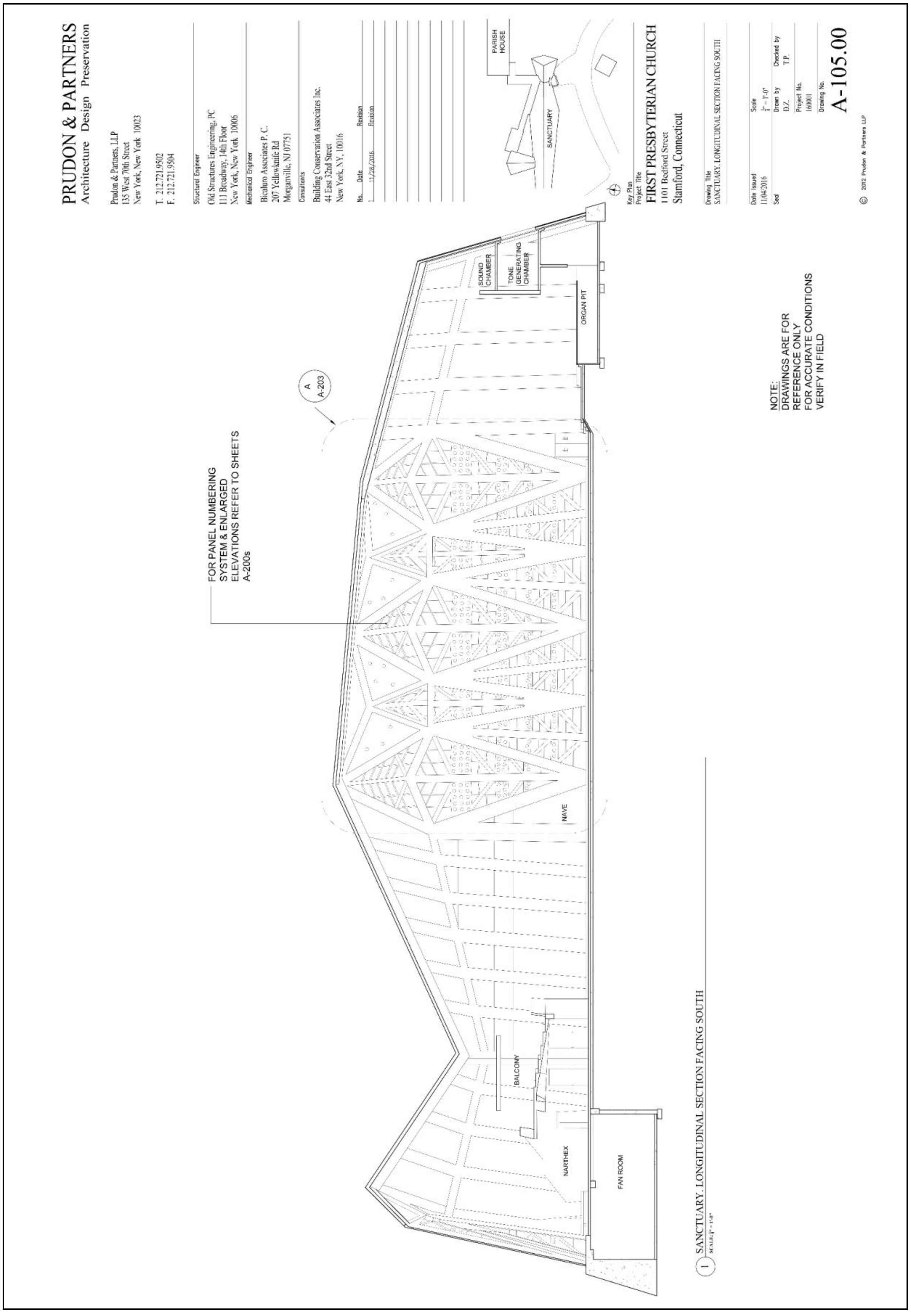
TRAP DOOR
81'-0"
SOUND CHAMBER S203
1 PLAN OF SOUND CHAMBER
TRAP DOOR & LADDER
TONE GENERATING CHAMBER S202
71'-6"
2 PLAN OF TONE GENERATING CHAMBER
FOR PANEL NUMBERING SYSTEM & ENLARGED ELEVATIONS REFER TO SHEETS A-200s
A
A-204
SOUND CHAMBER
TONE GENERATING CHAMBER
CHANCEL
ORGAN PIT
NAVE
BALCONY
NARTHEX
FAN ROOM
3 SANCTUARY. LONGITUDINAL SECTION FACING NORTH



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No. Date Revision
PARISH HOUSE
SANCTUARY
Key Plan
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
SANCTUARY, LONGITUDINAL SECTION FACING SOUTH
Date Issued
Scale
Drawn by
Checked by
Seal
Project No.
Drawing No.
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SOUND CHAMBER
TONE GENERATING CHAMBER
ORGAN PIT
A
A-203
FOR PANEL NUMBERING SYSTEM & ENLARGED ELEVATIONS REFER TO SHEETS A-200s
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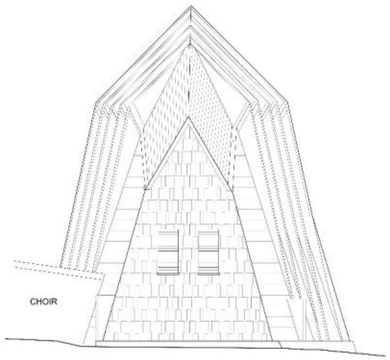
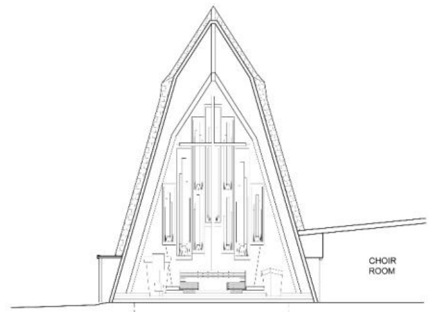
NAVE
BALCONY
NARTHEX
FAN ROOM
1 SANCTUARY, LONGITUDINAL SECTION FACING SOUTH

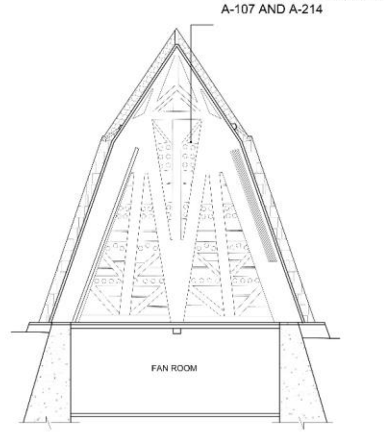


1 SANCTUARY. WEST ELEVATION
SCALE: $\frac{1}{8}$" = 1'-0"



2 SANCTUARY. CROSS SECTION FACING WEST
SCALE: $\frac{1}{8}$" = 1'-0"

FOR PANEL NUMBERING SYSTEM & ENLARGED ELEVATIONS REFER TO SHEETS A-107 AND A-214



3 SANCTUARY. CROSS SECTION FACING EAST
SCALE: $\frac{1}{8}$" = 1'-0"

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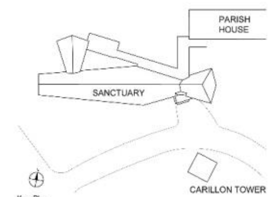
No.	Date	Revision
1	11/28/2016	Revision



Key Plan

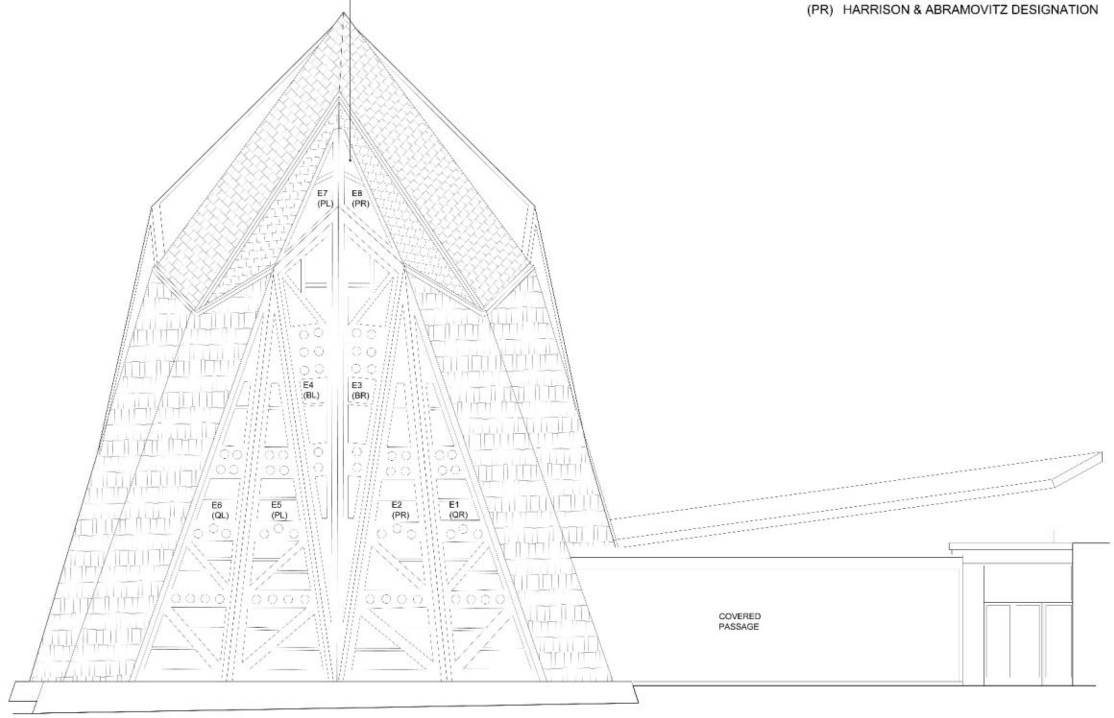
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut

Drawing Title
SANCTUARY. WEST ELEVATION AND CROSS SECTIONS

Date Issued: 11/04/2016
Scale: $\frac{1}{8}$" = 1'-0"
Seal
Drawn by: D.Z.
Checked by: T.P.
Project No.: 160001
Drawing No.: A-106.00

FOR INDIVIDUAL PANELS REFER TO SHEET A-207

PANEL NUMBERING LEGEND:
E2 PRUDON & PARTNERS DESIGNATION
(PR) HARRISON & ABRAMOVITZ DESIGNATION



1 SANCTUARY. EAST ELEVATION
SCALE: ¼" = 1'-0"

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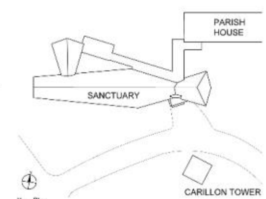
No.	Date	Revision

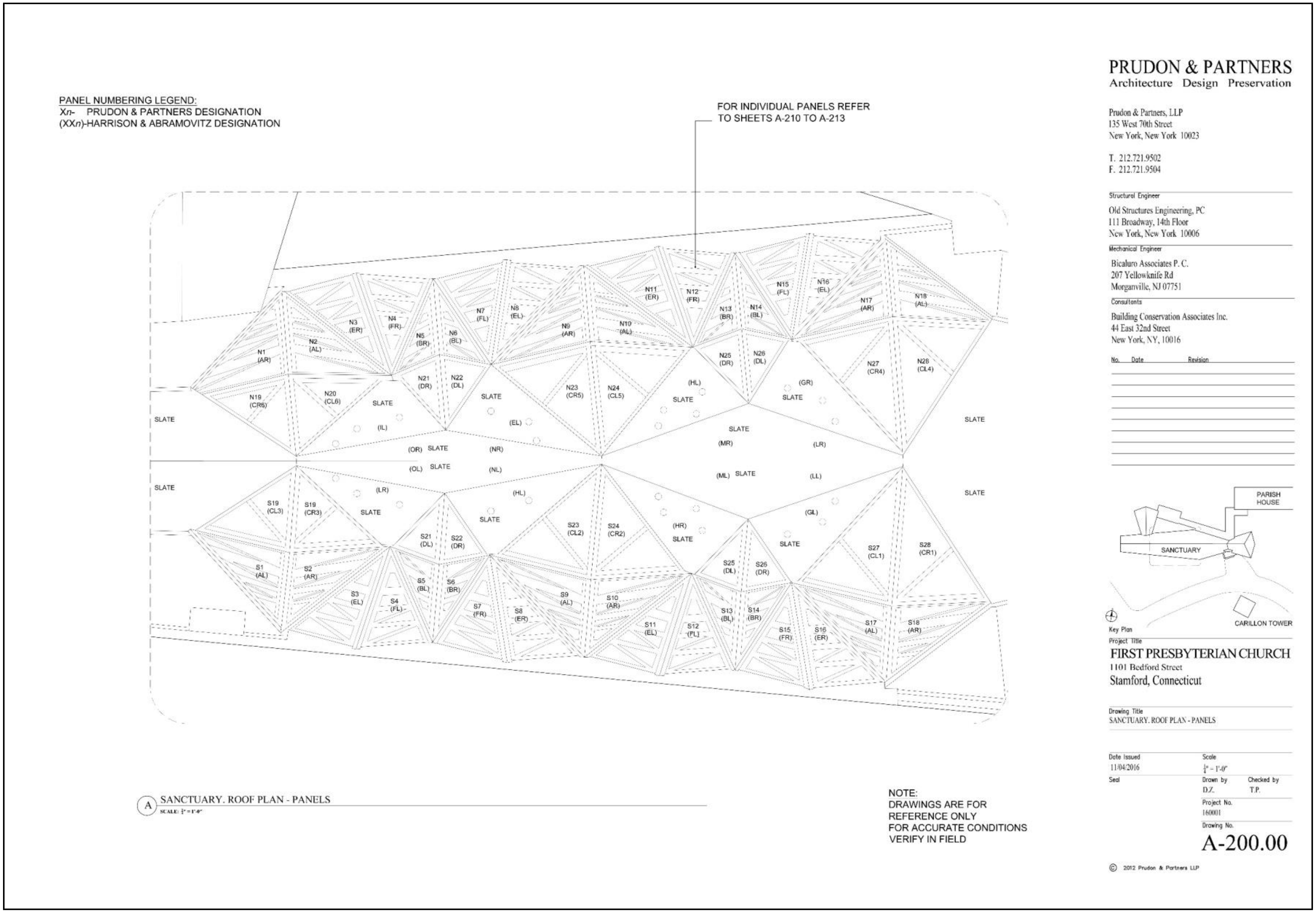


Key Plan

Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut

Drawing Title
SANCTUARY. EAST ELEVATION & WALL PANELS

Date Issued	Scale	
11/04/2016	¼" = 1'-0"	
Seal	Drawn by: D.Z.	Checked by: T.P.
	Project No.: 160001	
	Drawing No.: A-107.00	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Xn- PRUDON & PARTNERS DESIGNATION
(XXn)-HARRISON & ABRAMOVITZ DESIGNATION
FOR INDIVIDUAL PANELS REFER TO SHEETS A-210 TO A-213
SLATE
A SANCTUARY. ROOF PLAN - PANELS
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Building Conservation Associates Inc.
44 East 32nd Street
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No. Date Revision
PARISH HOUSE
SANCTUARY
CARILLON TOWER
Key Plan
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
SANCTUARY. ROOF PLAN - PANELS
Date Issued
11/04/2016
Scale
Seal
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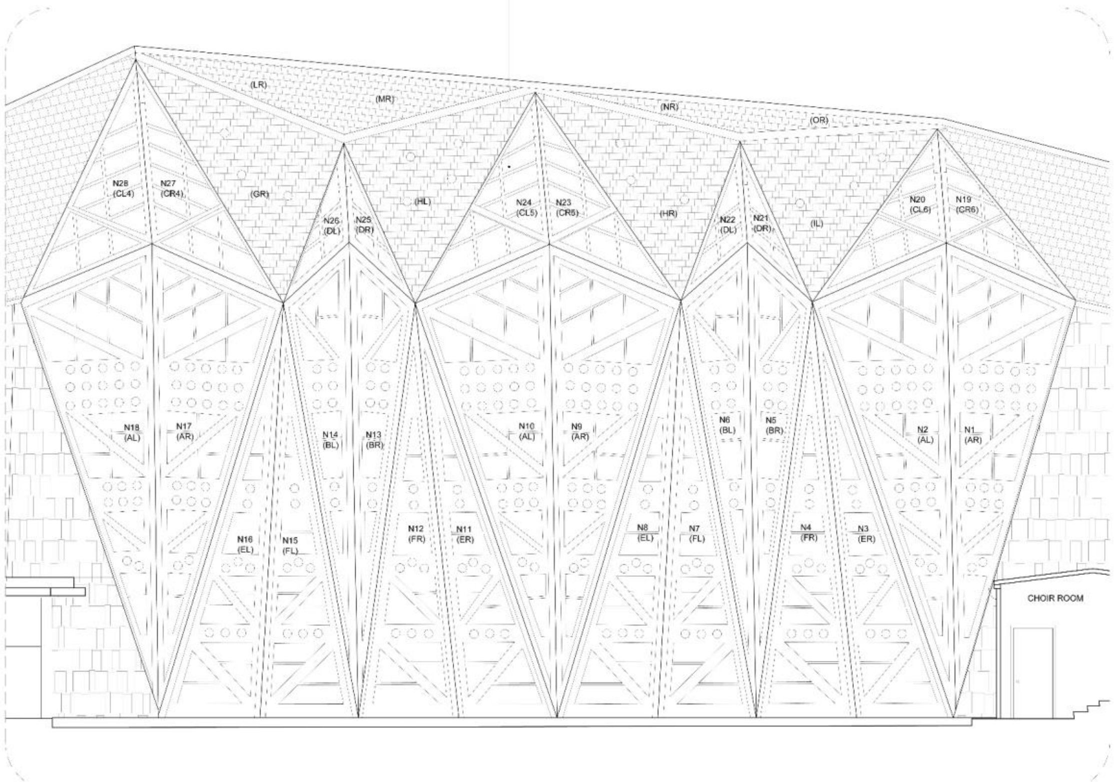
FOR INDIVIDUAL PANELS REFER TO SHEETS A-210 & A-211



A SANCTUARY. NORTH ELEVATION - WALL PANELS
SCALE: ¹⁄₈" - 1'-0"

NOTE:
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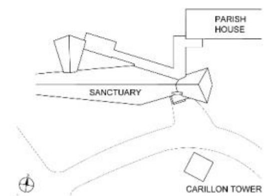
No.	Date	Revision

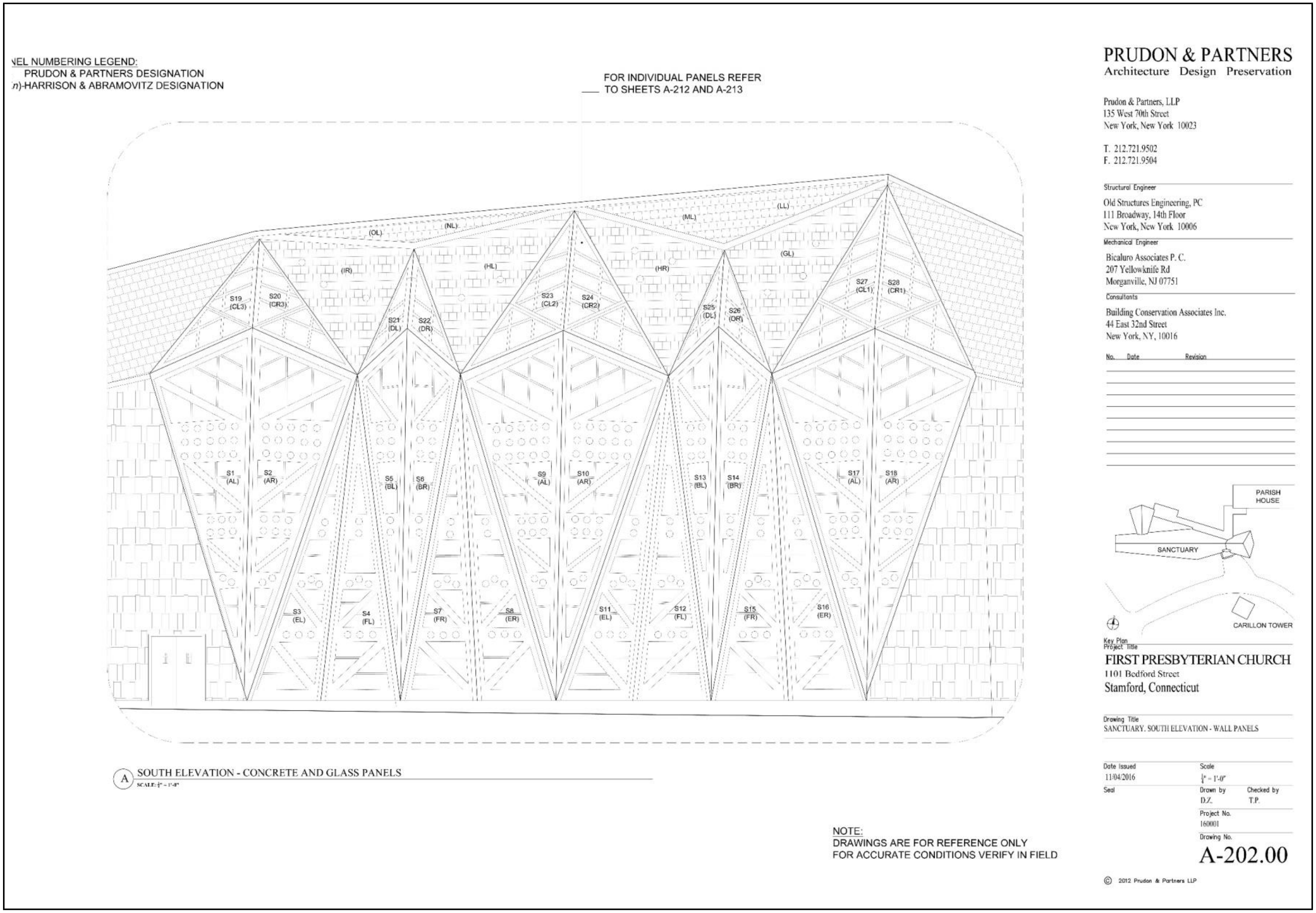
Key Plan



Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut

Drawing Title
SANCTUARY. NORTH ELEVATION - WALL PANELS

Date Issued: 11/04/2016
Scale: ¹⁄₈" - 1'-0"
Seal
Drawn by: D.Z.
Checked by: T.P.
Project No.: 160001
Drawing No.: A-201.00


NEL NUMBERING LEGEND:
PRUDON & PARTNERS DESIGNATION
n)-HARRISON & ABRAMOVITZ DESIGNATION
FOR INDIVIDUAL PANELS REFER TO SHEETS A-212 AND A-213
(OL) (NL) (ML) (LL) (IR) (HL) (HR) (GL)
S19 (CL3) S20 (CR3) S21 (DL) S22 (DR) S23 (CL2) S24 (CR2) S25 (DL) S26 (DR) S27 (CL1) S28 (CR1)
S1 (AL) S2 (AR) S5 (BL) S6 (BR) S9 (AL) S10 (AR) S13 (BL) S14 (BR) S17 (AL) S18 (AR)
S3 (EL) S4 (FL) S7 (FR) S8 (ER) S11 (EL) S12 (FL) S15 (FR) S16 (ER)
A SOUTH ELEVATION - CONCRETE AND GLASS PANELS
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No. Date Revision
PARISH HOUSE
SANCTUARY
CARILLON TOWER
Key Plan
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
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Drawing Title
SANCTUARY. SOUTH ELEVATION - WALL PANELS
Date Issued
11/04/2016
Scale
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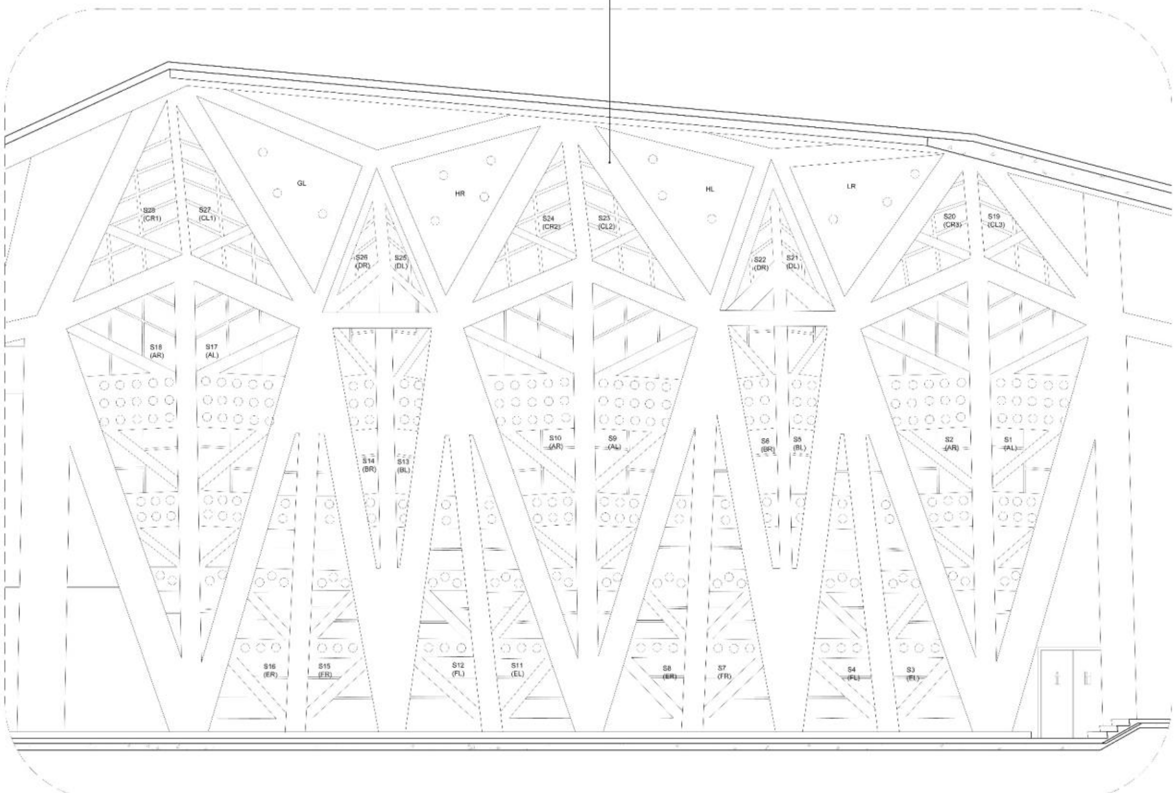

A NORTH ELEVATION - CONCRETE AND GLASS PANELS - INTERIOR
SCALE: 1/4" = 1'-0"

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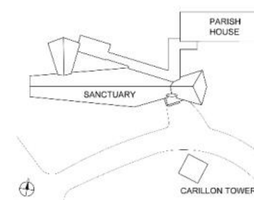
Key Plan



Project Title
FIRST PRESBYTERIAN CHURCH
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Stamford, Connecticut

Drawing Title
SANCTUARY, SOUTH ELEVATION - WALL PANELS INTERIOR

Date Issued 02/16/2017
Scale 1/4" = 1'-0"
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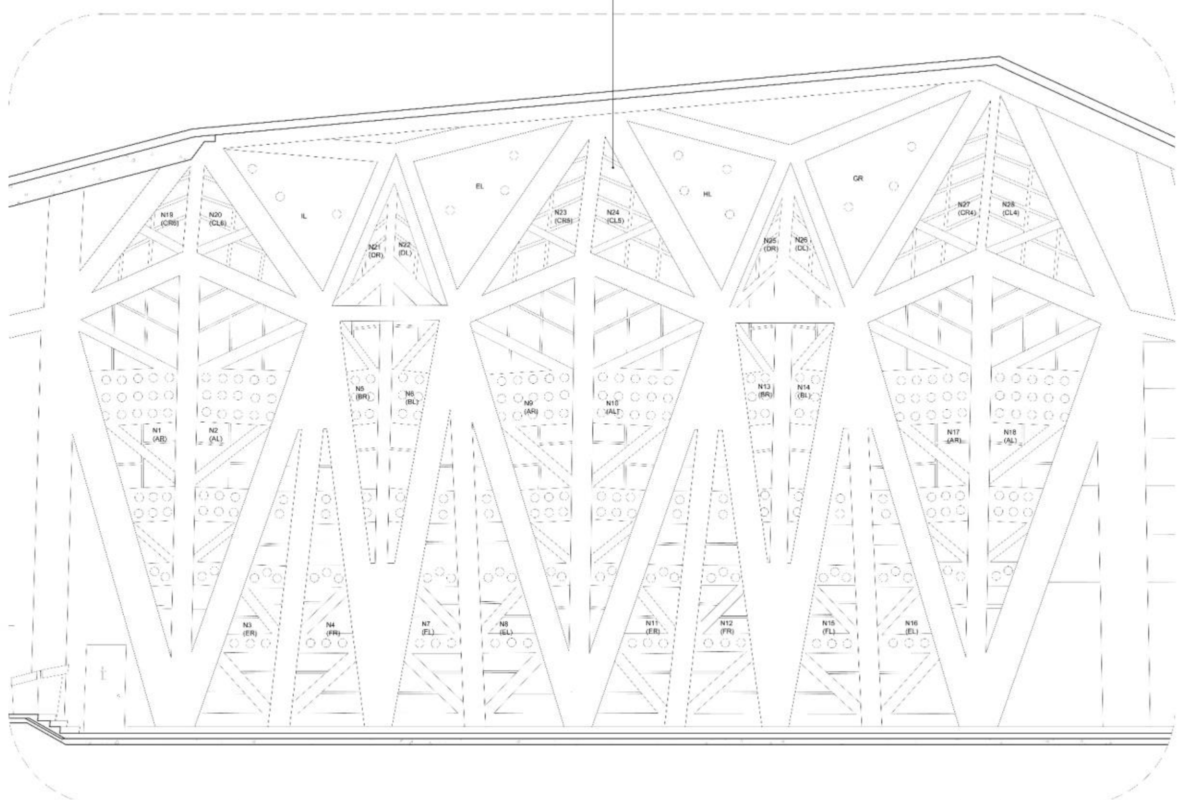

A SOUTH ELEVATION - CONCRETE AND GLASS PANELS - EXTERIOR
SCALE: 1/8" = 1'-0"

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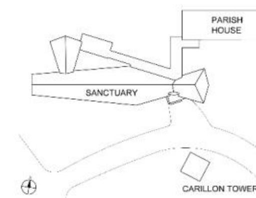
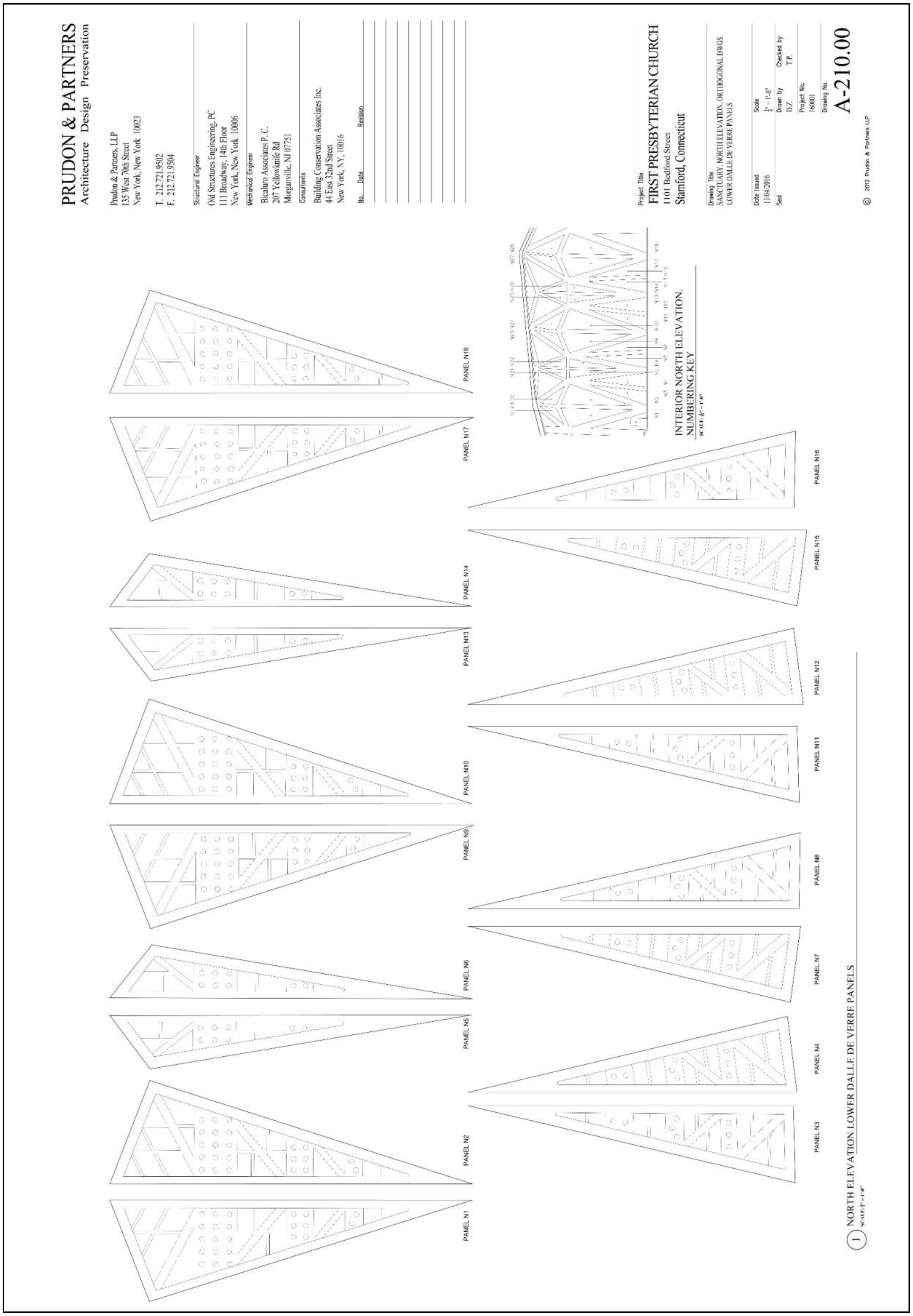


Key Plan

Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut

Drawing Title
SANCTUARY, NORTH ELEVATION - WALL PANELS INTERIOR

Date Issued	Scale	
02/16/2017	1/4" = 1'-0"	
Seal	Drawn by D.Z.	Checked by T.P.
	Project No. 160001	
	Drawing No. A-204.00	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No. Date Revision
PANEL N1
PANEL N2
PANEL N5
PANEL N6
PANEL N9
PANEL N10
PANEL N13
PANEL N14
PANEL N17
PANEL N18
PANEL N3
PANEL N4
PANEL N7
PANEL N8
PANEL N11
PANEL N12
PANEL N15
PANEL N16
INTERIOR NORTH ELEVATION.
NUMBERING KEY
1 NORTH ELEVATION LOWER DALLE DE VERRE PANELS
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
SANCTUARY. NORTH ELEVATION. ORTHOGONAL DWGS.
LOWER DALLE DE VERRE PANELS
Date Issued
11/04/2016
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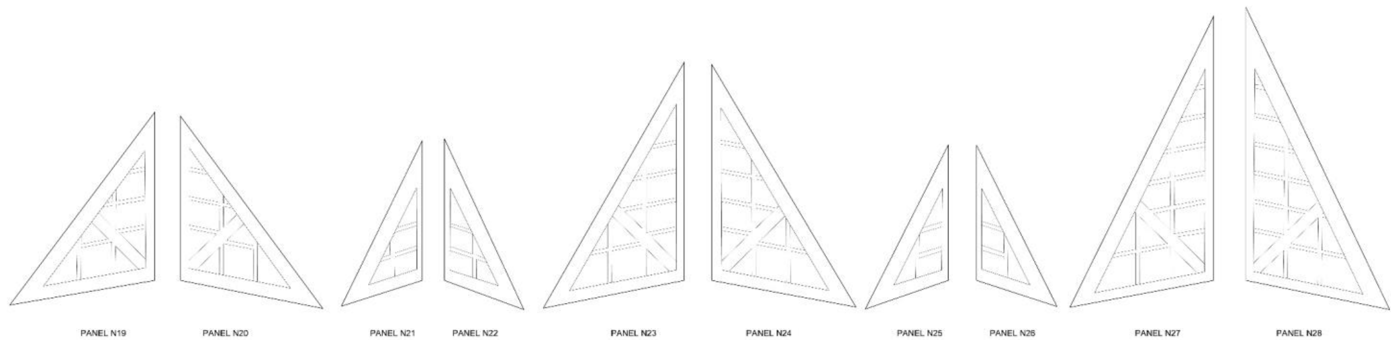
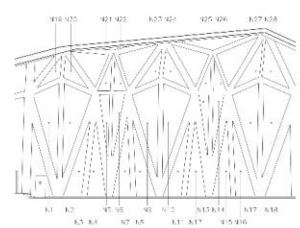


(1) NORTH ELEVATION UPPER DALLE DE VERRE PANELS



INTERIOR NORTH ELEVATION. KEY

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No.	Date	Revision

Key – Interior Elevation North

Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut

Drawing Title
SANCTUARY. NORTH ELEVATION. ORTHOGONAL DWGS.
UPPER DALLE DE VERRE PANELS

Date Issued 11/04/2016
Scale ¼" = 1'-0"
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Drawing No.
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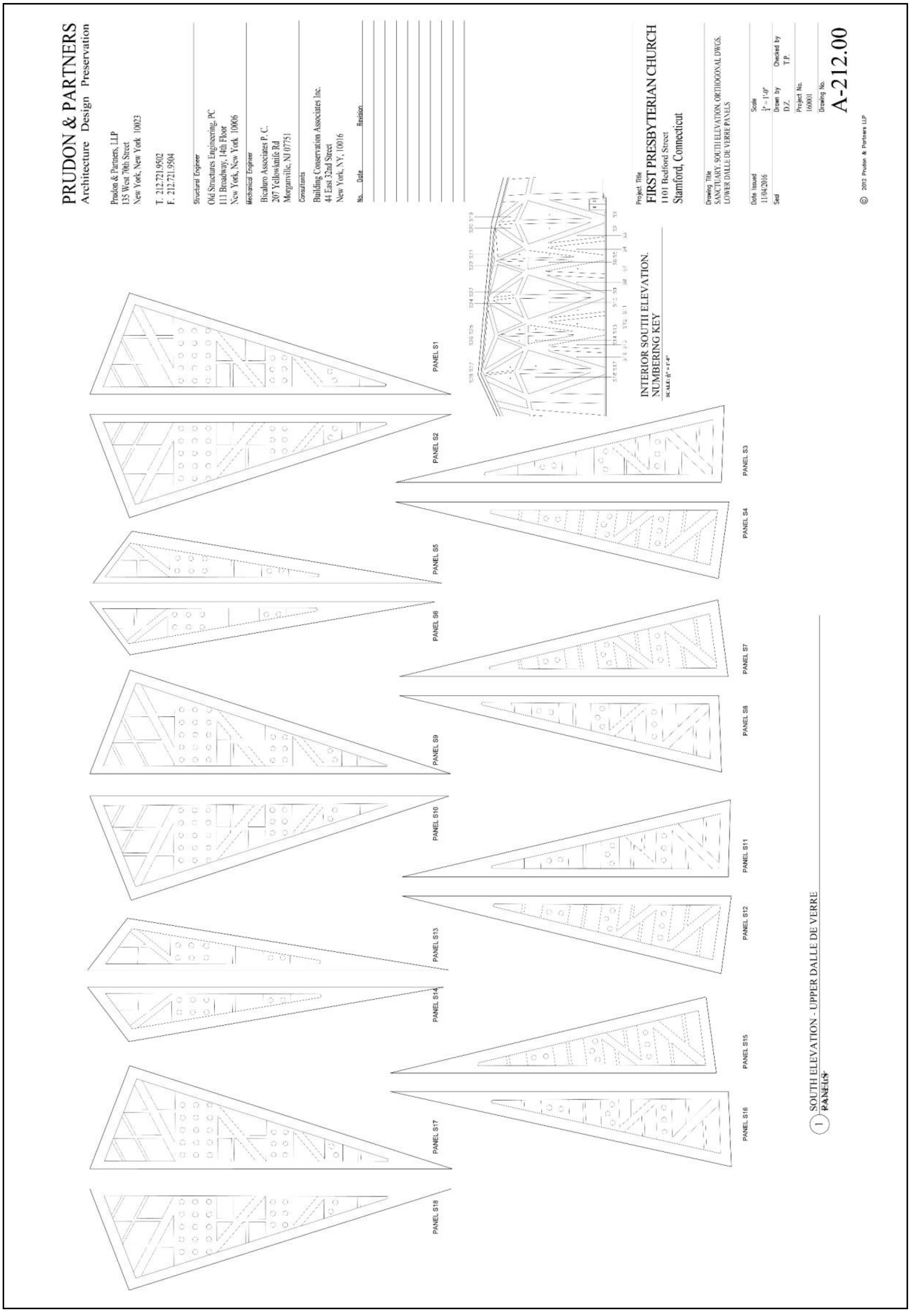
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44 East 32nd Street
New York, NY, 10016
No. Date Revision
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
SANCTUARY, SOUTH ELEVATION, ORTHOGONAL DWGS.
LOWER DALLE DE VERRE PANELS
Date Issued
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1" = 1'-0"
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Project No.
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INTERIOR SOUTH ELEVATION
NUMBERING KEY
PANEL S1
PANEL S2
PANEL S3
PANEL S4
PANEL S5
PANEL S6
PANEL S7
PANEL S8
PANEL S9
PANEL S10
PANEL S11
PANEL S12
PANEL S13
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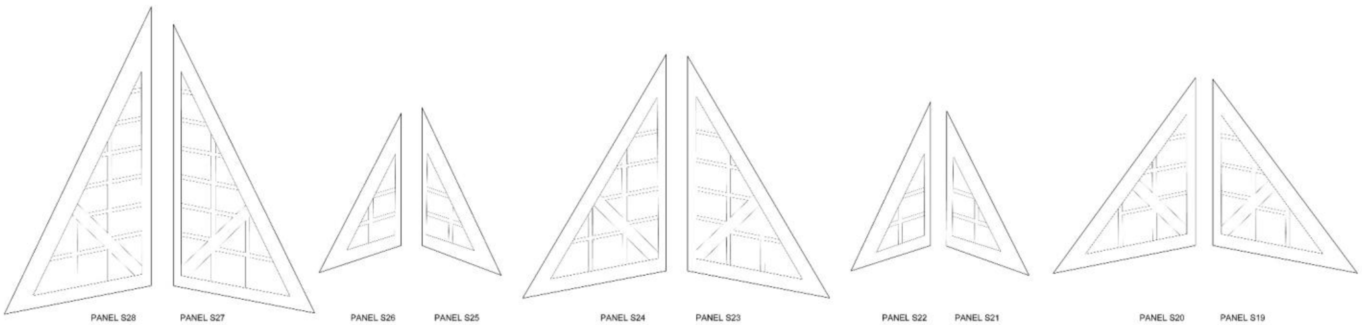
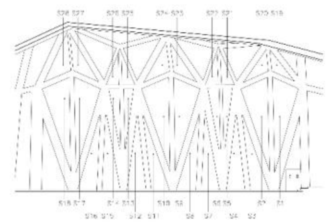
PANEL S15
PANEL S16
PANEL S17
PANEL S18
1 SOUTH ELEVATION - UPPER DALLE DE VERRE PANELS



1 SOUTH ELEVATION - UPPER DALLE DE VERRE PANELS



INTERIOR SOUTH ELEVATION.
NUMBERING KEY

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207 Yellowknife Rd
Morganville, NJ 07751

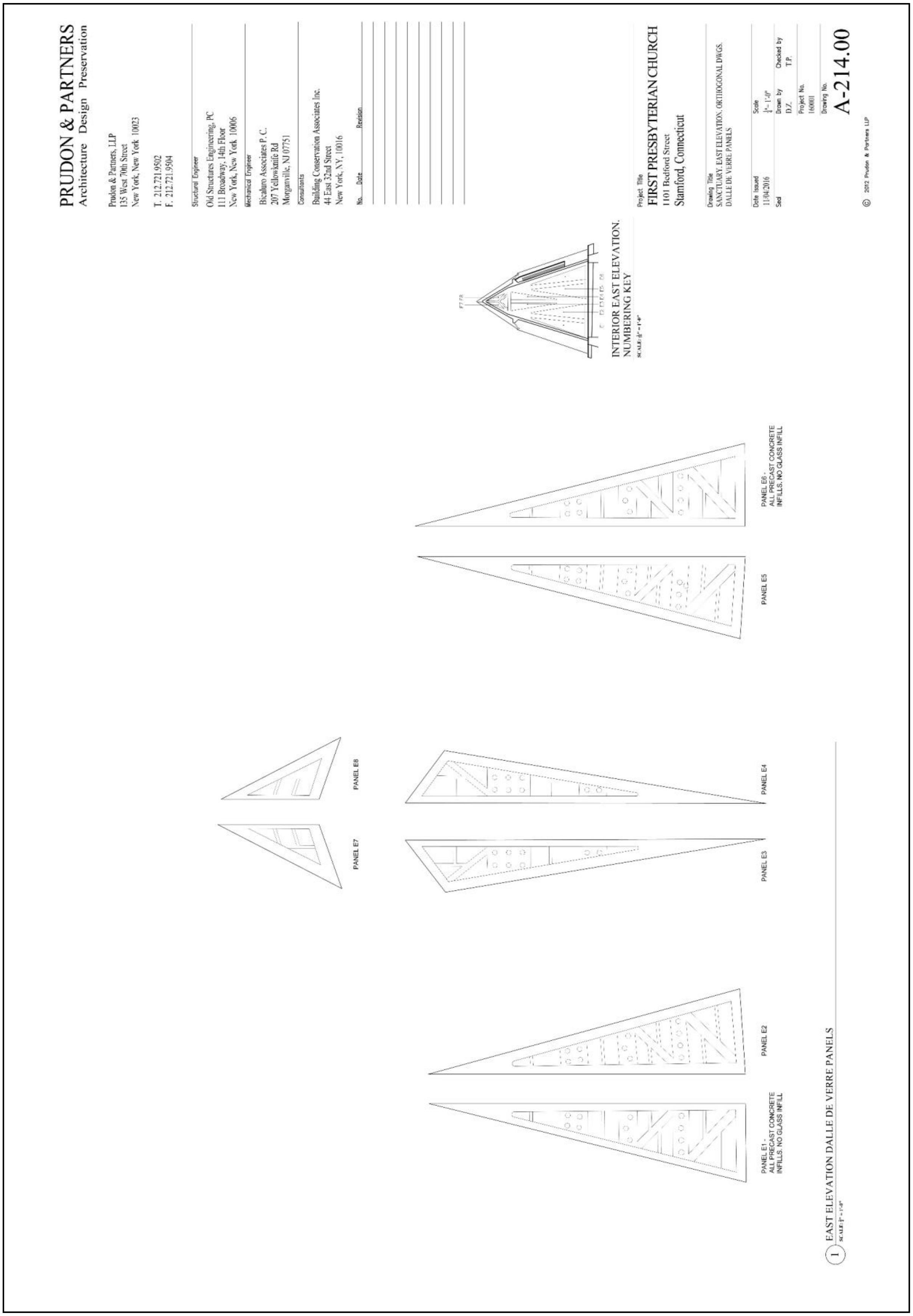
Consultants
Building Conservation Associates Inc.
44 East 32nd Street
New York, NY, 10016

No.	Date	Revision

Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut

Drawing Title
SANCTUARY. SOUTH ELEVATION. ORTHOGONAL DWGS.
UPPER DALLE DE VERRE PANELS

Date Issued: 11/04/2016
Scale: ½" = 1'-0"
Seal
Drawn by: D.Z.
Checked by: T.P.
Project No.: 160001
Drawing No.: A-213.00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Consultants
Building Conservation Associates Inc.
44 East 32nd Street
New York, NY, 10016
No. Date Revision
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
SANCTUARY, EAST ELEVATION, ORTHOGONAL DWGS.
DALLE DE VERRE PANELS
Date Issued
11/04/2016
Scale
Drawn by
D.Z.
Checked by
T.P.
Project No.
16001
Drawing No.
A-214.00
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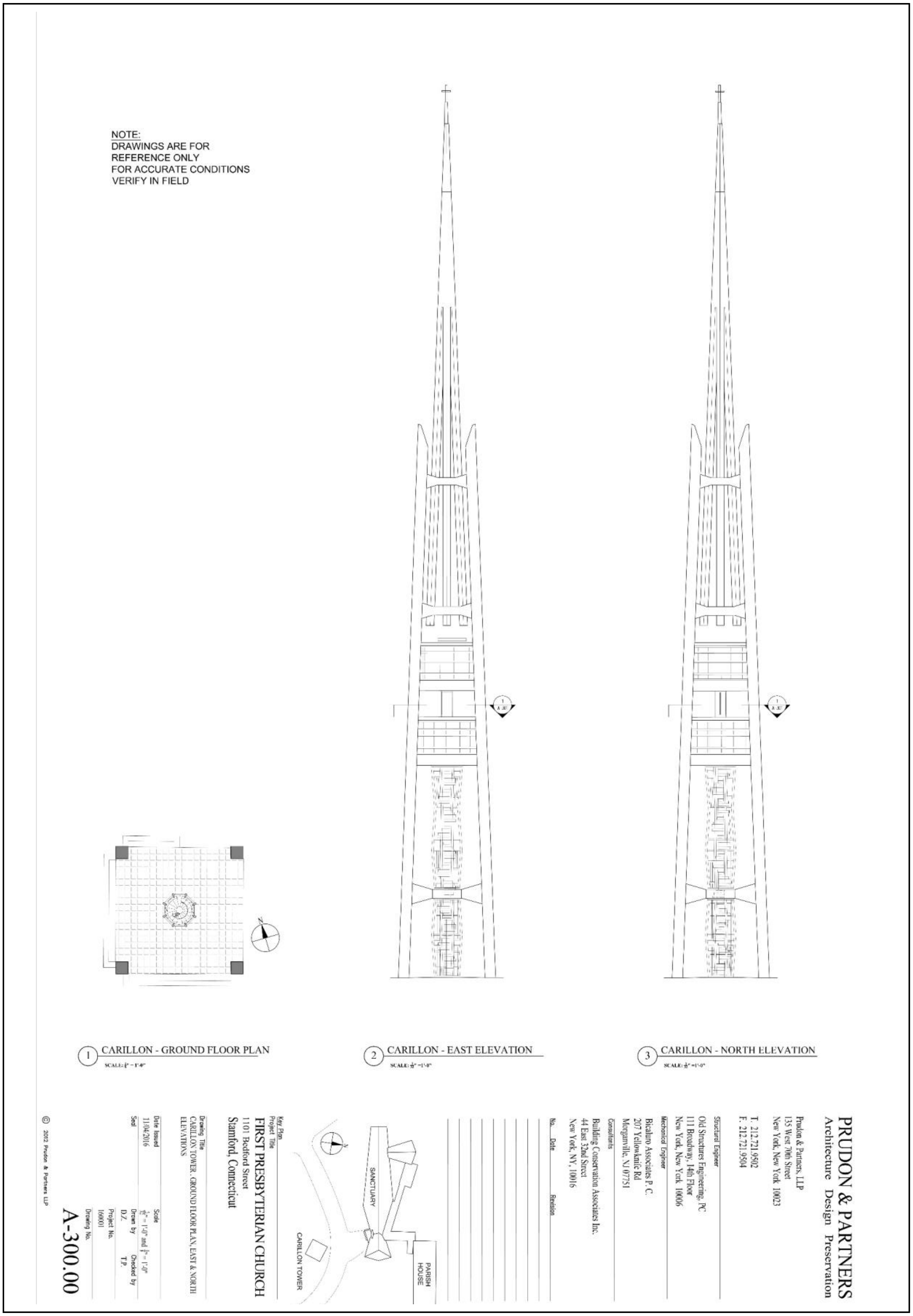
INTERIOR EAST ELEVATION.
NUMBERING KEY
PANEL E6 -
ALL PRECAST CONCRETE
INFILLS, NO GLASS INFILL
PANEL E5
PANEL E8
PANEL E4
PANEL E7
PANEL E3
PANEL E2
PANEL E1 -
ALL PRECAST CONCRETE
INFILLS, NO GLASS INFILL
1 EAST ELEVATION DALLE DE VERRE PANELS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1 CARILLON - GROUND FLOOR PLAN
2 CARILLON - EAST ELEVATION
3 CARILLON - NORTH ELEVATION
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No. Date Revision
SANCTUARY
PARISH HOUSE
CARILLON TOWER
Key Plan
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
CARILLON TOWER, GROUND FLOOR PLAN, EAST & NORTH ELEVATIONS
Date Issued
11/04/2016
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Project No.
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Drawing No.
A-300.00
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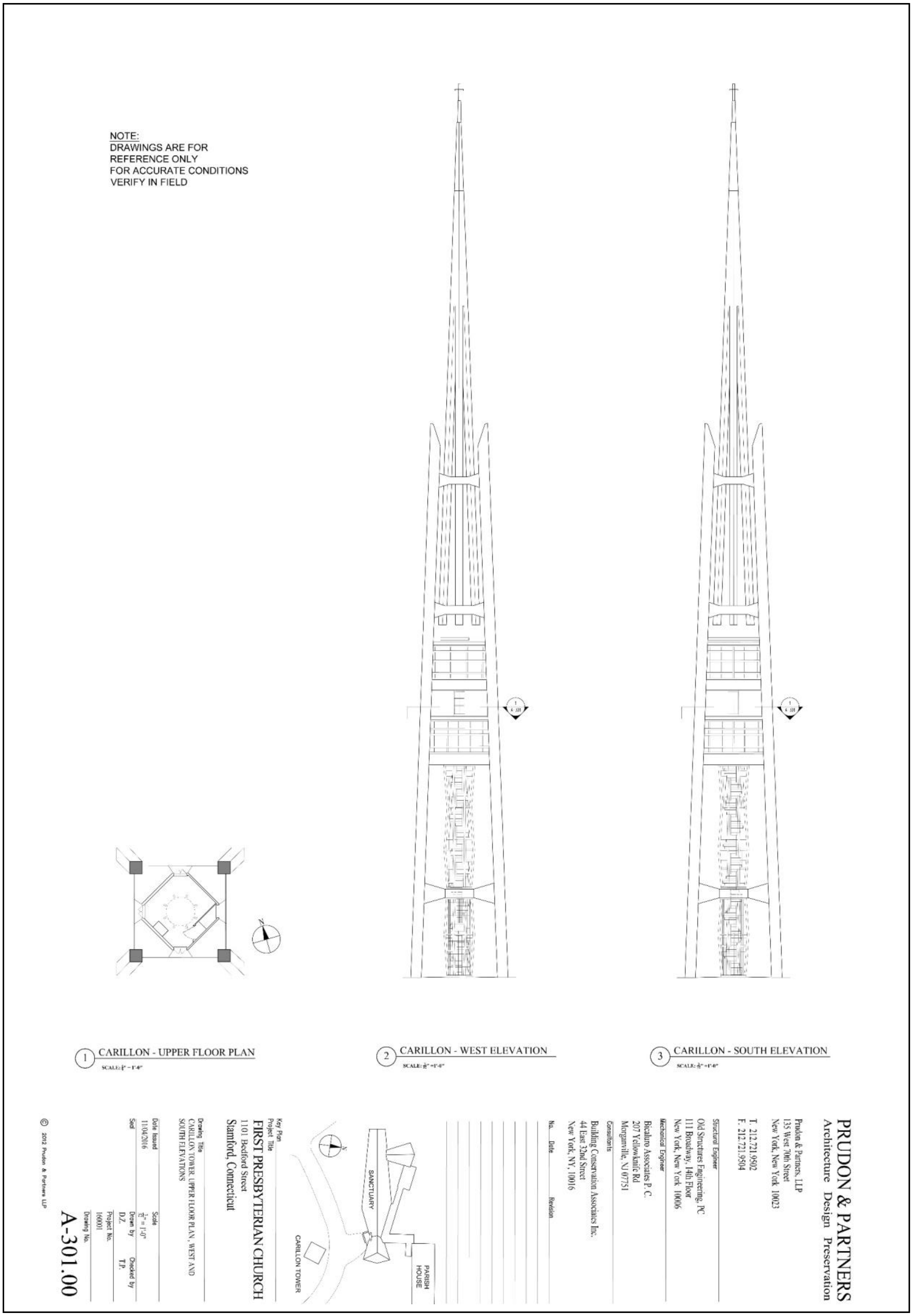
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2 CARILLON - WEST ELEVATION
3 CARILLON - SOUTH ELEVATION
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No. Date Revision
SANCTUARY
PARISH HOUSE
CARILLON TOWER
Key Plan
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
CARILLON TOWER, UPPER FLOOR PLAN, WEST AND SOUTH ELEVATIONS
Date Issued
11/04/2016
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Project No.
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Drawing No.
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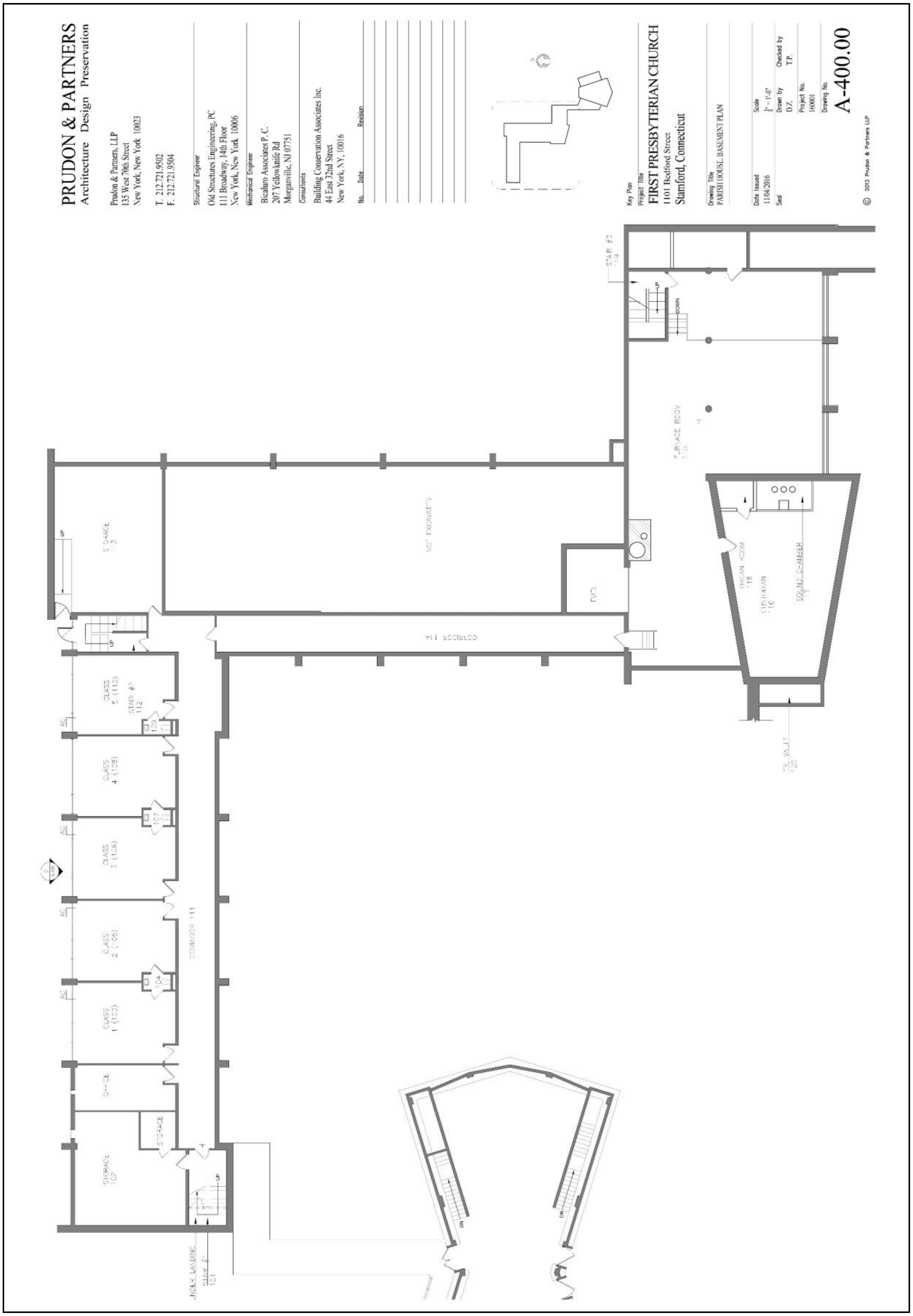
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No. Date Revision
Key Plan
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1101 Bedford Street
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Drawing Title
PARISH HOUSE: BASEMENT PLAN
Date Issued
11/04/2016
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Scale
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Drawing No.
A-400.00
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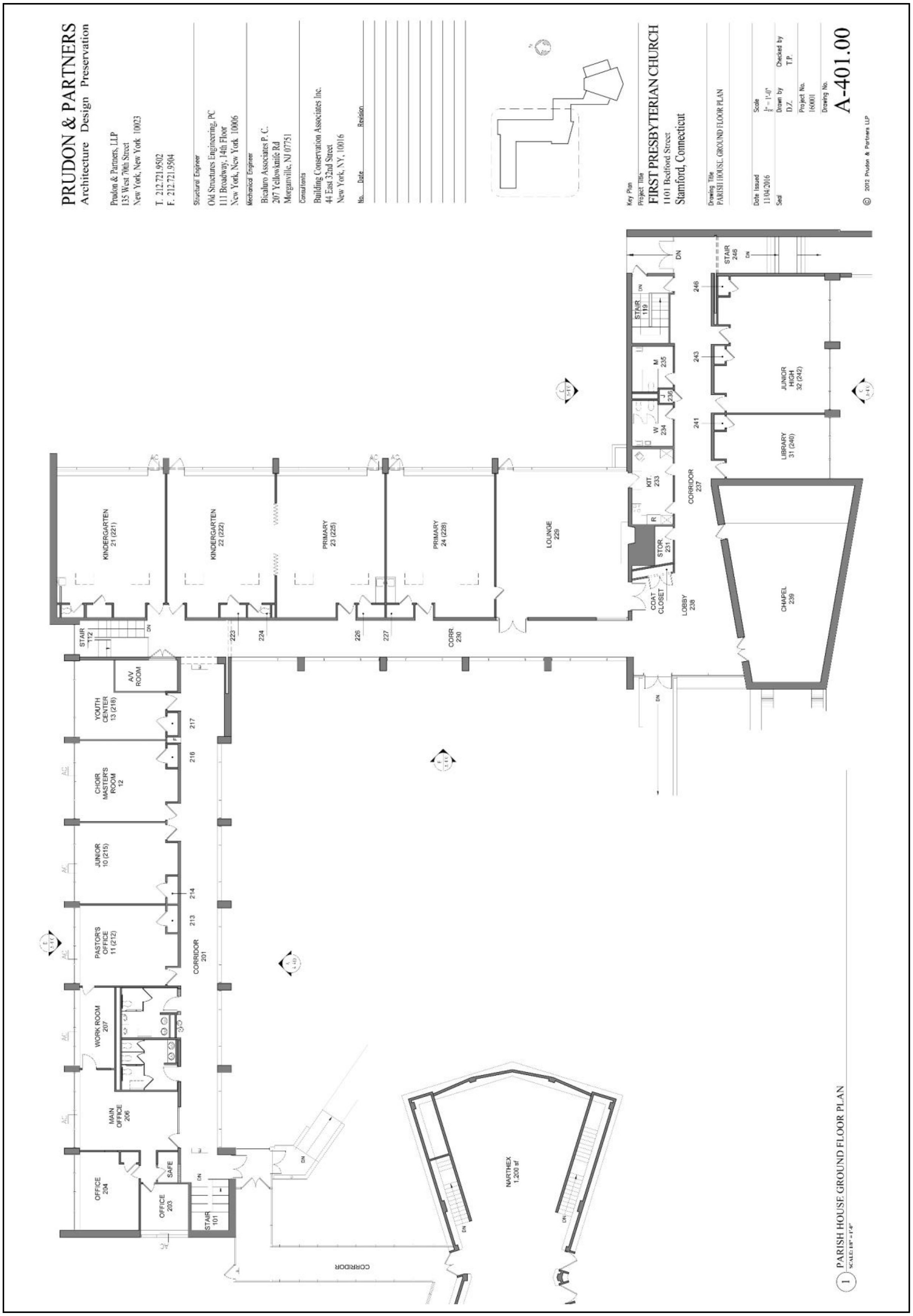
NOT EXCAVATED
CORRIDOR 114
CORRIDOR 111
STAIR #2
112
ORGAN ROOM
118
SOUND CHAMBER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Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
PARISH HOUSE GROUND FLOOR PLAN
Date Issued
11/04/2016
A-401.00
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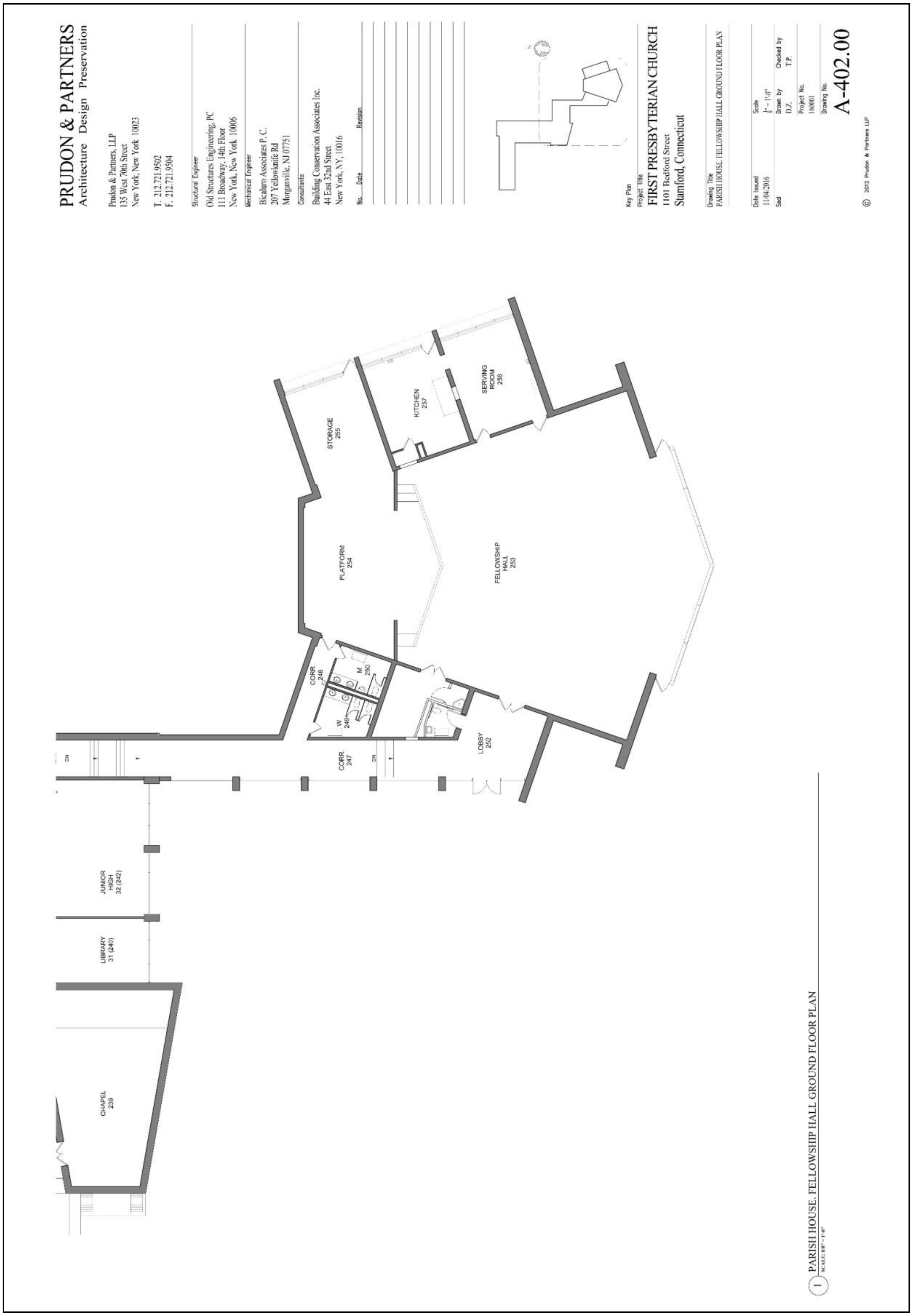
KINDERGARTEN 21 (221)
KINDERGARTEN 22 (222)
PRIMARY 23 (225)
PRIMARY 24 (228)
LOUNGE 229
CORR 230
CORRIDOR 237
LOBBY 238
CHAPEL 239
LIBRARY 31 (240)
JUNIOR HIGH 32 (242)
STAIR 119
STAIR 112
STAIR 101
STAIR 246
COAT CLOSET
A/V ROOM
YOUTH CENTER 13 (218)
CHOIR MASTER'S ROOM 12
JUNIOR 10 (215)
PASTOR'S OFFICE 11 (212)
CORRIDOR 201
WORK ROOM 207
MAIN OFFICE 206
OFFICE 204
OFFICE 203
SAFE
NARTHEX 1,200 sf
CORRIDOR
PARISH HOUSE GROUND FLOOR PLAN



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No. Date Revision
Key Plan
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
PARISH HOUSE. FELLOWSHIP HALL GROUND FLOOR PLAN
Date Issued
11/04/2016
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Scale
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Checked by
T.P.
Project No.
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Drawing No.
A-402.00
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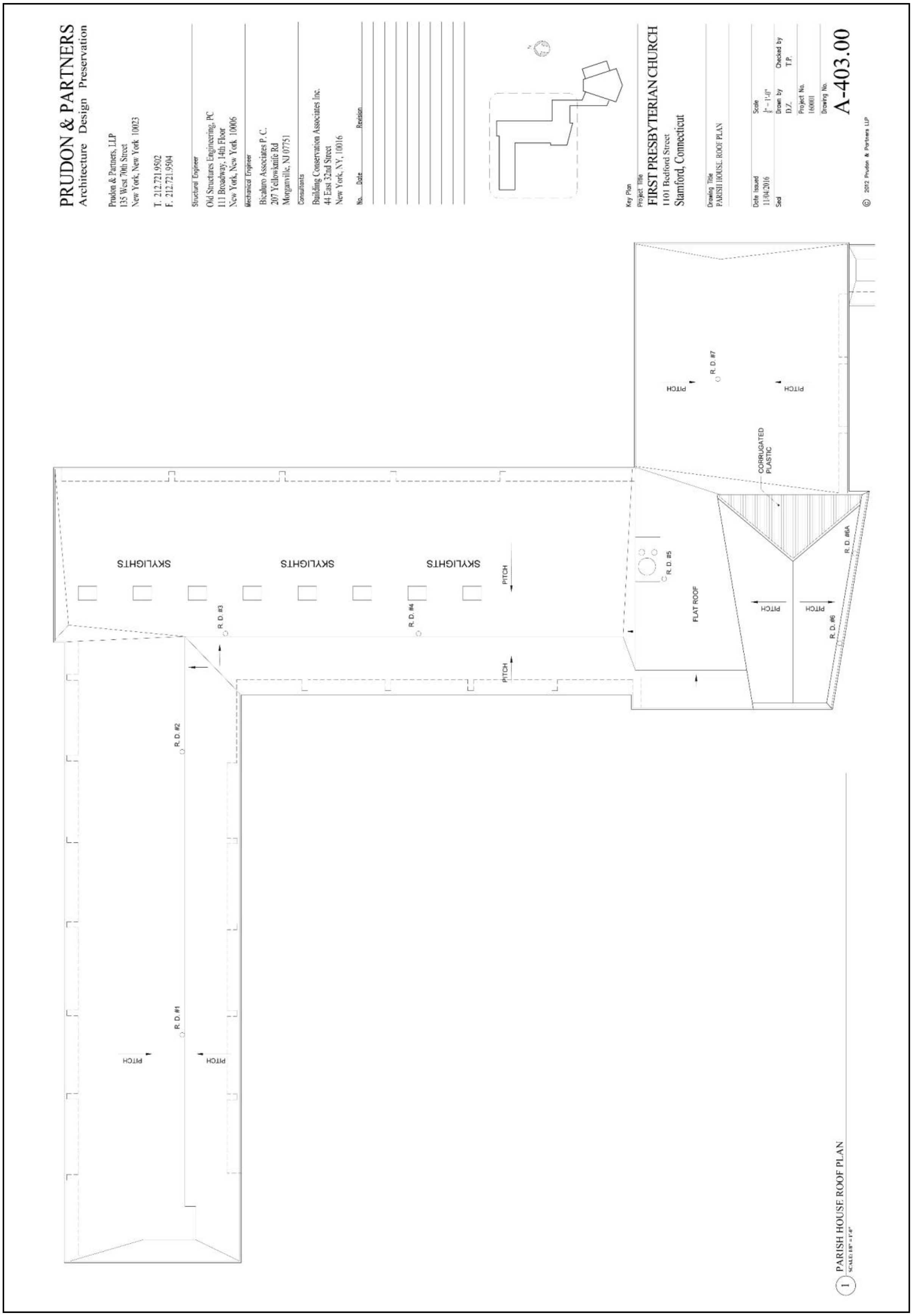
STORAGE 255
KITCHEN 257
SERVING ROOM 258
PLATFORM 254
FELLOWSHIP HALL 253
CORR. 248
M 250
W 249
CORR. 247
LOBBY 252
JUNIOR HIGH 32 (242)
LIBRARY 31 (240)
CHAPEL 239
1 PARISH HOUSE. FELLOWSHIP HALL GROUND FLOOR PLAN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Key Plan
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
PARISH HOUSE ROOF PLAN
Date Issued
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T.P.
Project No.
160001
Drawing No.
A-403.00
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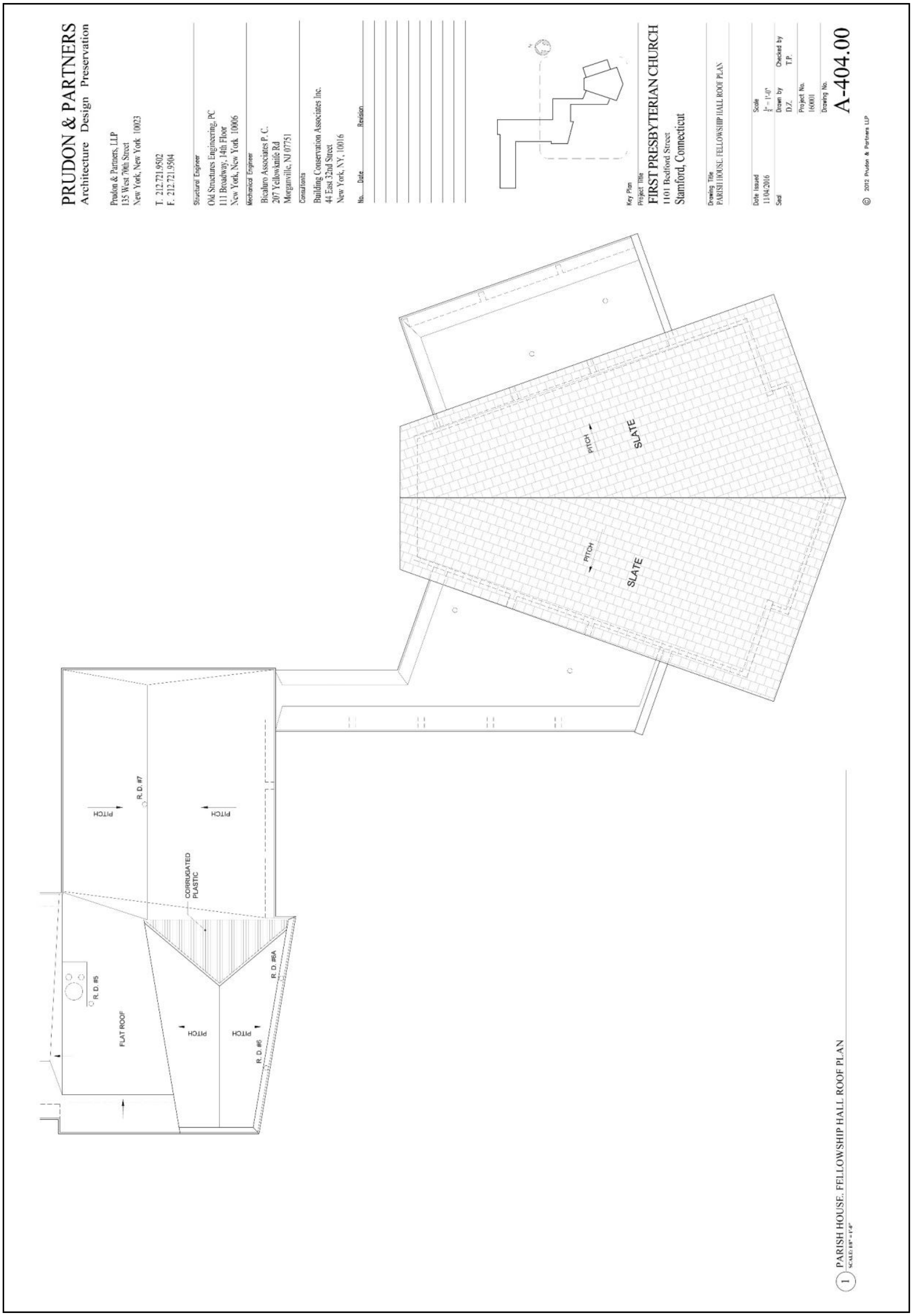
SKYLIGHTS
SKYLIGHTS
SKYLIGHTS
PITCH
R. D. #1
R. D. #2
R. D. #3
R. D. #4
R. D. #5
R. D. #6
R. D. #6A
R. D. #7
FLAT ROOF
CORRUGATED PLASTIC
1 PARISH HOUSE ROOF PLAN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No. Date Revision
Key Plan
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
PARISH HOUSE. FELLOWSHIP HALL ROOF PLAN
Date Issued
11/04/2016
Scale
Seal
Drawn by
D.Z.
Checked by
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Project No.
160001
Drawing No.
A-404.00
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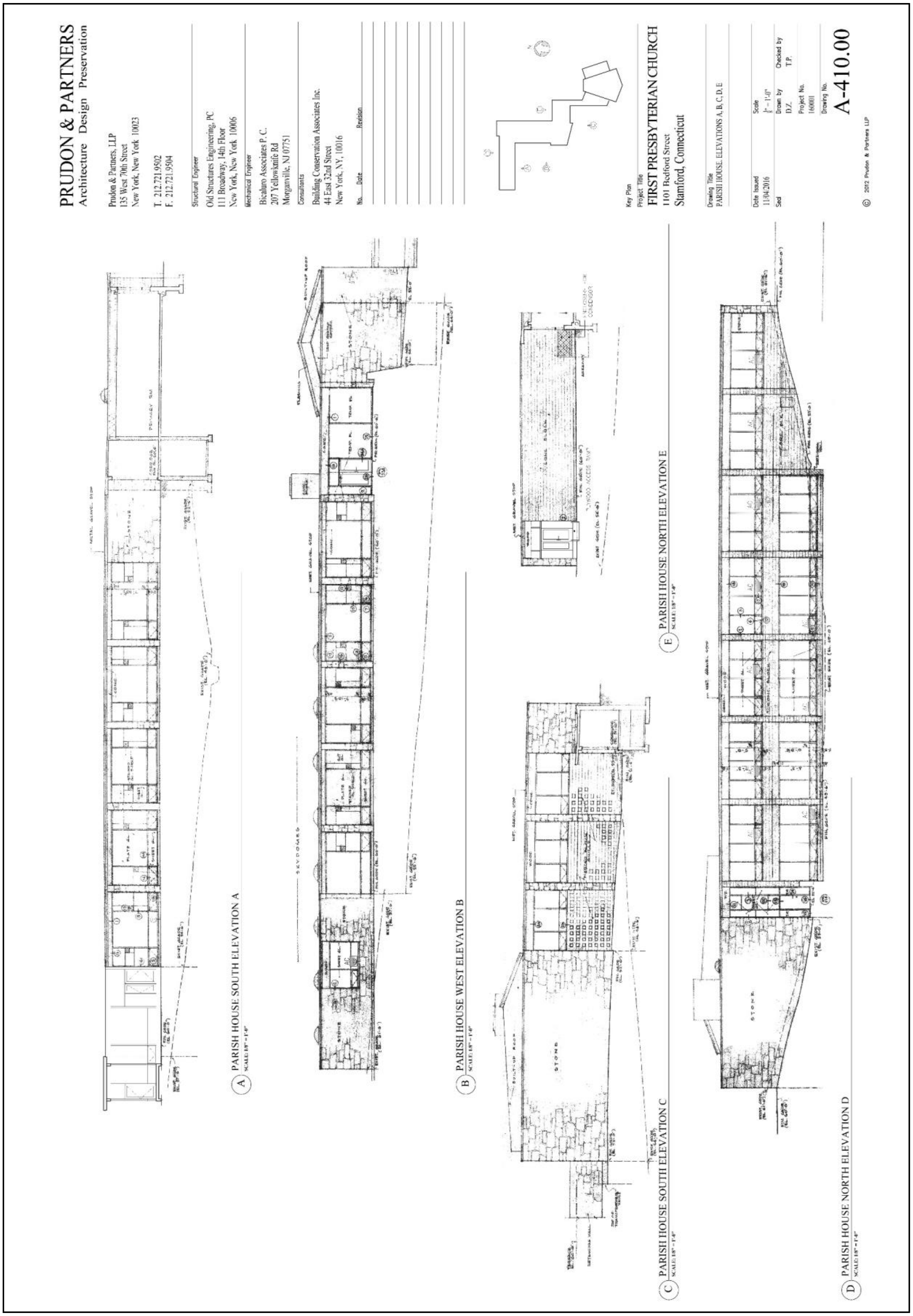
R. D. #5
FLAT ROOF
PITCH
R. D. #7
CORRUGATED PLASTIC
R. D. #6
R. D. #6A
SLATE
1 PARISH HOUSE. FELLOWSHIP HALL ROOF PLAN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No. Date Revision
Key Plan
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
PARISH HOUSE ELEVATIONS A, B, C, D, E
Date Issued
11/04/2016
Scale
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Project No.
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Drawing No.
A-410.00
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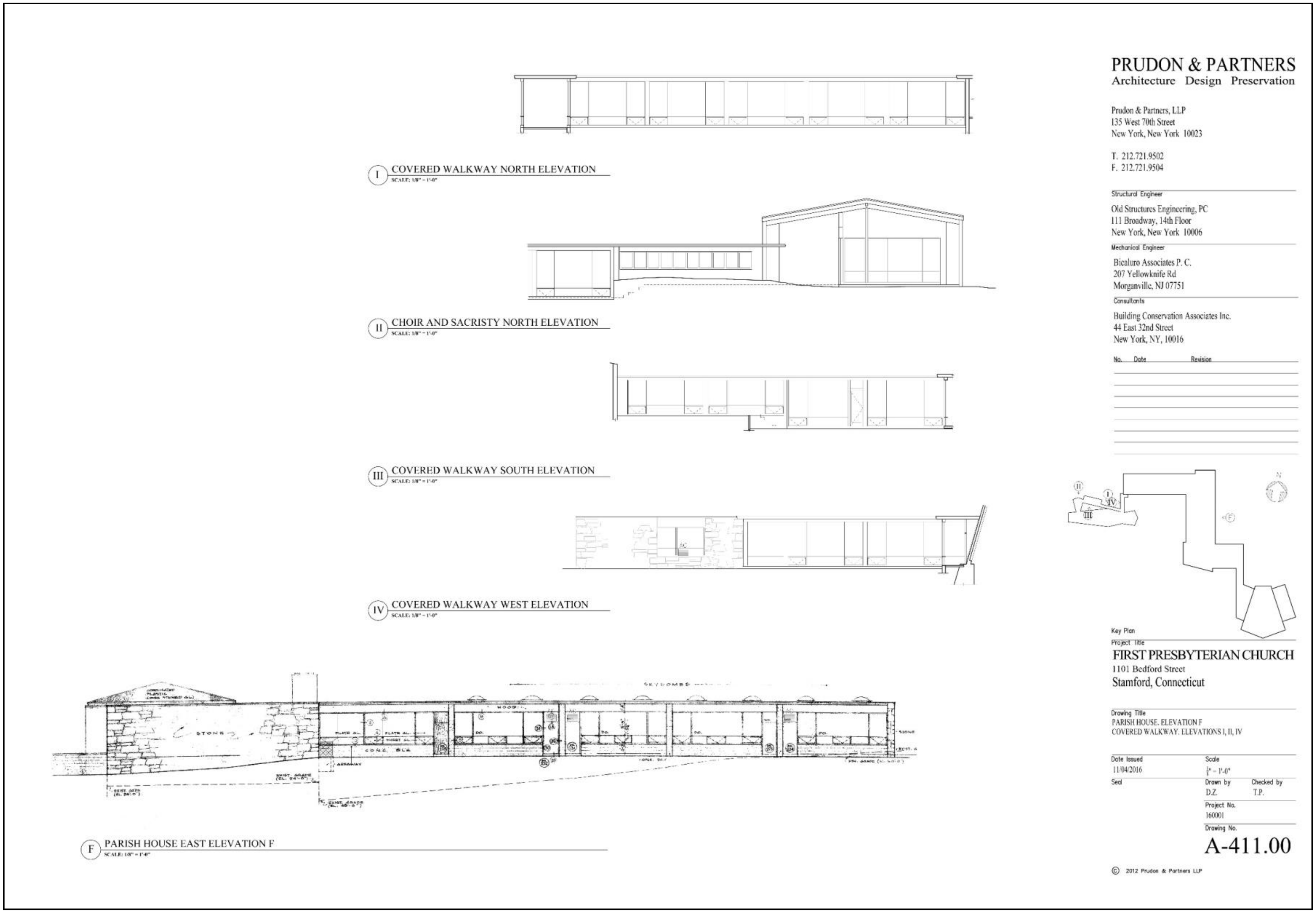
A PARISH HOUSE SOUTH ELEVATION A
B PARISH HOUSE WEST ELEVATION B
C PARISH HOUSE SOUTH ELEVATION C
D PARISH HOUSE NORTH ELEVATION D
E PARISH HOUSE NORTH ELEVATION E


I COVERED WALKWAY NORTH ELEVATION
SCALE: 1/8" = 1'-0"
II CHOIR AND SACRISTY NORTH ELEVATION
SCALE: 1/8" = 1'-0"
III COVERED WALKWAY SOUTH ELEVATION
SCALE: 1/8" = 1'-0"
IV COVERED WALKWAY WEST ELEVATION
SCALE: 1/8" = 1'-0"
F PARISH HOUSE EAST ELEVATION F
SCALE: 1/8" = 1'-0"
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Morganville, NJ 07751
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Building Conservation Associates Inc.
44 East 32nd Street
New York, NY, 10016
No. Date Revision
Key Plan
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
PARISH HOUSE. ELEVATION F
COVERED WALKWAY. ELEVATIONS I, II, IV
Date Issued
11/04/2016
Scale
1/8" = 1'-0"
Seal
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Project No.
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Drawing No.
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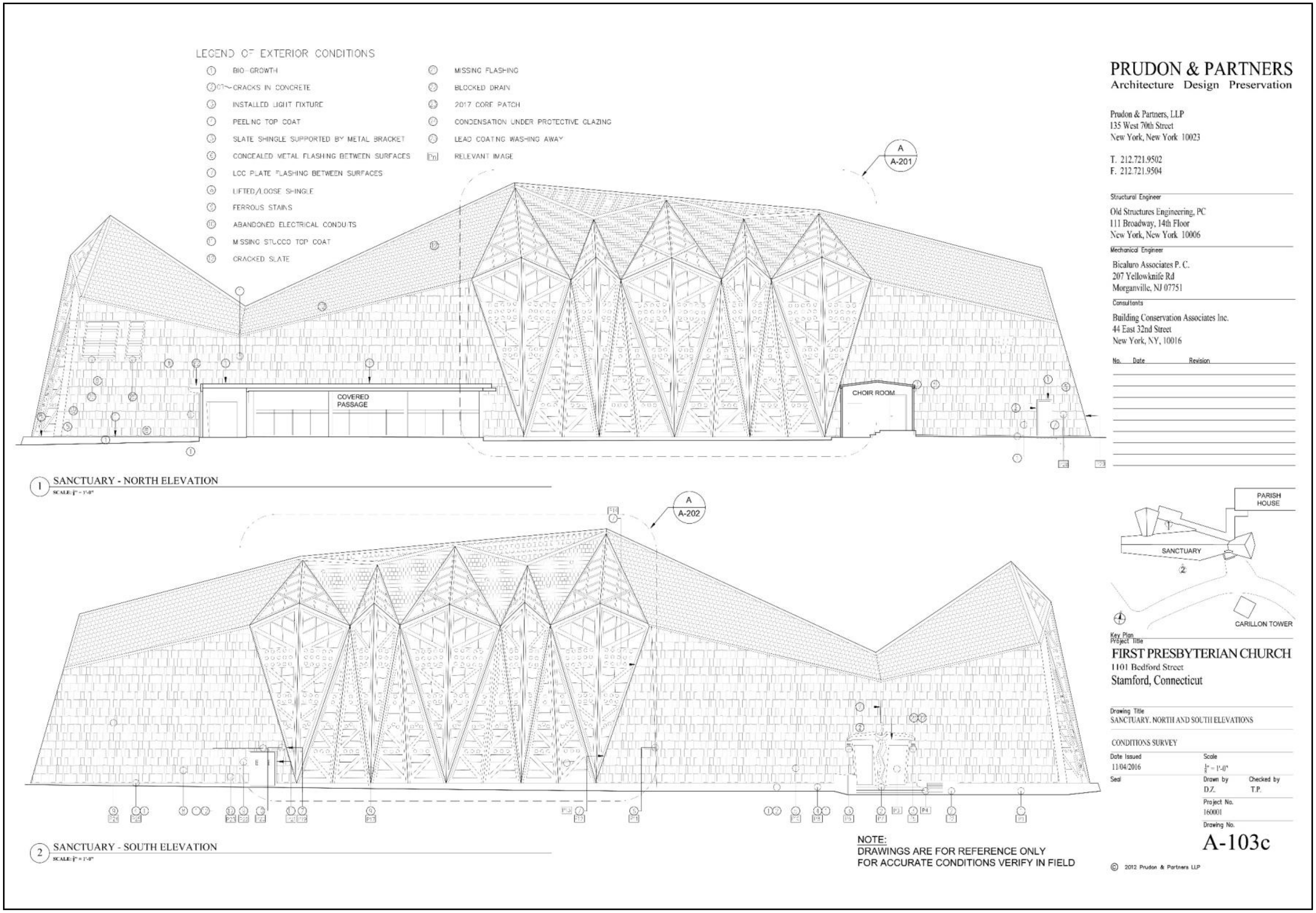
LEGEND OF EXTERIOR CONDITIONS
1 BIO-GROWTH
2 CRACKS IN CONCRETE
INSTALLED LIGHT FIXTURE
PEELING TOP COAT
SLATE SHINGLE SUPPORTED BY METAL BRACKET
CONCEALED METAL FLASHING BETWEEN SURFACES
LCC PLATE FLASHING BETWEEN SURFACES
LIFTED/LOOSE SHINGLE
FERROUS STAINS
ABANDONED ELECTRICAL CONDUITS
MISSING STUCCO TOP COAT
CRACKED SLATE
MISSING FLASHING
BLOCKED DRAIN
2017 CORE PATCH
CONDENSATION UNDER PROTECTIVE GLAZING
LEAD COATING WASHING AWAY
RELEVANT IMAGE
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44 East 32nd Street
New York, NY, 10016
No. Date Revision
A
A-201
COVERED PASSAGE
CHOIR ROOM
1 SANCTUARY - NORTH ELEVATION
A
A-202
PARISH HOUSE
SANCTUARY
CARILLON TOWER
Key Plan
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
SANCTUARY, NORTH AND SOUTH ELEVATIONS
CONDITIONS SURVEY
Date Issued
11/04/2016
Seal
Scale
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Project No.
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Drawing No.
A-103c
2 SANCTUARY - SOUTH ELEVATION
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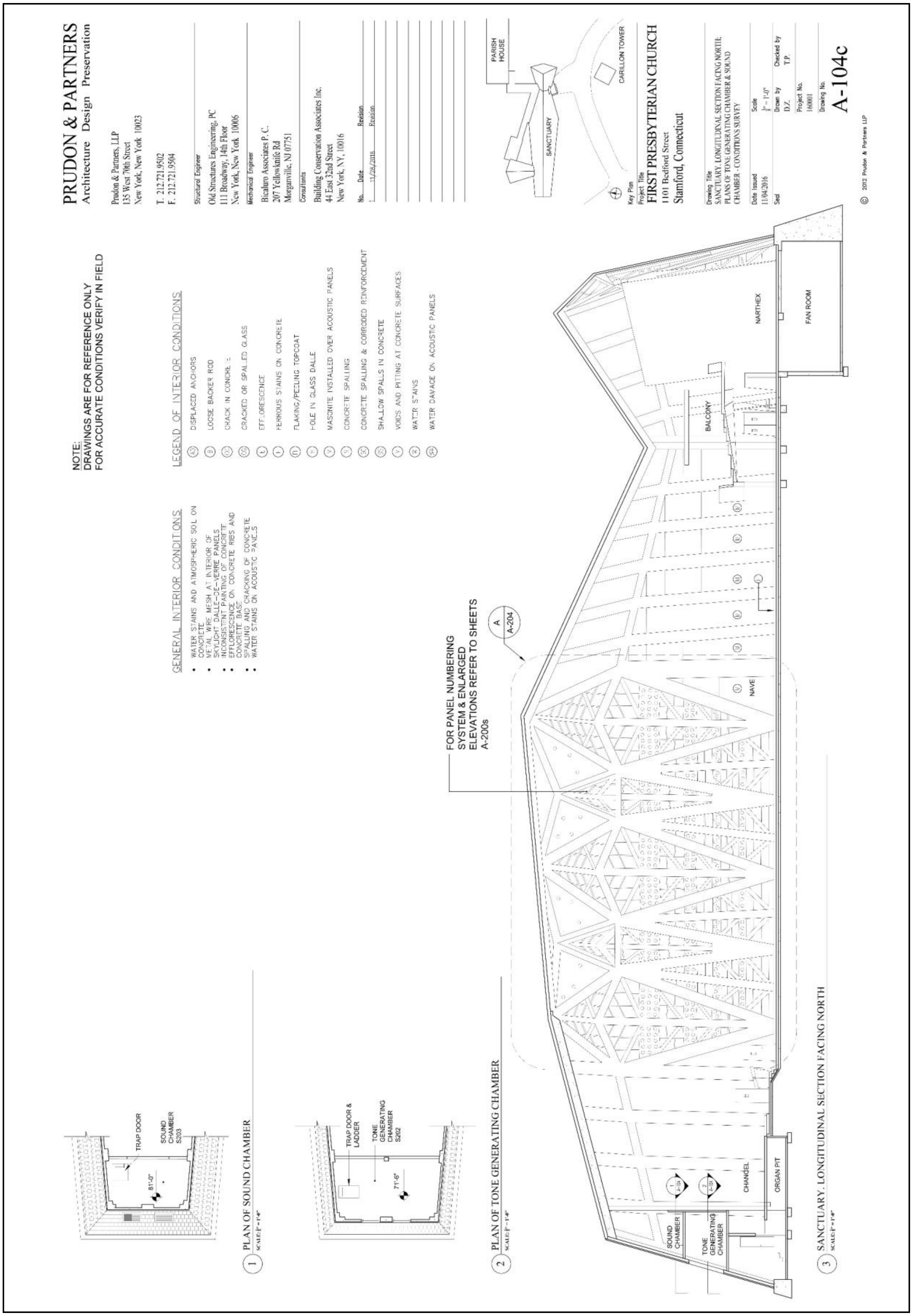
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GENERAL INTERIOR CONDITIONS
WATER STAINS AND ATMOSPHERIC SOIL ON CONCRETE
METAL WIRE MESH AT INTERIOR OF SKYLIGHT DALLE-DE-VERRE PANELS
INCONSISTENT PAINTING OF CONCRETE
EFFLORESCENCE ON CONCRETE RIBS AND CONCRETE BASE
SPALLING AND CRACKING OF CONCRETE
WATER STAINS ON ACOUSTIC PANELS
LEGEND OF INTERIOR CONDITIONS
DISPLACED ANCHORS
LOOSE BACKER ROD
CRACK IN CONCRETE
CRACKED OR SPALLED GLASS
EFFLORESCENCE
FERROUS STAINS ON CONCRETE
FLAKING/PEELING TOPCOAT
HOLE IN GLASS DALLE
MASONITE INSTALLED OVER ACOUSTIC PANELS
CONCRETE SPALLING
CONCRETE SPALLING & CORRODED REINFORCEMENT
SHALLOW SPALLS IN CONCRETE
VOIDS AND PITTING AT CONCRETE SURFACES
WATER STAINS
WATER DAMAGE ON ACOUSTIC PANELS
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Building Conservation Associates Inc.
44 East 32nd Street
New York, NY, 10016
No. Date Revision
1 11/28/2016 Revision
TRAP DOOR
SOUND CHAMBER S203
81'-0"
1 PLAN OF SOUND CHAMBER
TRAP DOOR & LADDER
TONE GENERATING CHAMBER S202
71'-6"
2 PLAN OF TONE GENERATING CHAMBER
FOR PANEL NUMBERING SYSTEM & ENLARGED ELEVATIONS REFER TO SHEETS A-200s
A
A-204
SOUND CHAMBER
TONE GENERATING CHAMBER
CHANCEL
ORGAN PIT
NAVE
BALCONY
NARTHEX
FAN ROOM
3 SANCTUARY. LONGITUDINAL SECTION FACING NORTH
PARISH HOUSE
SANCTUARY
CARILLON TOWER
Key Plan
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
SANCTUARY. LONGITUDINAL SECTION FACING NORTH; PLANS OF TONE GENERATING CHAMBER & SOUND CHAMBER - CONDITIONS SURVEY
Date Issued
11/04/2016
Scale
Seal
Drawn by
D.Z.
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Project No.
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Drawing No.
A-104c
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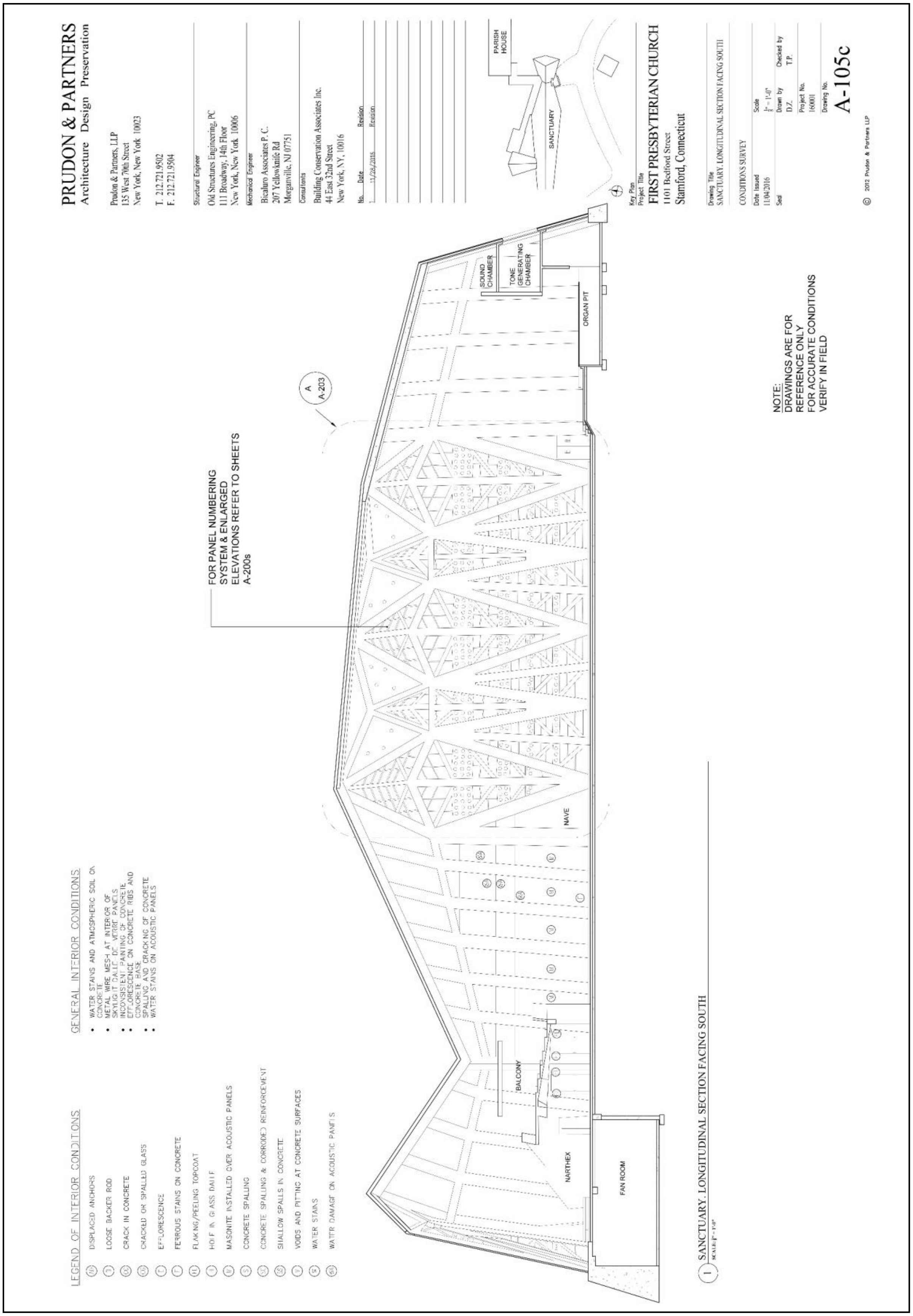
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Morganville, NJ 07751
Consultants
Building Conservation Associates Inc.
44 East 32nd Street
New York, NY, 10016
No. Date Revision
1 11/26/2016 Revision
LEGEND OF INTERIOR CONDITIONS
DISPLACED ANCHORS
LOOSE BACKER ROD
CRACK IN CONCRETE
CRACKED OR SPALLED GLASS
EFFLORESCENCE
FERROUS STAINS ON CONCRETE
FLAKING/PEELING TOPCOAT
HOLE IN GLASS DALLE
MASONITE INSTALLED OVER ACOUSTIC PANELS
CONCRETE SPALLING
CONCRETE SPALLING & CORRODED REINFORCEMENT
SHALLOW SPALLS IN CONCRETE
VOIDS AND PITTING AT CONCRETE SURFACES
WATER STAINS
WATER DAMAGE ON ACOUSTIC PANELS
GENERAL INTERIOR CONDITIONS
• WATER STAINS AND ATMOSPHERIC SOIL ON CONCRETE
• METAL WIRE MESH AT INTERIOR OF SKYLIGHT DALLE DE VERRE PANELS
• INCONSISTENT PAINTING OF CONCRETE
• EFFLORESCENCE ON CONCRETE RIBS AND CONCRETE BASE
• SPALLING AND CRACKING OF CONCRETE
• WATER STAINS ON ACOUSTIC PANELS
FOR PANEL NUMBERING SYSTEM & ENLARGED ELEVATIONS REFER TO SHEETS A-200s
A
A-203
BALCONY
NARTHEX
NAVE
FAN ROOM
SOUND CHAMBER
TONE GENERATING CHAMBER
ORGAN PIT
PARISH HOUSE
SANCTUARY
1 SANCTUARY. LONGITUDINAL SECTION FACING SOUTH
NOTE:
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FOR ACCURATE CONDITIONS VERIFY IN FIELD
Key Plan
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
SANCTUARY. LONGITUDINAL SECTION FACING SOUTH
CONDITIONS SURVEY
Date Issued
11/04/2016
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Project No.
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Drawing No.
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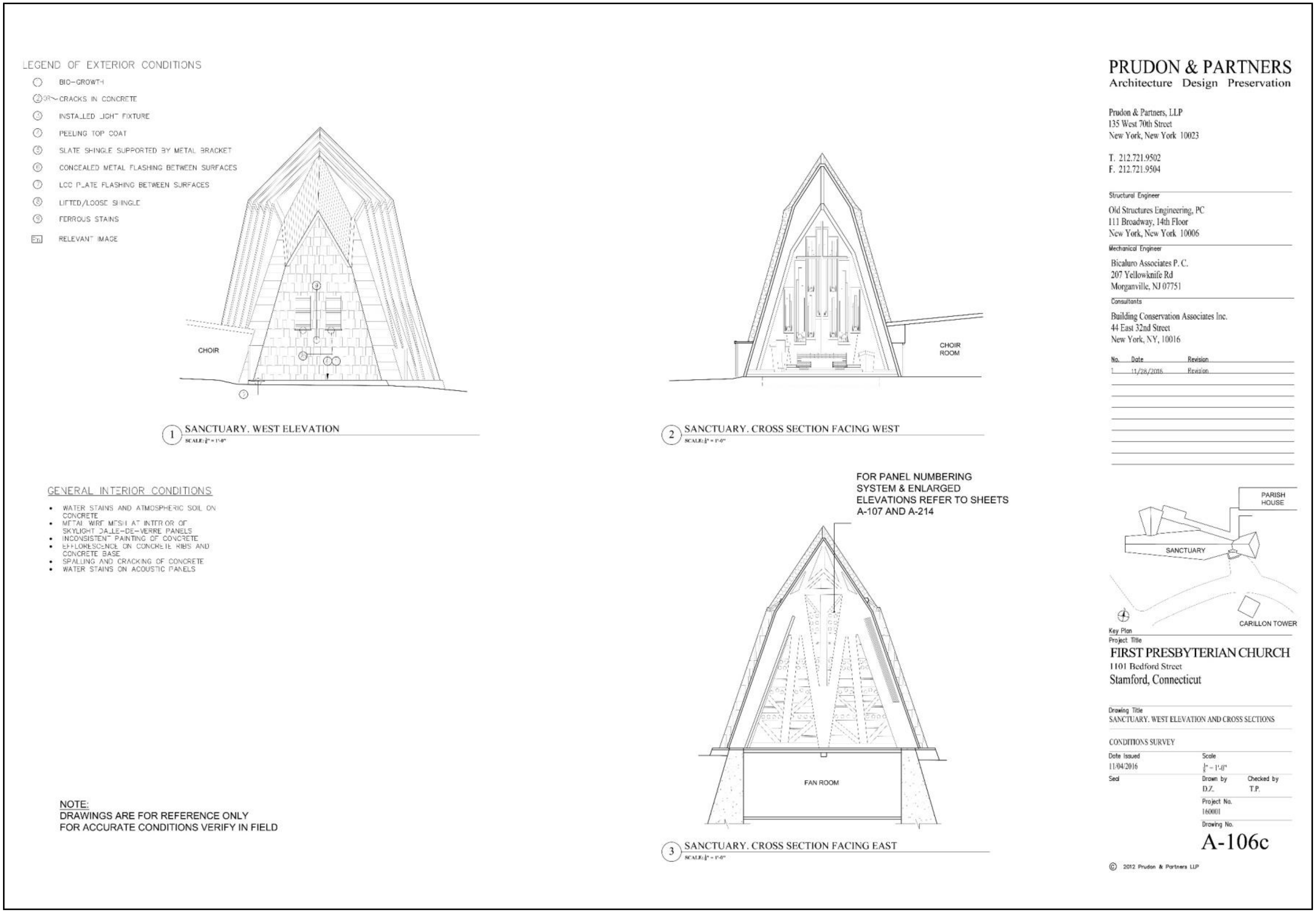
LEGEND OF EXTERIOR CONDITIONS
BIO-GROWTH
CRACKS IN CONCRETE
INSTALLED LIGHT FIXTURE
PEELING TOP COAT
SLATE SHINGLE SUPPORTED BY METAL BRACKET
CONCEALED METAL FLASHING BETWEEN SURFACES
LCC PLATE FLASHING BETWEEN SURFACES
LIFTED/LOOSE SHINGLE
FERROUS STAINS
RELEVANT IMAGE
CHOIR
1 SANCTUARY. WEST ELEVATION
CHOIR ROOM
2 SANCTUARY. CROSS SECTION FACING WEST
GENERAL INTERIOR CONDITIONS
• WATER STAINS AND ATMOSPHERIC SOIL ON CONCRETE
• METAL WIRE MESH AT INTERIOR OF SKYLIGHT DALLE-DE-VERRE PANELS
• INCONSISTENT PAINTING OF CONCRETE
• EFFLORESCENCE ON CONCRETE RIBS AND CONCRETE BASE
• SPALLING AND CRACKING OF CONCRETE
• WATER STAINS ON ACOUSTIC PANELS
FOR PANEL NUMBERING SYSTEM & ENLARGED ELEVATIONS REFER TO SHEETS A-107 AND A-214
FAN ROOM
3 SANCTUARY. CROSS SECTION FACING EAST
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Building Conservation Associates Inc.
44 East 32nd Street
New York, NY, 10016
No. Date Revision
1 11/28/2016 Revision
PARISH HOUSE
SANCTUARY
CARILLON TOWER
Key Plan
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
SANCTUARY. WEST ELEVATION AND CROSS SECTIONS
CONDITIONS SURVEY
Date Issued
11/04/2016
Scale
Seal
Drawn by
D.Z.
Checked by
T.P.
Project No.
160001
Drawing No.
A-106c
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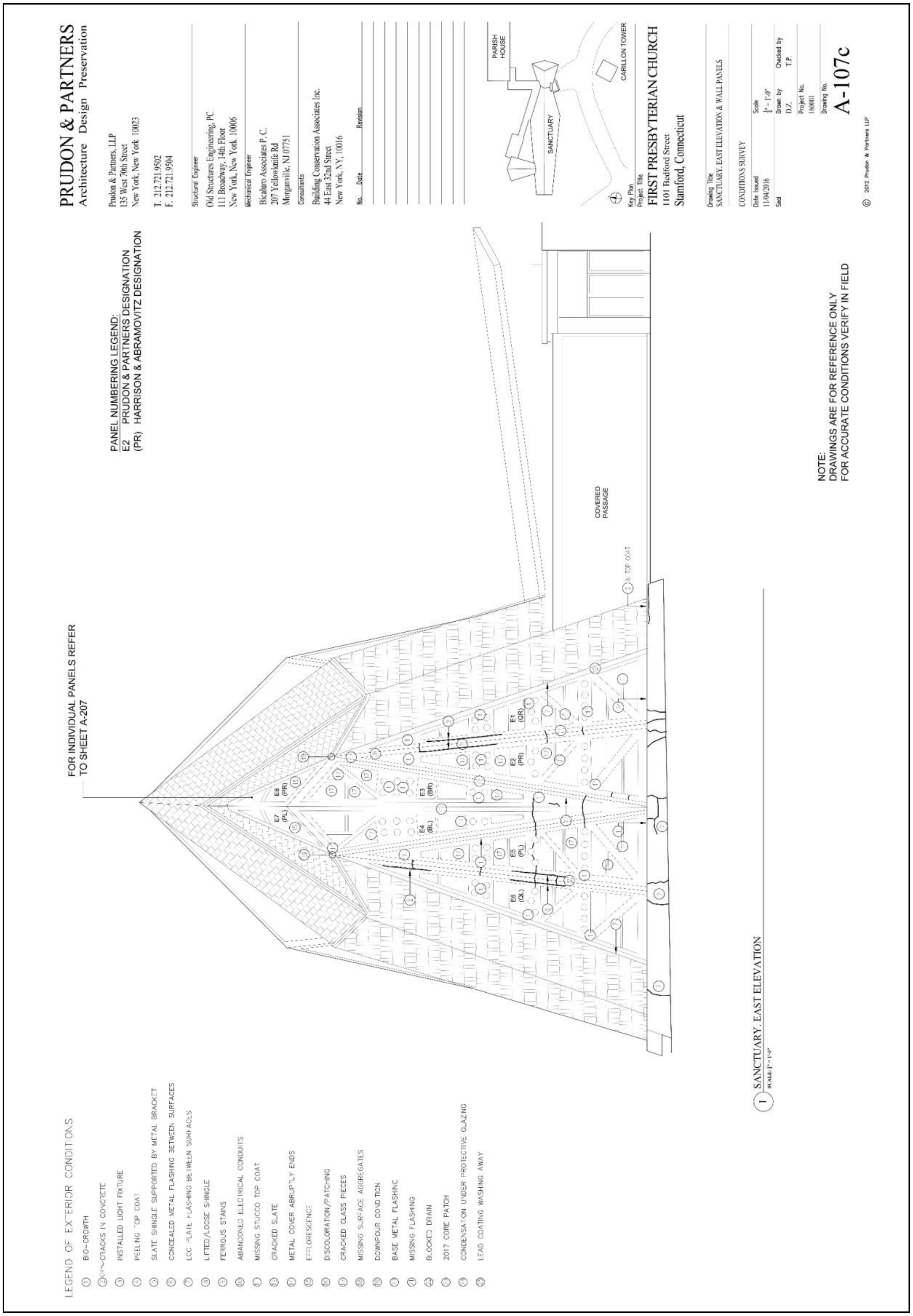
LEGEND OF EXTERIOR CONDITIONS
1 BIO-CROWTH
2 CRACKS IN CONCRETE
3 INSTALLED LIGHT FIXTURE
4 PEELING TOP COAT
5 SLATE SHINGLE SUPPORTED BY METAL BRACKET
6 CONCEALED METAL FLASHING BETWEEN SURFACES
7 LCC PLATE FLASHING BETWEEN SURFACES
8 LIFTED/LOOSE SHINGLE
9 FERROUS STAINS
10 ABANDONED ELECTRICAL CONDUITS
11 MISSING STUCCO TOP COAT
12 CRACKED SLATE
13 METAL COVER ABRUPTLY ENDS
14 EFFLORESCENCE
15 DISCOLORATION/PATCHING
16 CRACKED GLASS PIECES
17 MISSING SURFACE AGGREGATES
18 DOWNPOUR CONDITION
19 BASE METAL FLASHING
20 MISSING FLASHING
21 BLOCKED DRAIN
22 2017 CORE PATCH
23 CONDENSATION UNDER PROTECTIVE GLAZING
24 LEAD COATING WASHING AWAY
FOR INDIVIDUAL PANELS REFER TO SHEET A-207
PANEL NUMBERING LEGEND:
E2 PRUDON & PARTNERS DESIGNATION
(PR) HARRISON & ABRAMOVITZ DESIGNATION
E7 (PL)
E8 (PR)
E4 (BL)
E3 (BR)
E6 (QL)
E5 (PL)
E2 (PR)
E1 (QR)
COVERED PASSAGE
1 SANCTUARY. EAST ELEVATION
NOTE:
DRAWINGS ARE FOR REFERENCE ONLY
FOR ACCURATE CONDITIONS VERIFY IN FIELD
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Consultants
Building Conservation Associates Inc.
44 East 32nd Street
New York, NY, 10016
No. Date Revision
PARISH HOUSE
SANCTUARY
CARILLON TOWER
Key Plan
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
SANCTUARY. EAST ELEVATION & WALL PANELS
CONDITIONS SURVEY
Date Issued 11/04/2016
Scale
Seal
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Project No. 160001
Drawing No.
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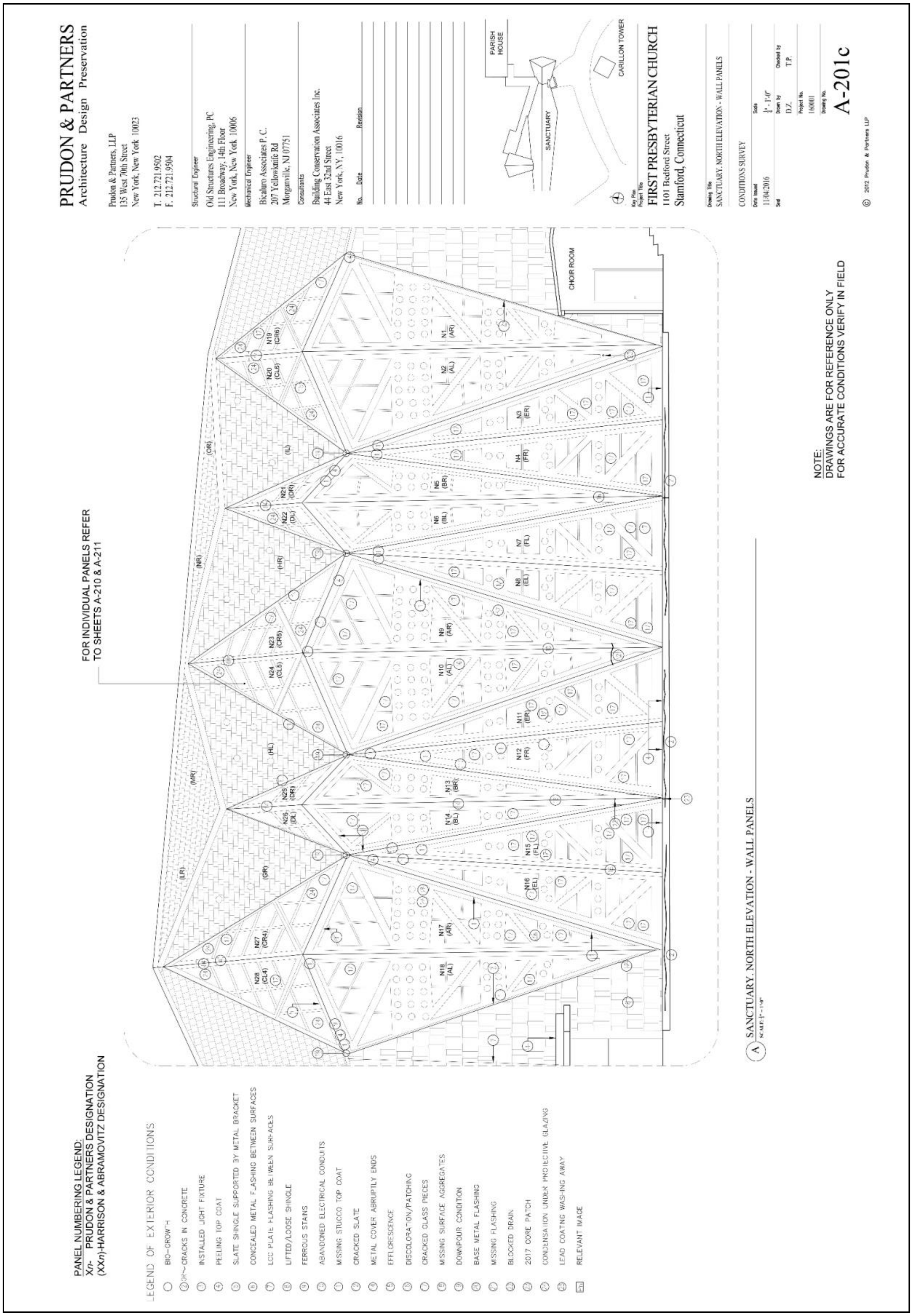
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Xn- PRUDON & PARTNERS DESIGNATION
(XXn)-HARRISON & ABRAMOVITZ DESIGNATION
LEGEND OF EXTERIOR CONDITIONS
BIO-GROWTH
CRACKS IN CONCRETE
INSTALLED LIGHT FIXTURE
PEELING TOP COAT
SLATE SHINGLE SUPPORTED BY METAL BRACKET
CONCEALED METAL FLASHING BETWEEN SURFACES
LCC PLATE FLASHING BETWEEN SURFACES
LIFTED/LOOSE SHINGLE
FERROUS STAINS
ABANDONED ELECTRICAL CONDUITS
MISSING STUCCO TOP COAT
CRACKED SLATE
METAL COVER ABRUPTLY ENDS
EFFLORESCENCE
DISCOLORATION/PATCHING
CRACKED GLASS PIECES
MISSING SURFACE AGGREGATES
DOWNPOUR CONDITION
BASE METAL FLASHING
MISSING FLASHING
BLOCKED DRAIN
2017 CORE PATCH
CONDENSATION UNDER PROTECTIVE GLAZING
LEAD COATING WASHING AWAY
RELEVANT IMAGE
FOR INDIVIDUAL PANELS REFER TO SHEETS A-210 & A-211
CHOIR ROOM
A SANCTUARY. NORTH ELEVATION - WALL PANELS
NOTE:
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PARISH HOUSE
SANCTUARY
CARILLON TOWER
Key Plan
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
SANCTUARY. NORTH ELEVATION - WALL PANELS
CONDITIONS SURVEY
Date Issued
11/04/2016
Scale
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Checked by
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Project No.
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Drawing No.
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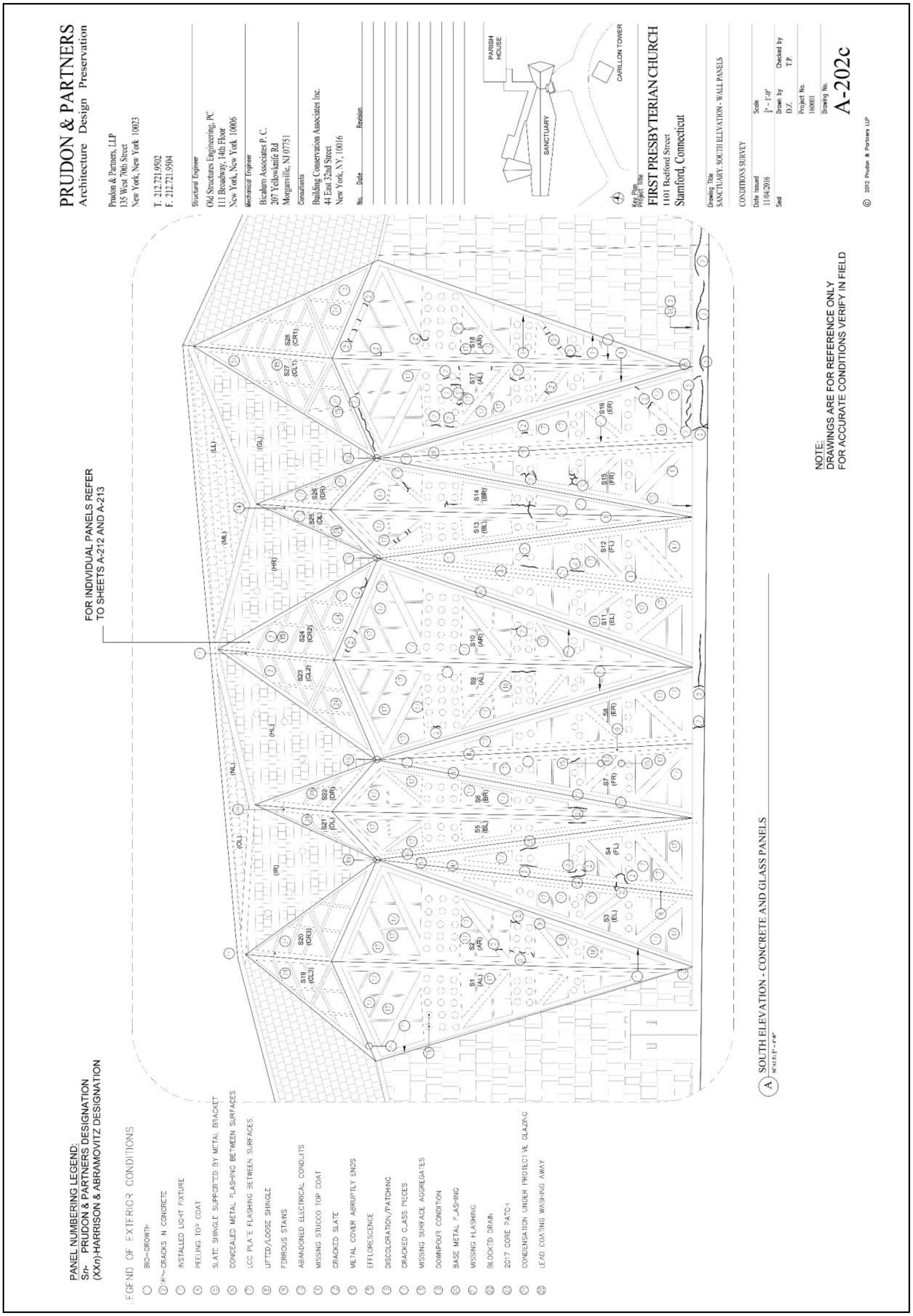
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(XXn)-HARRISON & ABRAMOVITZ DESIGNATION
EGEND OF EXTERIOR CONDITIONS
BIO-GROWTH
CRACKS IN CONCRETE
INSTALLED LIGHT FIXTURE
PEELING TOP COAT
SLATE SHINGLE SUPPORTED BY METAL BRACKET
CONCEALED METAL FLASHING BETWEEN SURFACES
LCC PLATE FLASHING BETWEEN SURFACES
LIFTED/LOOSE SHINGLE
FERROUS STAINS
ABANDONED ELECTRICAL CONDUITS
MISSING STUCCO TOP COAT
CRACKED SLATE
METAL COVER ABRUPTLY ENDS
EFFLORESCENCE
DISCOLORATION/PATCHING
CRACKED GLASS PIECES
MISSING SURFACE AGGREGATES
DOWNPOUR CONDITION
BASE METAL FLASHING
MISSING FLASHING
BLOCKED DRAIN
2017 CORE PATCH
CONDENSATION UNDER PROTECTIVE GLAZING
LEAD COATING WASHING AWAY
FOR INDIVIDUAL PANELS REFER TO SHEETS A-212 AND A-213
A SOUTH ELEVATION - CONCRETE AND GLASS PANELS
NOTE:
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New York, NY, 10016
No. Date Revision
PARISH HOUSE
SANCTUARY
CARILLON TOWER
Key Plan
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
SANCTUARY. SOUTH ELEVATION - WALL PANELS
CONDITIONS SURVEY
Date Issued
11/04/2016
Scale
Seal
Drawn by
D.Z.
Checked by
T.P.
Project No.
160001
Drawing No.
A-202c
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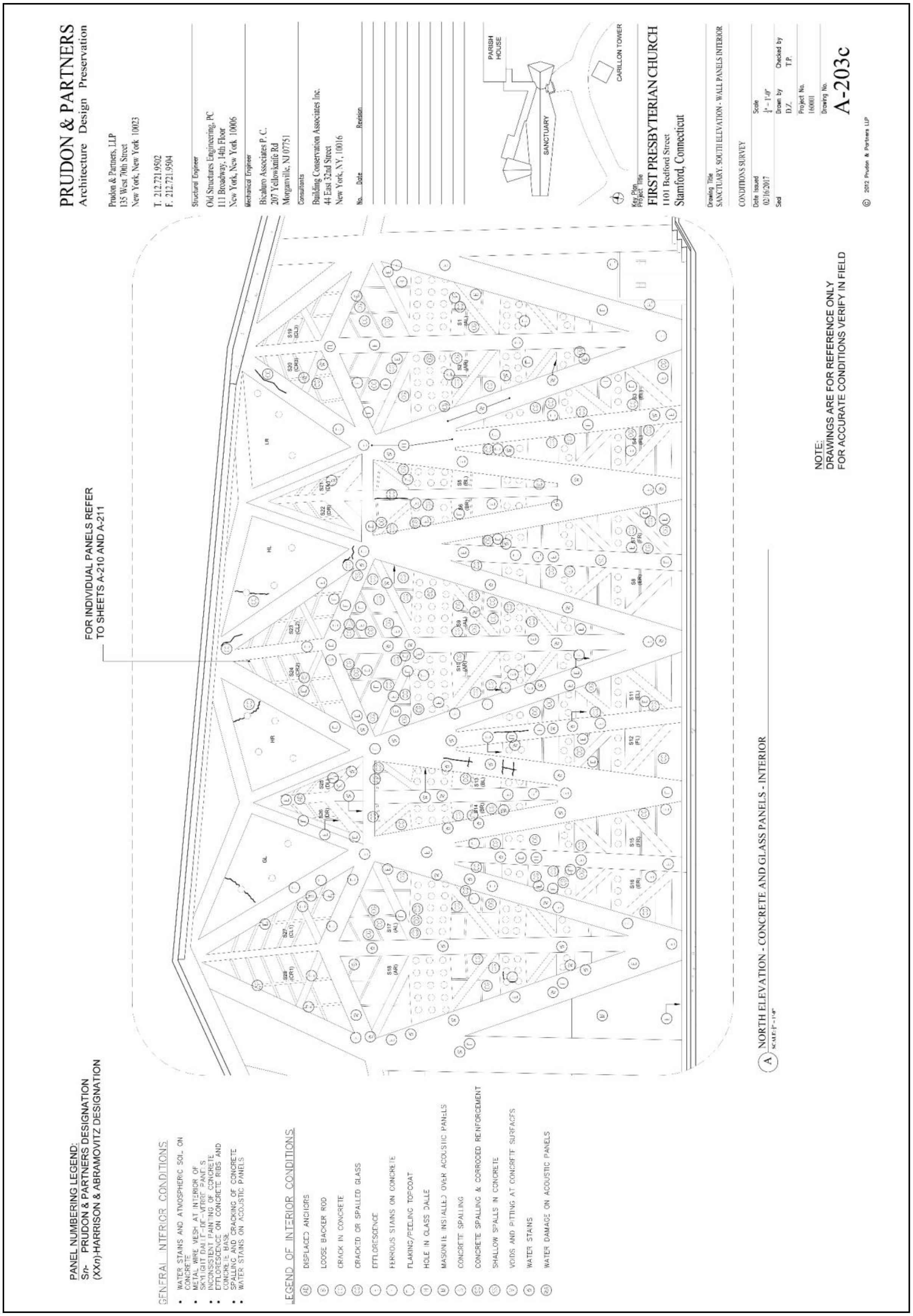
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Consultants
Building Conservation Associates Inc.
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New York, NY, 10016
No. Date Revision
PARISH HOUSE
SANCTUARY
CARILLON TOWER
Key Plan
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
SANCTUARY: SOUTH ELEVATION - WALL PANELS INTERIOR
CONDITIONS SURVEY
Date Issued 02/16/2017
Scale
Drawn by D.Z.
Checked by T.P.
Project No. 16001
Drawing No.
A-203c
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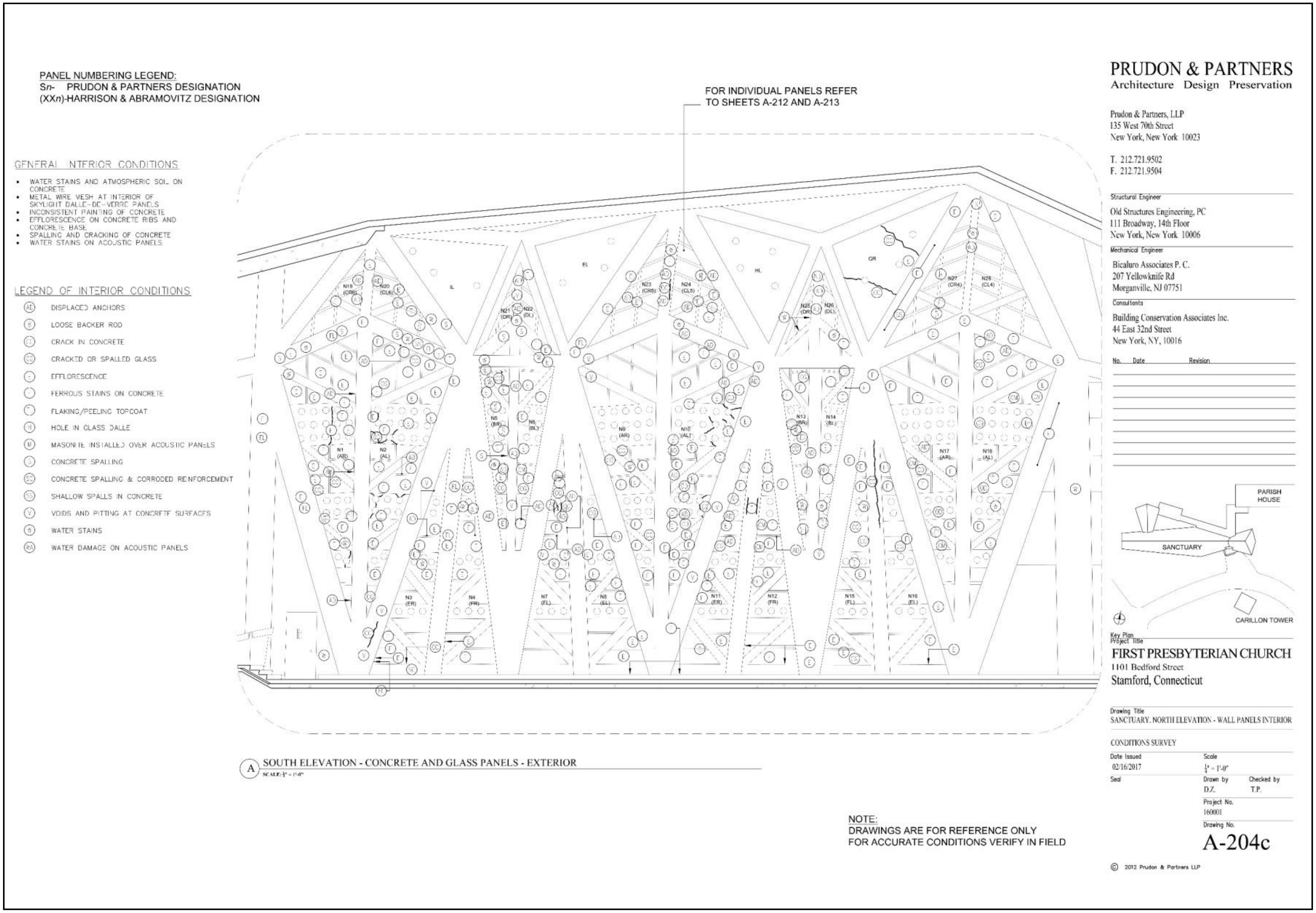
FOR INDIVIDUAL PANELS REFER
TO SHEETS A-210 AND A-211
A NORTH ELEVATION - CONCRETE AND GLASS PANELS - INTERIOR
PANEL NUMBERING LEGEND:
Sn- PRUDON & PARTNERS DESIGNATION
(XXn)-HARRISON & ABRAMOVITZ DESIGNATION
GENERAL INTERIOR CONDITIONS
WATER STAINS AND ATMOSPHERIC SOIL ON CONCRETE
METAL WIRE MESH AT INTERIOR OF SKYLIGHT DALLE-DE-VERRE PANELS
INCONSISTENT PAINTING OF CONCRETE
EFFLORESCENCE ON CONCRETE RIBS AND CONCRETE BASE
SPALLING AND CRACKING OF CONCRETE
WATER STAINS ON ACOUSTIC PANELS
LEGEND OF INTERIOR CONDITIONS
DISPLACED ANCHORS
LOOSE BACKER ROD
CRACK IN CONCRETE
CRACKED OR SPALLED GLASS
EFFLORESCENCE
FERROUS STAINS ON CONCRETE
FLAKING/PEELING TOPCOAT
HOLE IN GLASS DALLE
MASONITE INSTALLED OVER ACOUSTIC PANELS
CONCRETE SPALLING
CONCRETE SPALLING & CORRODED REINFORCEMENT
SHALLOW SPALLS IN CONCRETE
VOIDS AND PITTING AT CONCRETE SURFACES
WATER STAINS
WATER DAMAGE ON ACOUSTIC PANELS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(XXn)-HARRISON & ABRAMOVITZ DESIGNATION
GENERAL INTERIOR CONDITIONS
WATER STAINS AND ATMOSPHERIC SOIL ON CONCRETE
METAL WIRE MESH AT INTERIOR OF SKYLIGHT DALLE-DE-VERRE PANELS
INCONSISTENT PAINTING OF CONCRETE
EFFLORESCENCE ON CONCRETE RIBS AND CONCRETE BASE
SPALLING AND CRACKING OF CONCRETE
WATER STAINS ON ACOUSTIC PANELS
LEGEND OF INTERIOR CONDITIONS
DISPLACED ANCHORS
LOOSE BACKER ROD
CRACK IN CONCRETE
CRACKED OR SPALLED GLASS
EFFLORESCENCE
FERROUS STAINS ON CONCRETE
FLAKING/PEELING TOPCOAT
HOLE IN GLASS DALLE
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CONCRETE SPALLING
CONCRETE SPALLING & CORRODED REINFORCEMENT
SHALLOW SPALLS IN CONCRETE
VOIDS AND PITTING AT CONCRETE SURFACES
WATER STAINS
WATER DAMAGE ON ACOUSTIC PANELS
FOR INDIVIDUAL PANELS REFER TO SHEETS A-212 AND A-213
A SOUTH ELEVATION - CONCRETE AND GLASS PANELS - EXTERIOR
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No. Date Revision
PARISH HOUSE
SANCTUARY
CARILLON TOWER
Key Plan
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
SANCTUARY, NORTH ELEVATION - WALL PANELS INTERIOR
CONDITIONS SURVEY
Date Issued 02/16/2017
Scale 1/4" = 1'-0"
Seal
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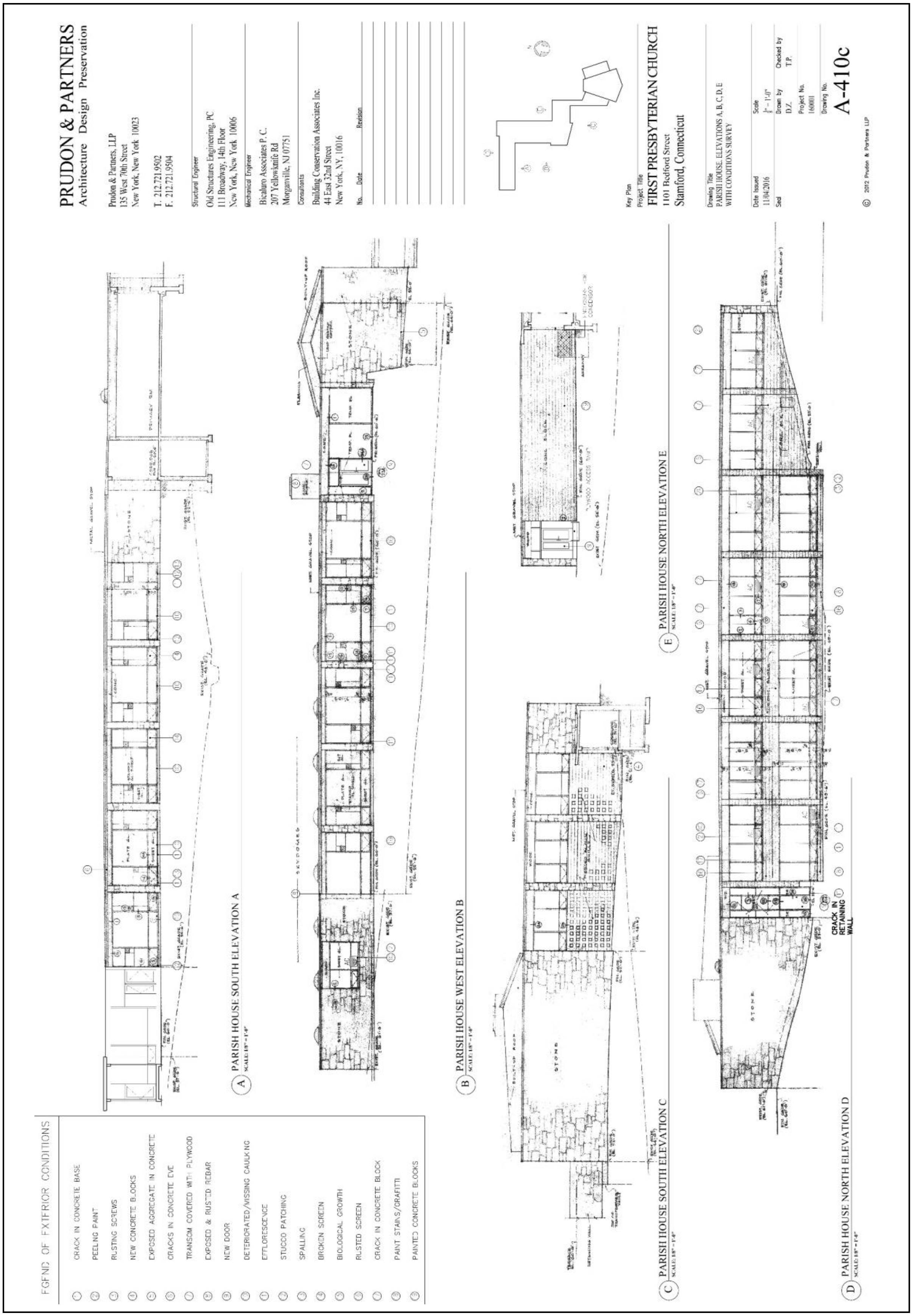
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No. Date Revision
Key Plan
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
PARISH HOUSE ELEVATIONS A, B, C, D, E
WITH CONDITIONS SURVEY
Date Issued
11/04/2016
Seal
Scale
Drawn by
D.Z.
Checked by
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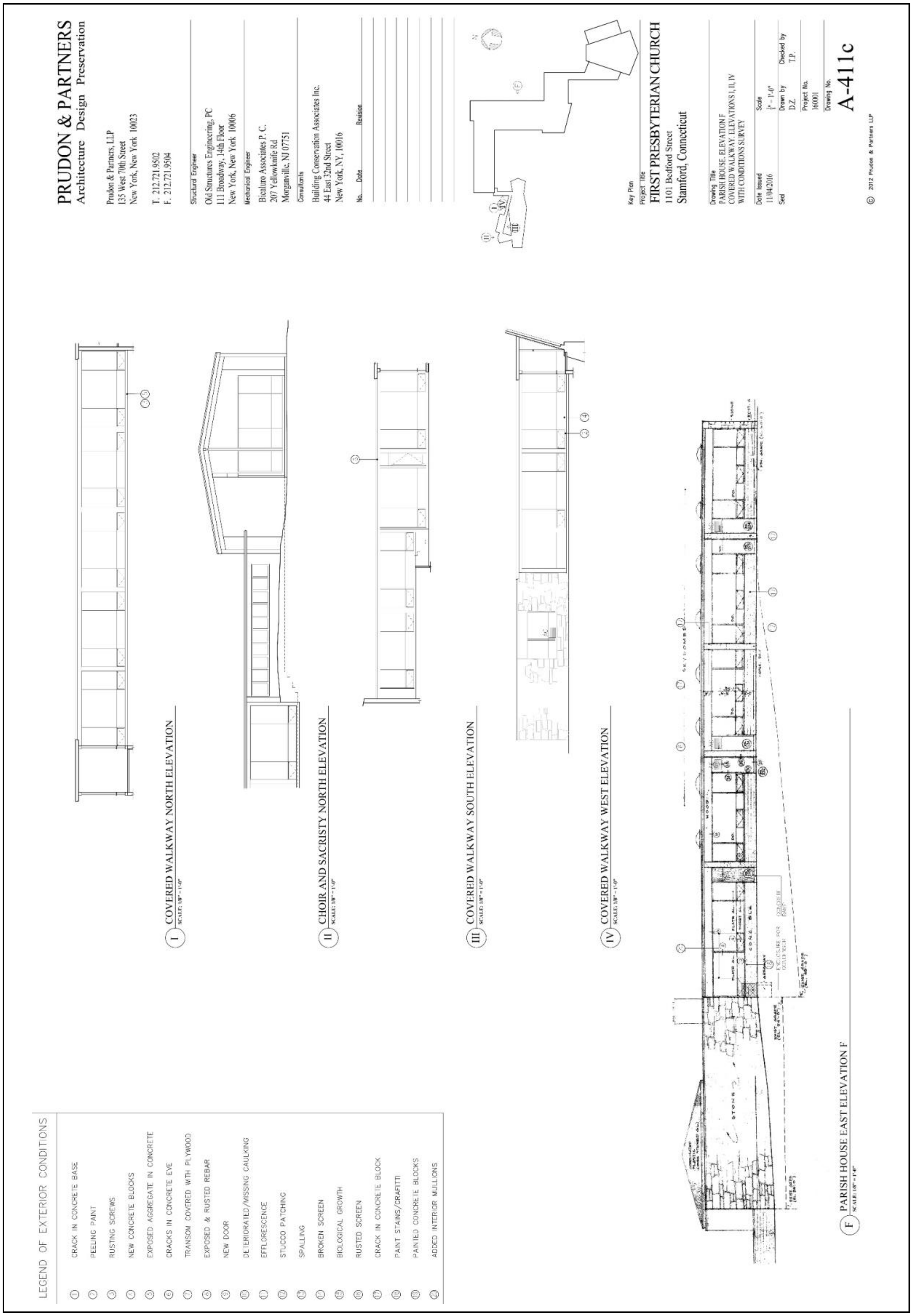
Project No.
16001
Drawing No.
A-410c
© 2012 Prudon & Partners LLP
A PARISH HOUSE SOUTH ELEVATION A
B PARISH HOUSE WEST ELEVATION B
C PARISH HOUSE SOUTH ELEVATION C
D PARISH HOUSE NORTH ELEVATION D
E PARISH HOUSE NORTH ELEVATION E
CRACK IN RETAINING WALL
LEGEND OF EXTERIOR CONDITIONS
CRACK IN CONCRETE BASE
PEELING PAINT
RUSTING SCREWS
NEW CONCRETE BLOCKS
EXPOSED AGGREGATE IN CONCRETE
CRACKS IN CONCRETE EVE
TRANSOM COVERED WITH PLYWOOD
EXPOSED & RUSTED REBAR
NEW DOOR
DETERIORATED/MISSING CAULKING
EFFLORESCENCE
STUCCO PATCHING
SPALLING
BROKEN SCREEN
BIOLOGICAL GROWTH
RUSTED SCREEN
CRACK IN CONCRETE BLOCK
PAINT STAINS/GRAFITTI
PAINTED CONCRETE BLOCKS


LEGEND OF EXTERIOR CONDITIONS
1 CRACK IN CONCRETE BASE
2 PEELING PAINT
3 RUSTING SCREWS
4 NEW CONCRETE BLOCKS
5 EXPOSED AGGREGATE IN CONCRETE
6 CRACKS IN CONCRETE EVE
7 TRANSOM COVERED WITH PLYWOOD
8 EXPOSED & RUSTED REBAR
9 NEW DOOR
10 DETERIORATED/MISSING CAULKING
11 EFFLORESCENCE
12 STUCCO PATCHING
13 SPALLING
14 BROKEN SCREEN
15 BIOLOGICAL GROWTH
16 RUSTED SCREEN
17 CRACK IN CONCRETE BLOCK
18 PAINT STAINS/GRAFITTI
19 PAINTED CONCRETE BLOCKS
20 ADDED INTERIOR MULLIONS
I COVERED WALKWAY NORTH ELEVATION
SCALE: 1/8" = 1'-0"
II CHOIR AND SACRISTY NORTH ELEVATION
SCALE: 1/8" = 1'-0"
III COVERED WALKWAY SOUTH ELEVATION
SCALE: 1/8" = 1'-0"
IV COVERED WALKWAY WEST ELEVATION
SCALE: 1/8" = 1'-0"
F PARISH HOUSE EAST ELEVATION F
SCALE: 1/8" = 1'-0"
STONE
SKYDOMES
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New York, NY, 10016
No. Date Revision
Key Plan
Project Title
FIRST PRESBYTERIAN CHURCH
1101 Bedford Street
Stamford, Connecticut
Drawing Title
PARISH HOUSE. ELEVATION F
COVERED WALKWAY. ELEVATIONS I, II, IV
WITH CONDITIONS SURVEY
Date Issued
11/04/2016
Scale
1/8" = 1'-0"
Seal
Drawn by
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Checked by
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Project No.
160001
Drawing No.
A-411c
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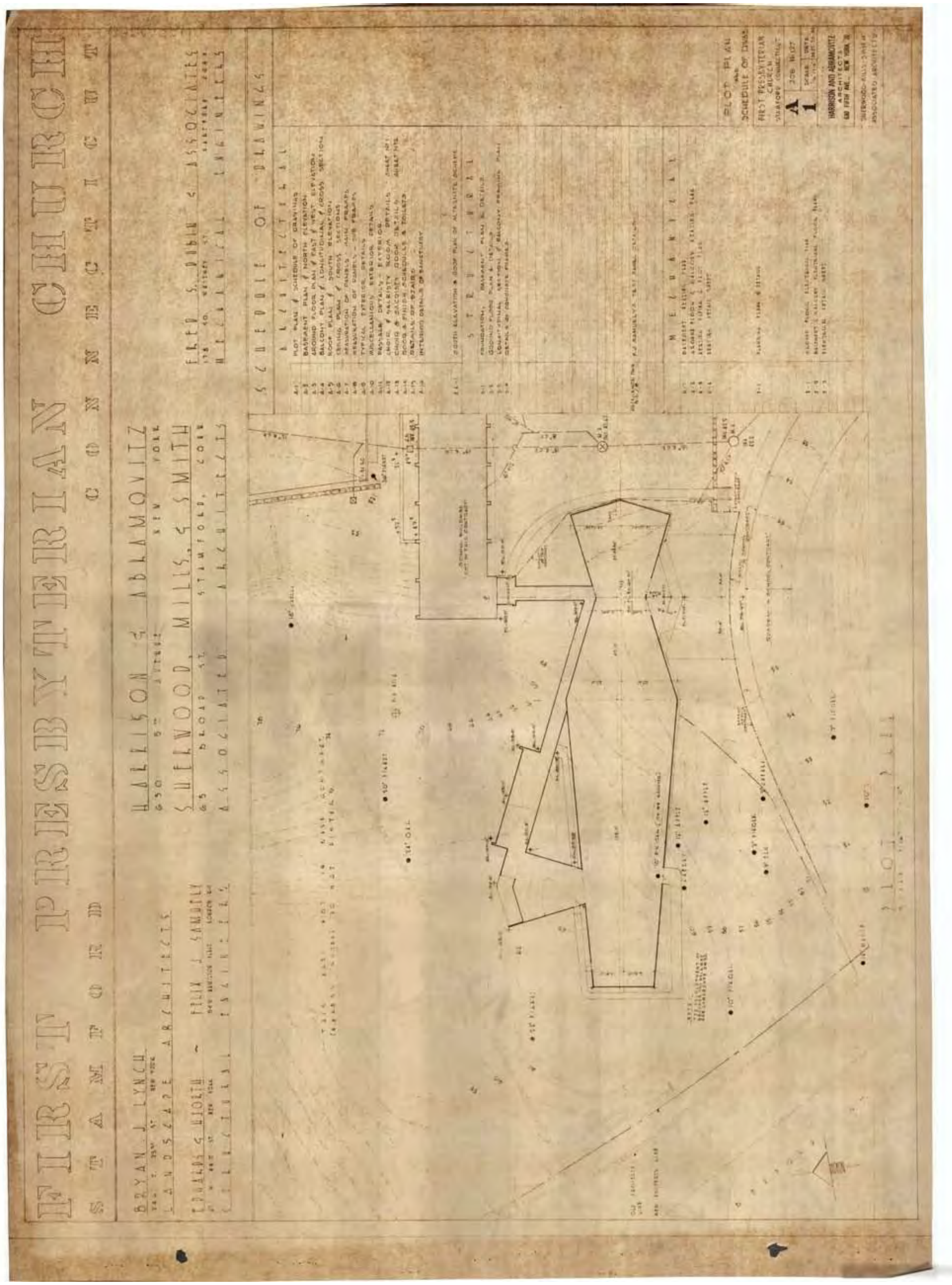
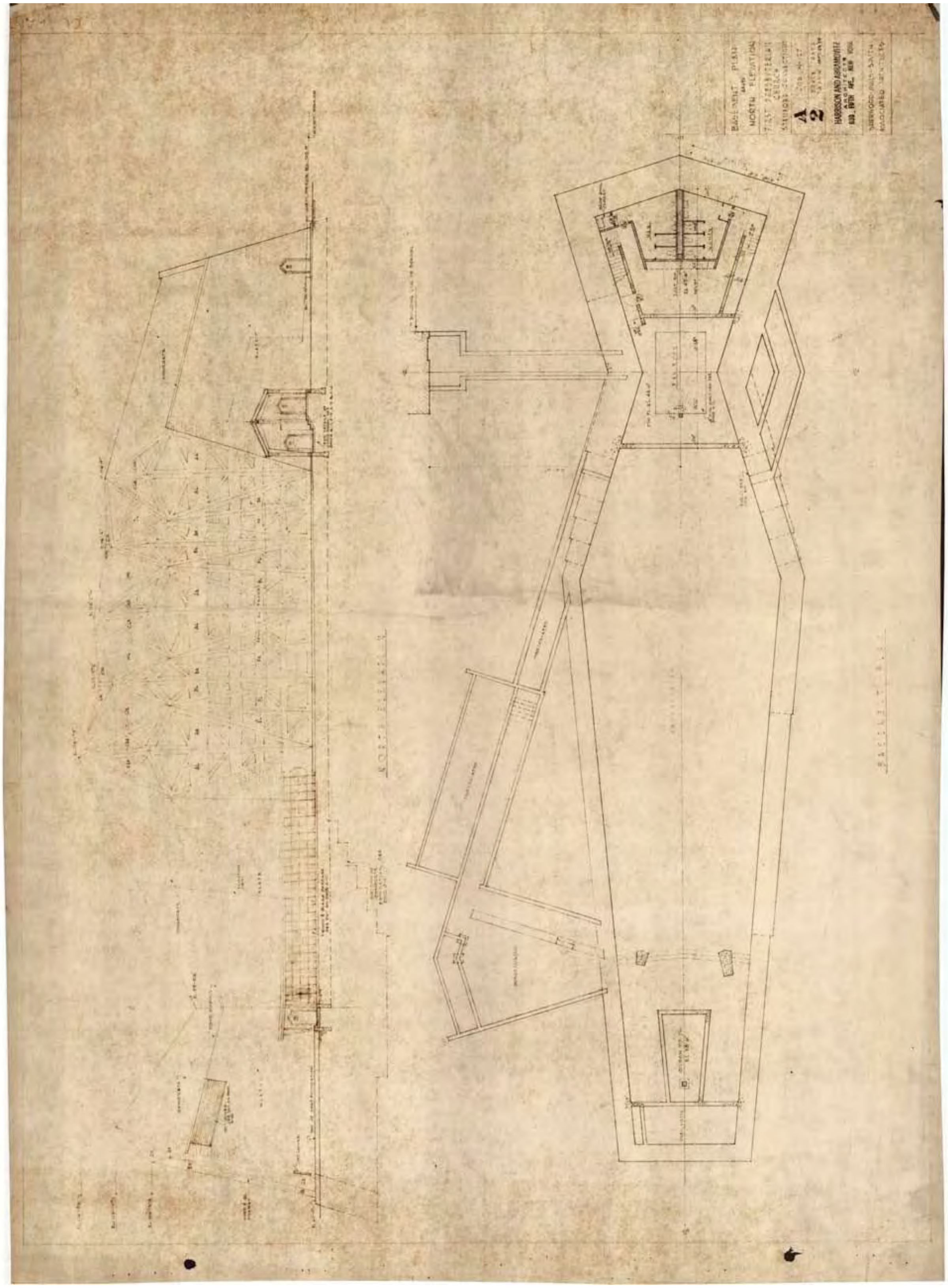
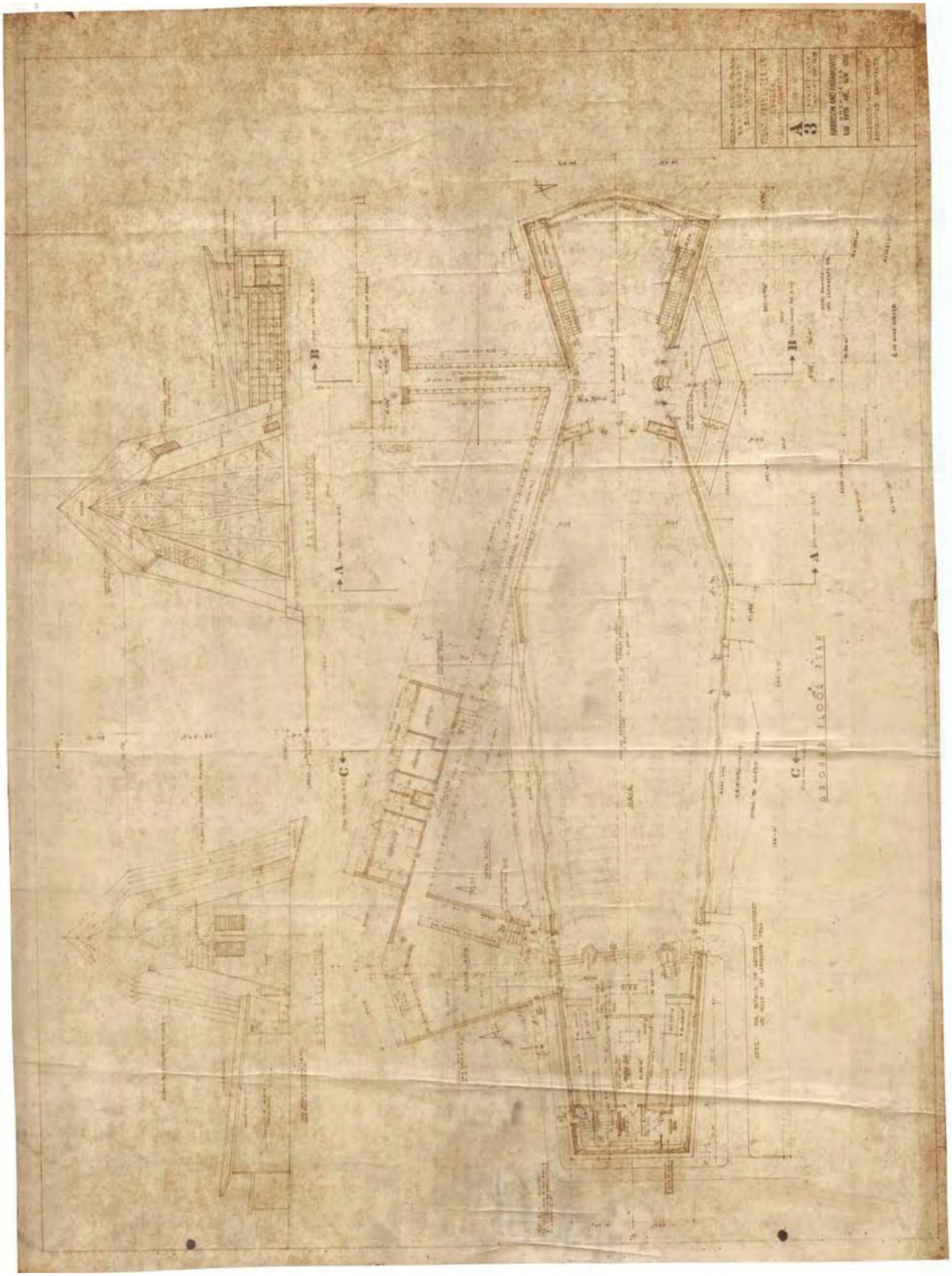
Appendix 2 Harrison Drawings

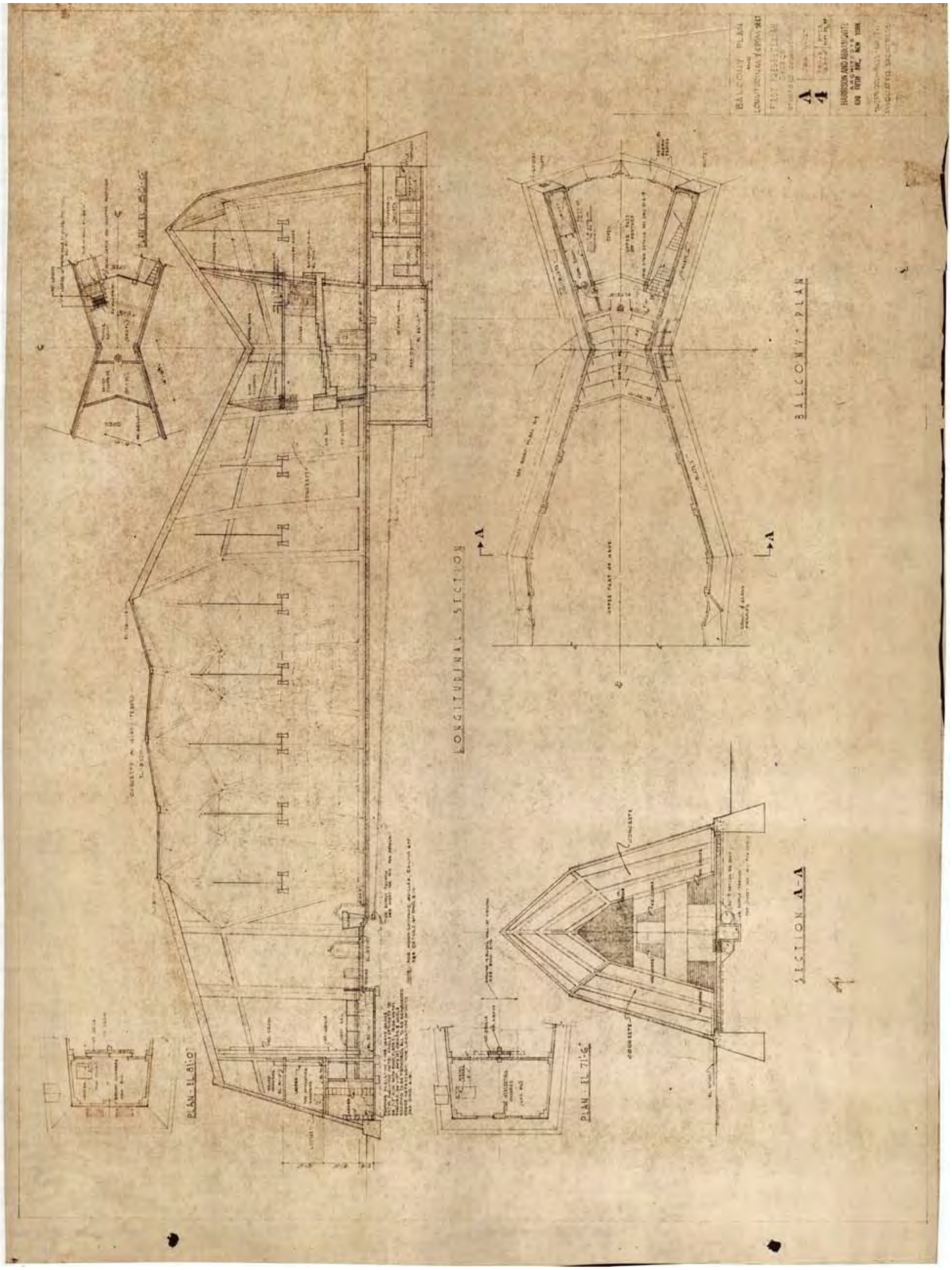
List of Drawings

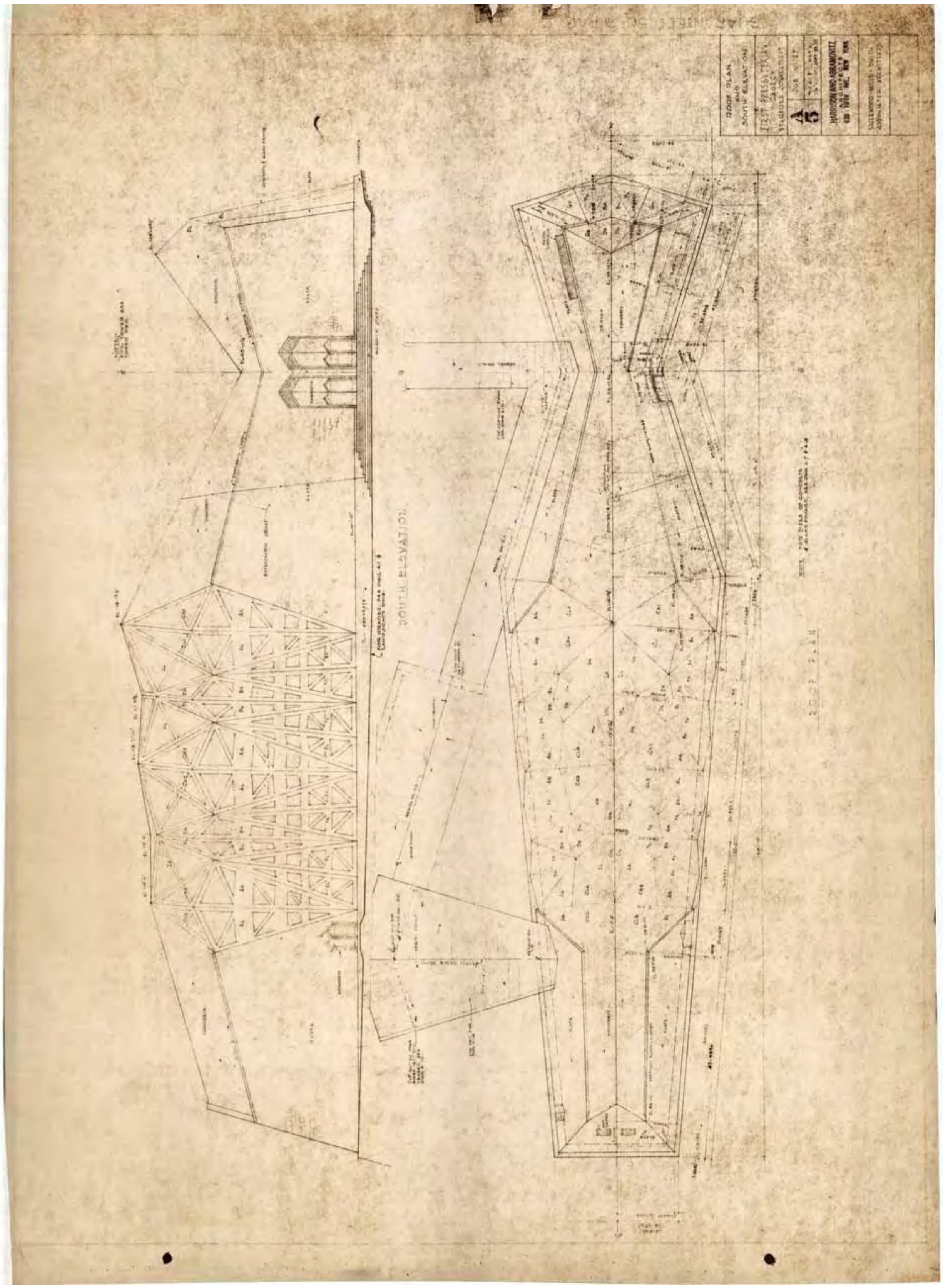
A1	PLOT PLAN AND SCHEDULE OF DRAWINGS
A2	BASEMENT PLAN AND NORTH ELEVATION
A3	GROUND FLOOR PLAN EAST AND WEST ELEVATIONS
A4	BALCONY PLAN AND LONGITUDINAL AND CROSS SECT.
A5	ROOF PLAN AND SOUTH ELEVATION
A6	CEILING PLAN AND CROSS SECTIONS
A7	MEASURATION OF PANELS MAIN FRAMES
A8	MEASURATION OF PANELS SUB FRAMES
A9	TYPICAL EXTERIOR DETAILS
A10	MISCELLANEOUS EXTERIOR DETAILS
A11	PASSAGE DETAILS: EXTERIOR
A12	CHOIR & SACRISTY ROOM DETAILS; SHEET NO 1
A13	CHOIR & SACRISTY ROOM DETAILS; SHEET NO 2
A14	DOOR & FINISH SCHEDULES; TOILET & PL. & ELEVS.
A15	DETAILS OF STAIRS
A16	INTERIOR DETAILS OF SANCTUARY
AA1	SOUTH ELEVATION AND ROOF PLAN
S1	FOUNDATION AND BASEMENT PLAN
S2	GROUND FLOOR PLAN AND DETAILS
S3	UPPER FLOOR PLANS AND LONGITUDINAL SECTION
S4	DETAILS OF CONCRETE FRAMES
H1	BASEMENT HEATING PLAN
H2	GROUND FLOOR & BALCONY HEATING PLAN
H3	HEATING PIPING AND PLOT PLAN
H4	HEATING DETAIL SHEET
P1	PLUMBING PLANS & DETAILS
E1	GROUND FLOOR ELECTRICAL PLAN
E2	BASEMENT & BALCONY ELECTRICAL FLOOR PLANS
E3	ELECTRICAL DETAIL SHEET

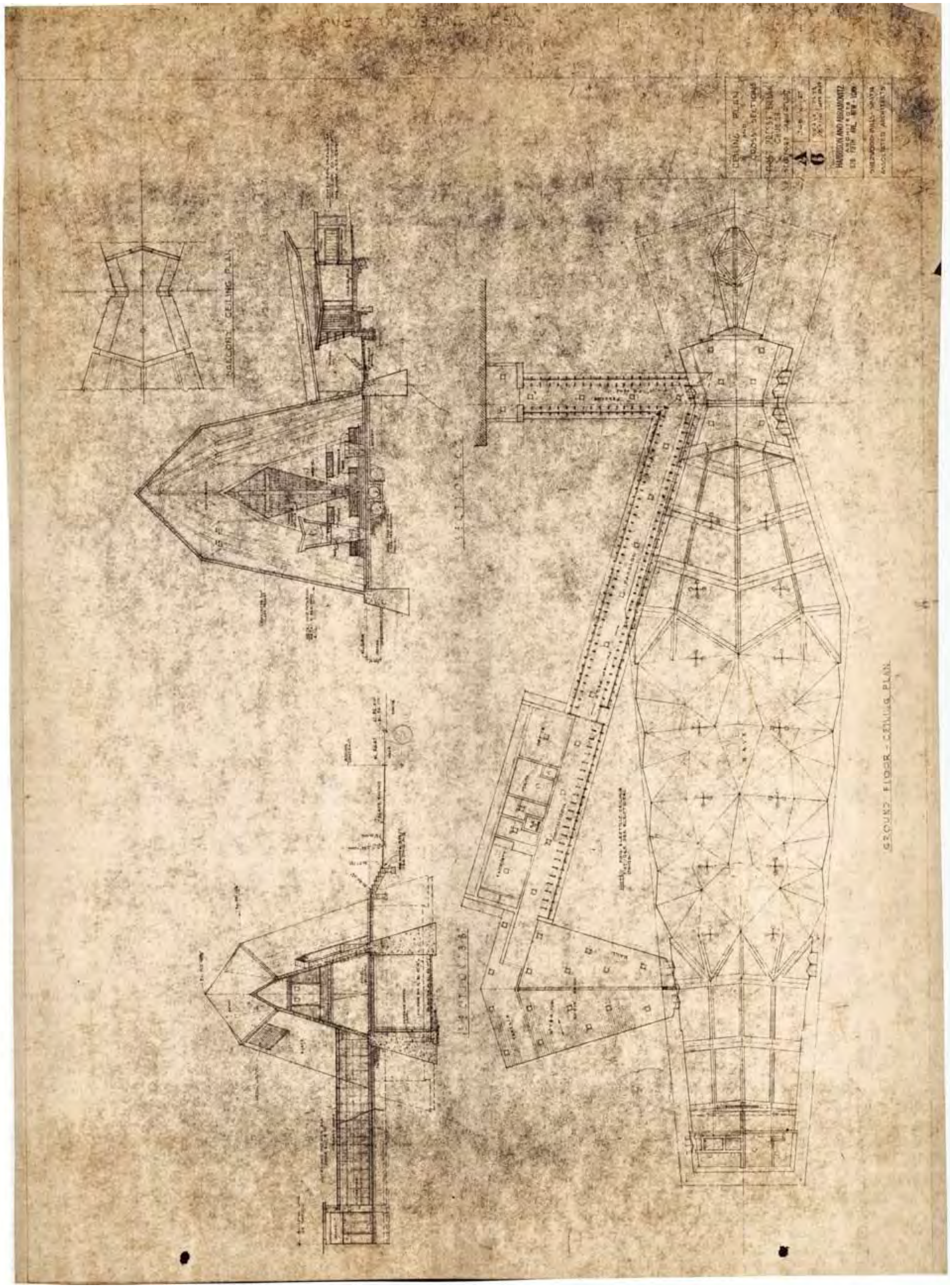

FIRST PRESBYTERIAN CHURCH
STAMFORD CONNECTICUT
BRYAN J. LYNCH
LANDSCAPE ARCHITECTS
HARRISON & ABRAMOVITZ
SHERWOOD, MILLS & SMITH
SCHEDULE OF DRAWINGS
PLOT PLAN

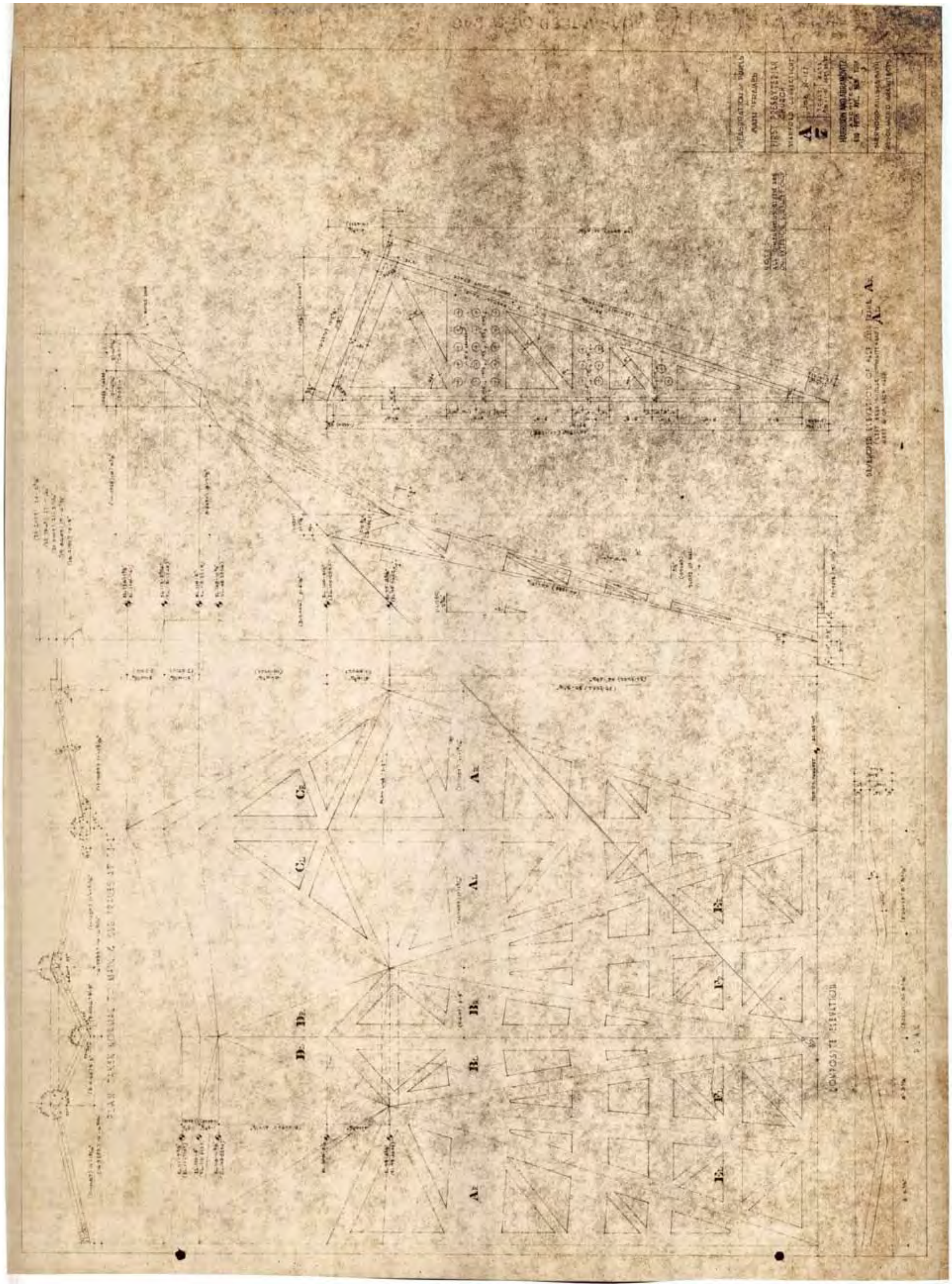

NORTH ELEVATION
A
2
HARRISON AND ABRAMOVITZ
ARCHITECTS

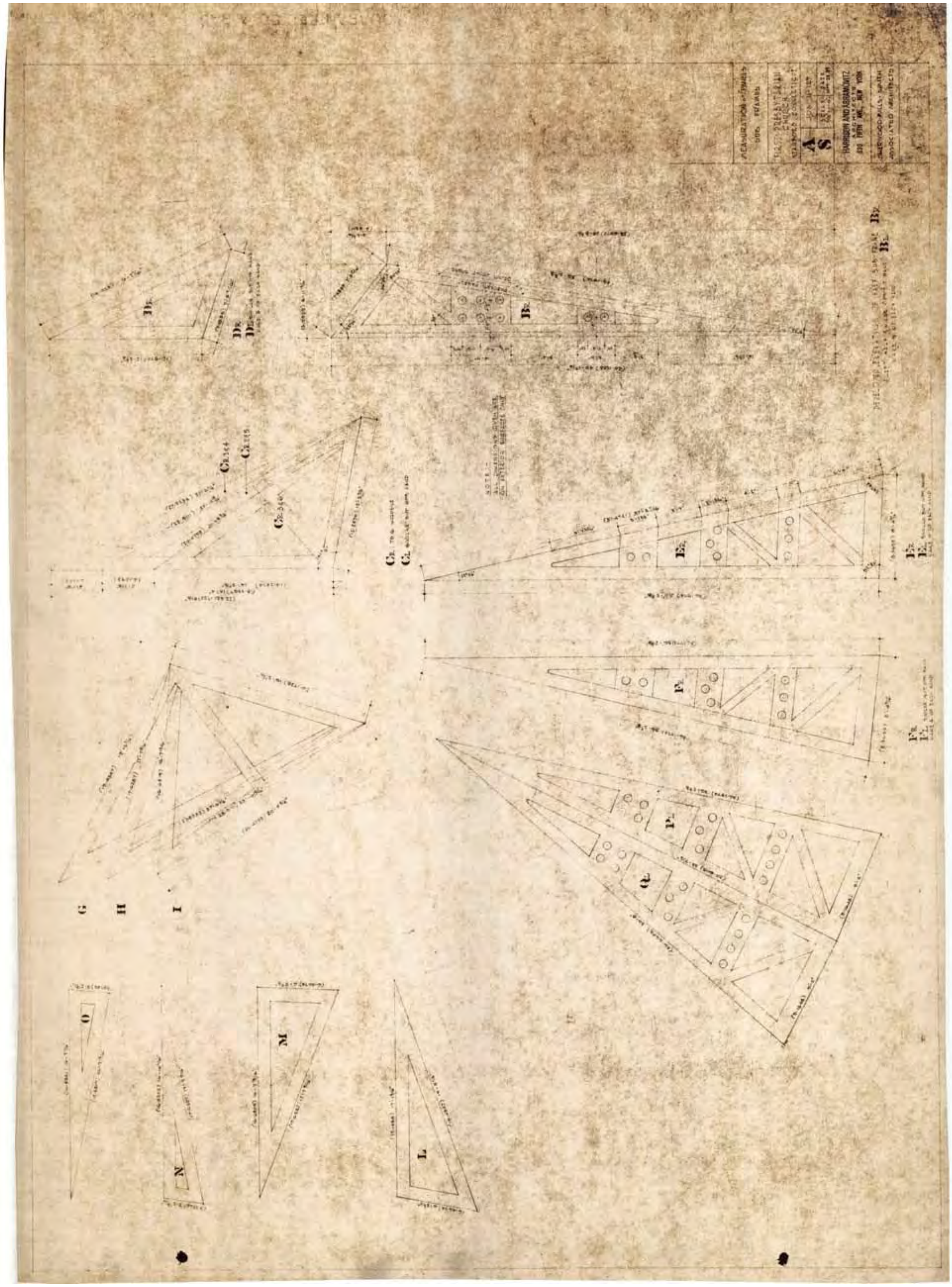


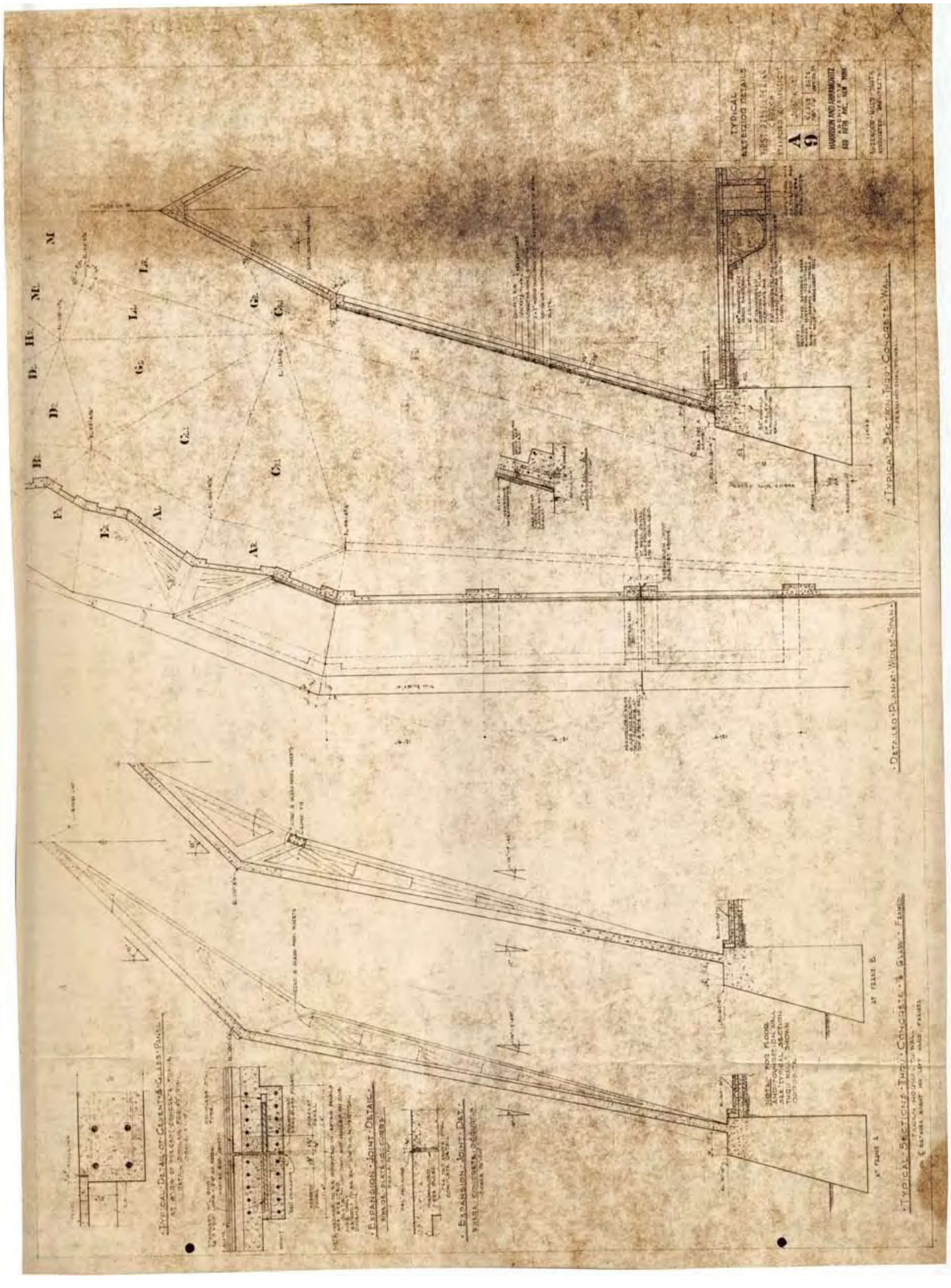

LONGITUDINAL SECTION
BALCONY PLAN
SECTION A-A

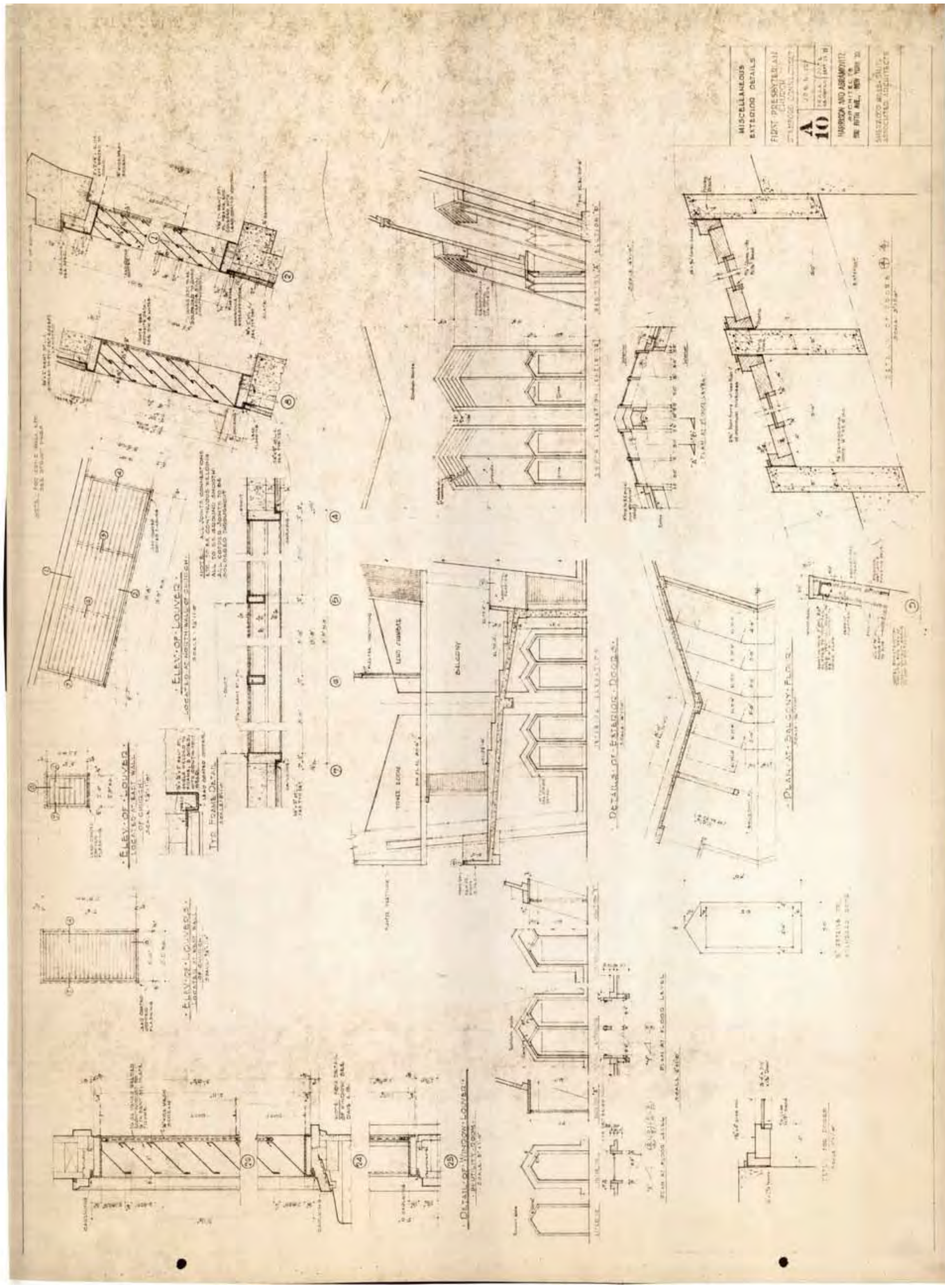


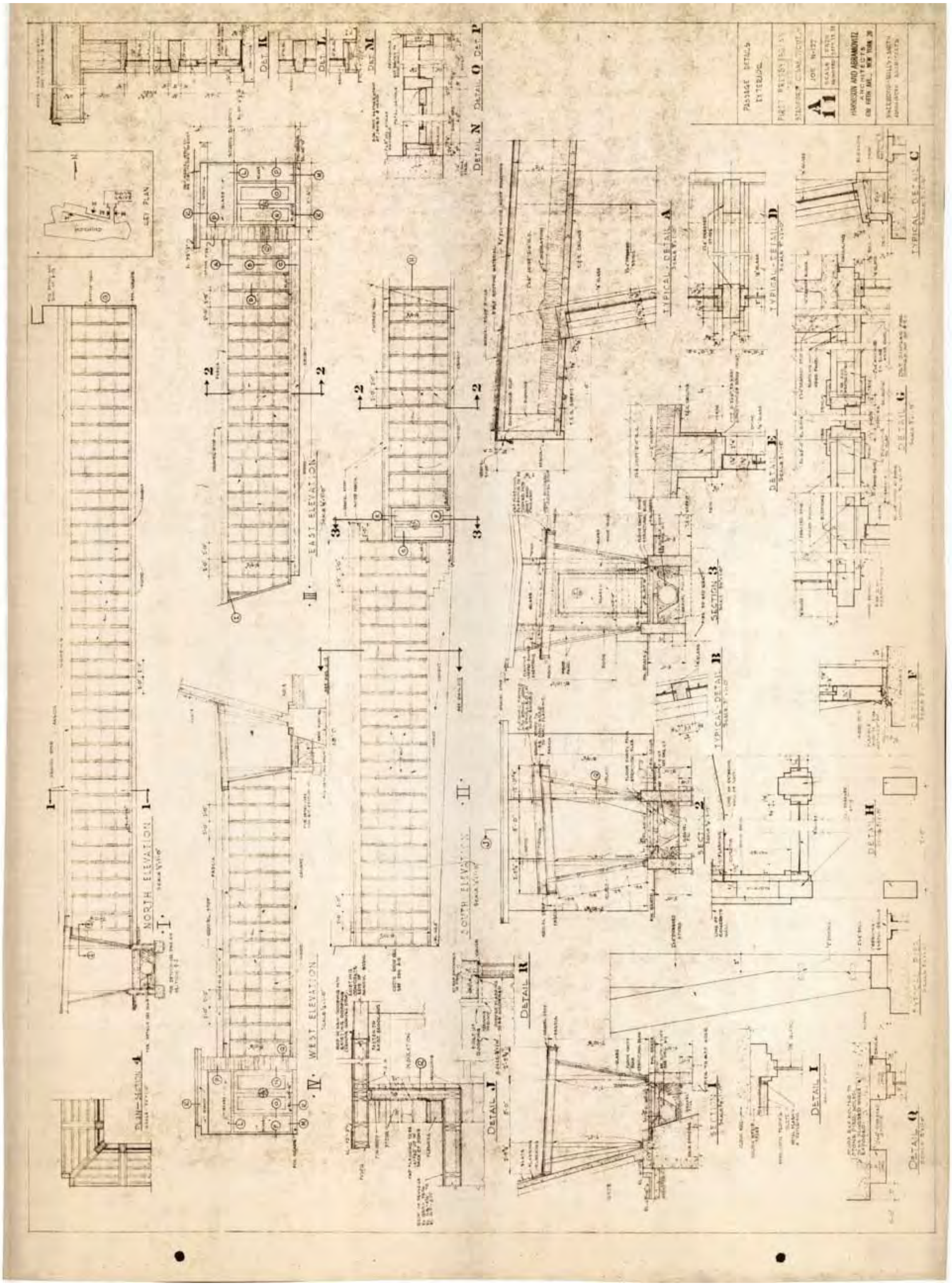

GROUND FLOOR - CEILING PLAN

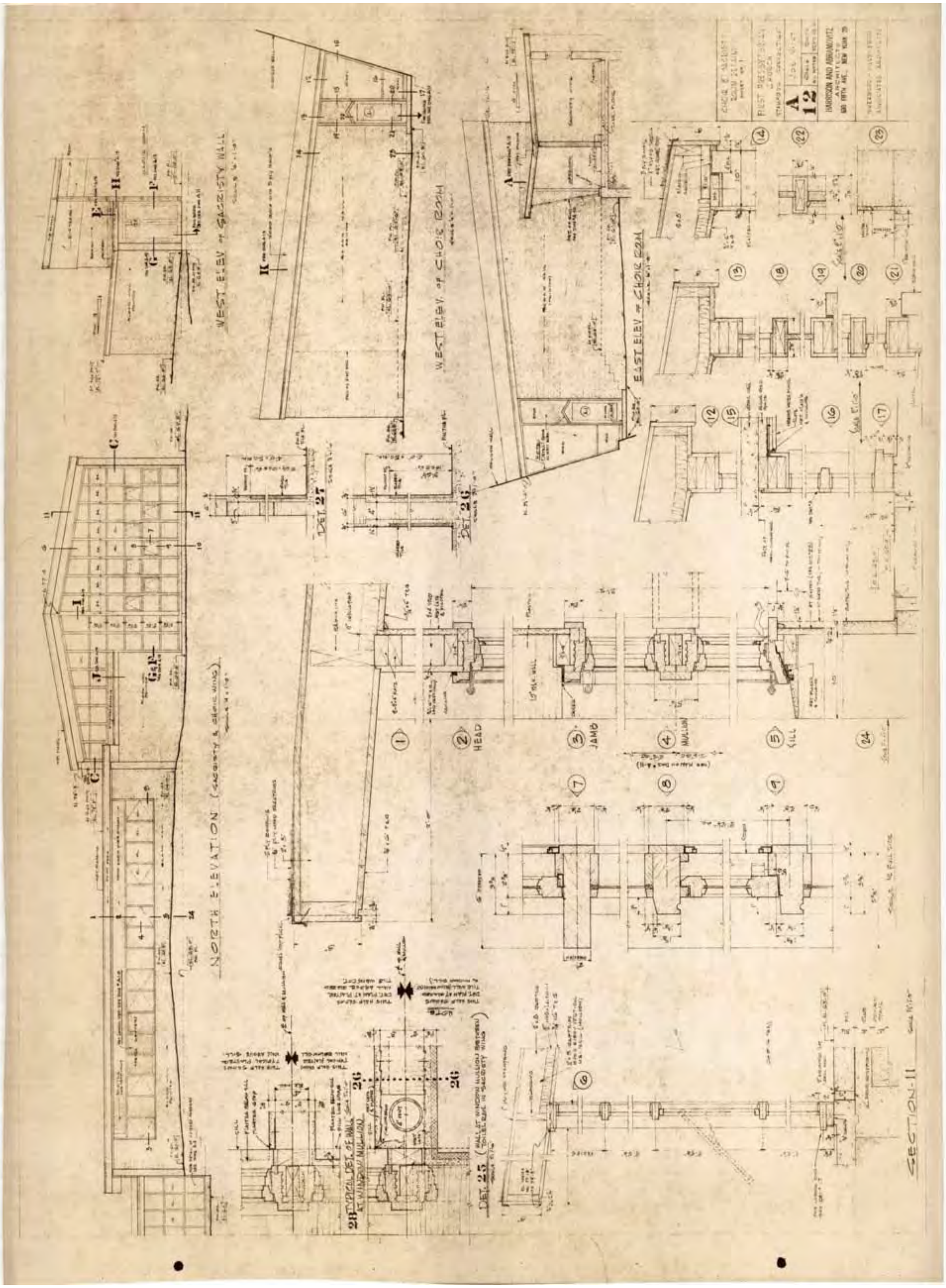


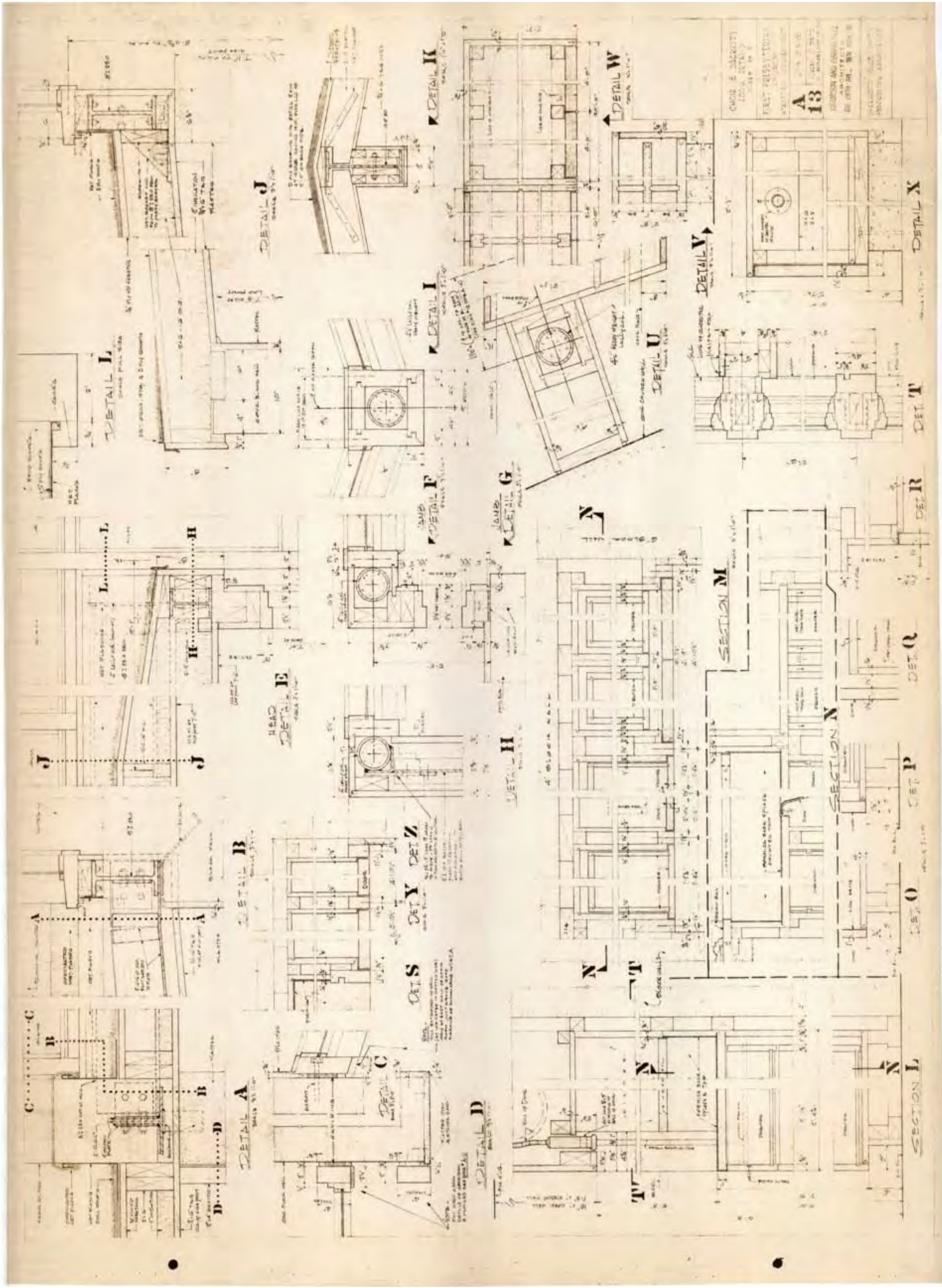



TYPICAL EXTERIOR DETAILS
A
9
HARRISON AND ABRAMOVITZ
TYPICAL SECTION THRU CONCRETE WALL
DETAILED PLAN AT WIDEST SPAN
TYPICAL SECTIONS THRU CONCRETE & GLASS PANEL
EXPANSION JOINT DETAIL




NORTH ELEVATION
EAST ELEVATION
WEST ELEVATION
SOUTH ELEVATION
TYPICAL DETAIL A
TYPICAL DETAIL B
TYPICAL DETAIL C
TYPICAL DETAIL D
SECTION 3
DETAIL E
DETAIL F
DETAIL G
DETAIL H
DETAIL I
DETAIL J
DETAIL N
DETAIL Q
DETAIL R
KEY PLAN
A
11


NORTH ELEVATION (SACRISTY & CHOIR WING)
WEST ELEV OF SACRISTY WALL
WEST ELEV OF CHOIR ROOM
EAST ELEV OF CHOIR ROOM
SECTION II
HEAD
JAMB
MULLION
SILL
A
12
HARRISON AND ABRAMOVITZ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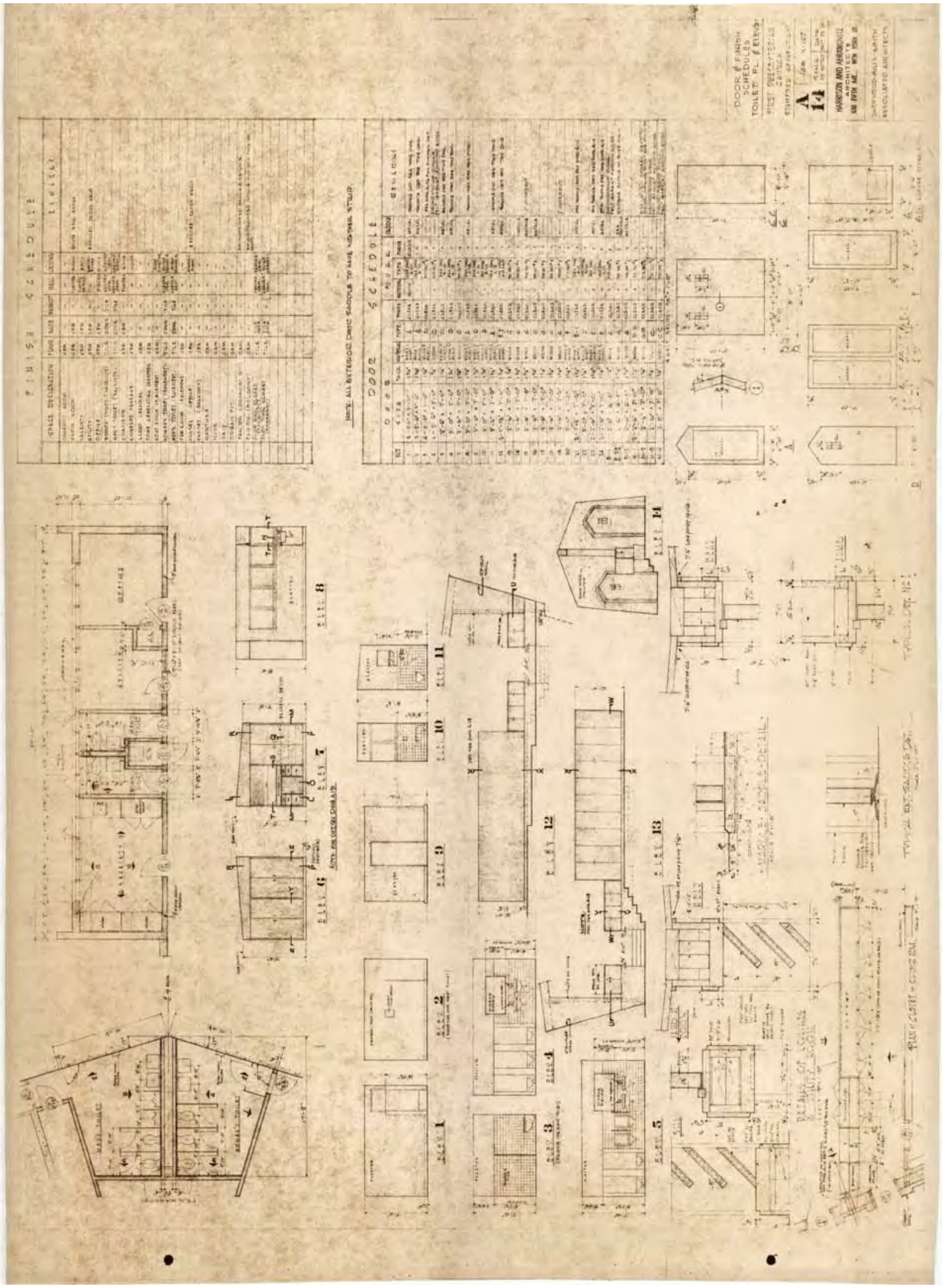

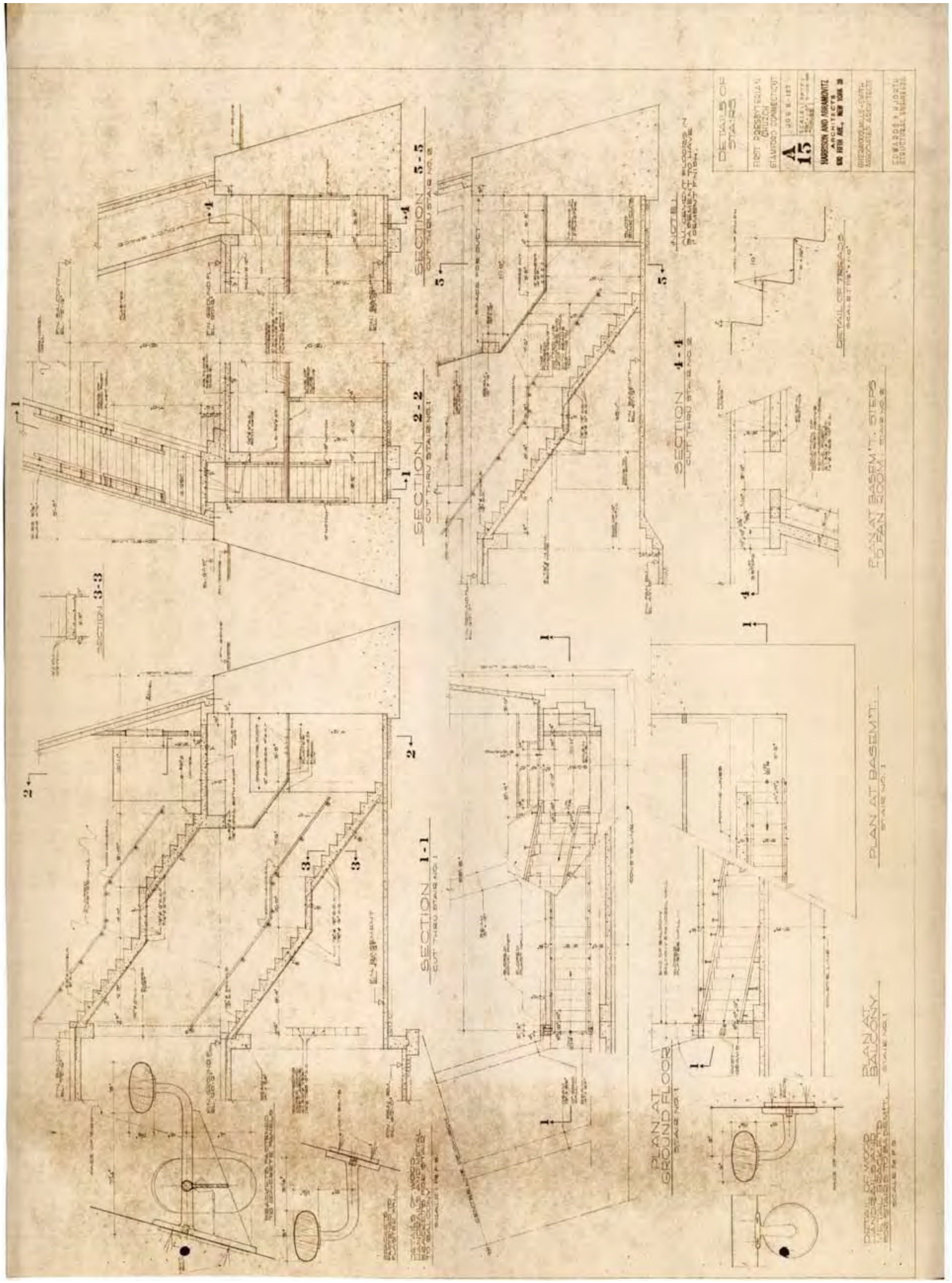
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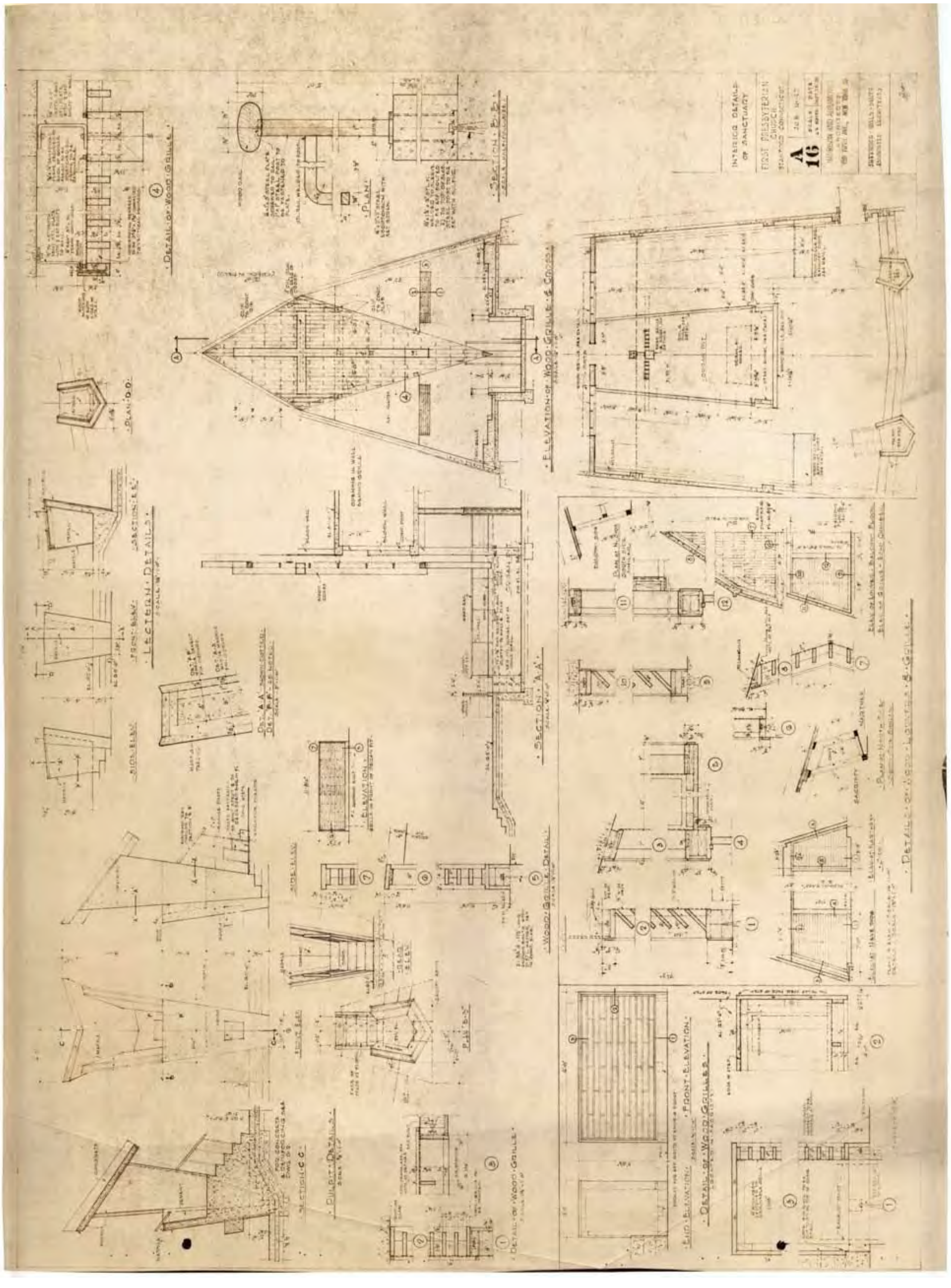

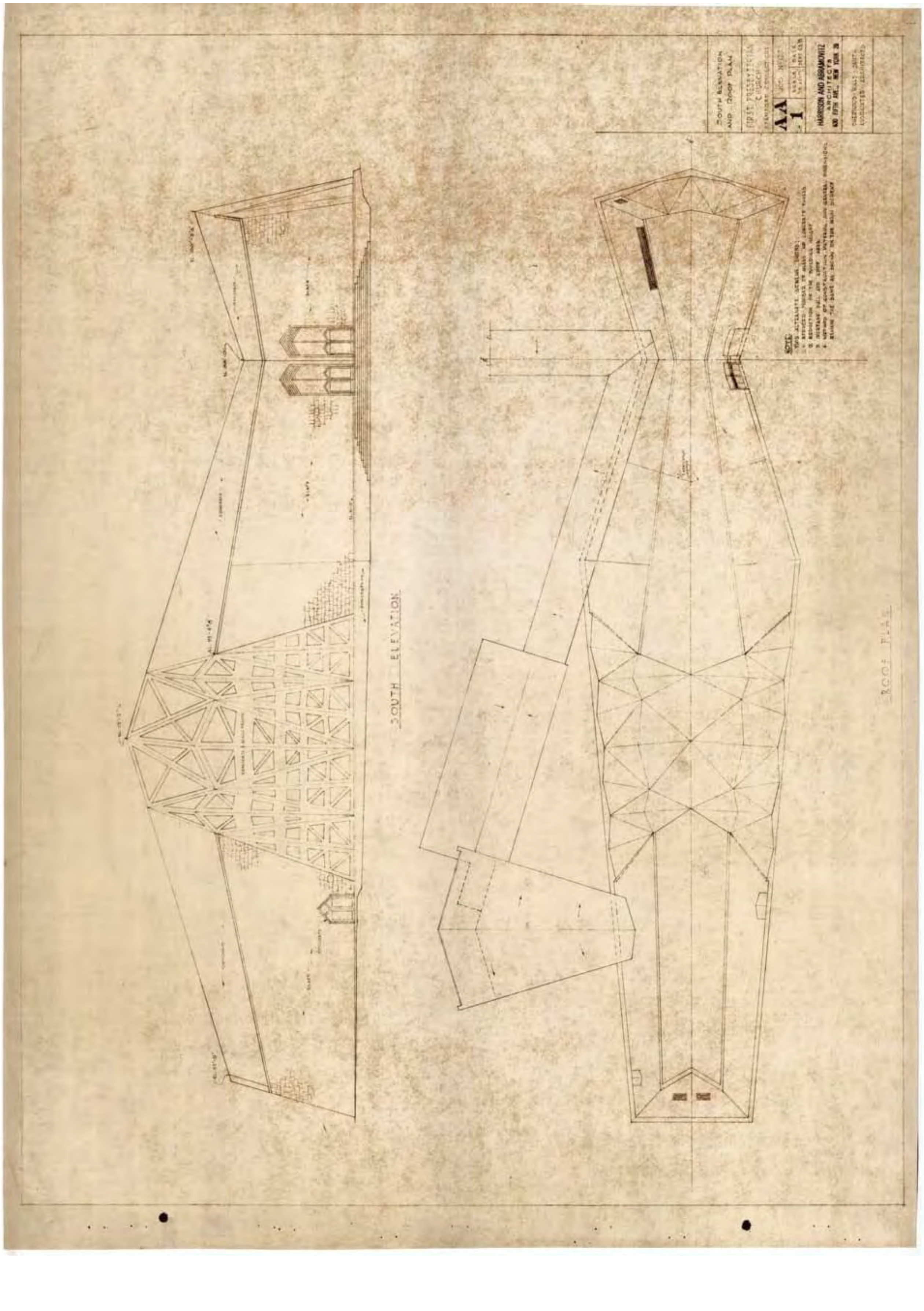
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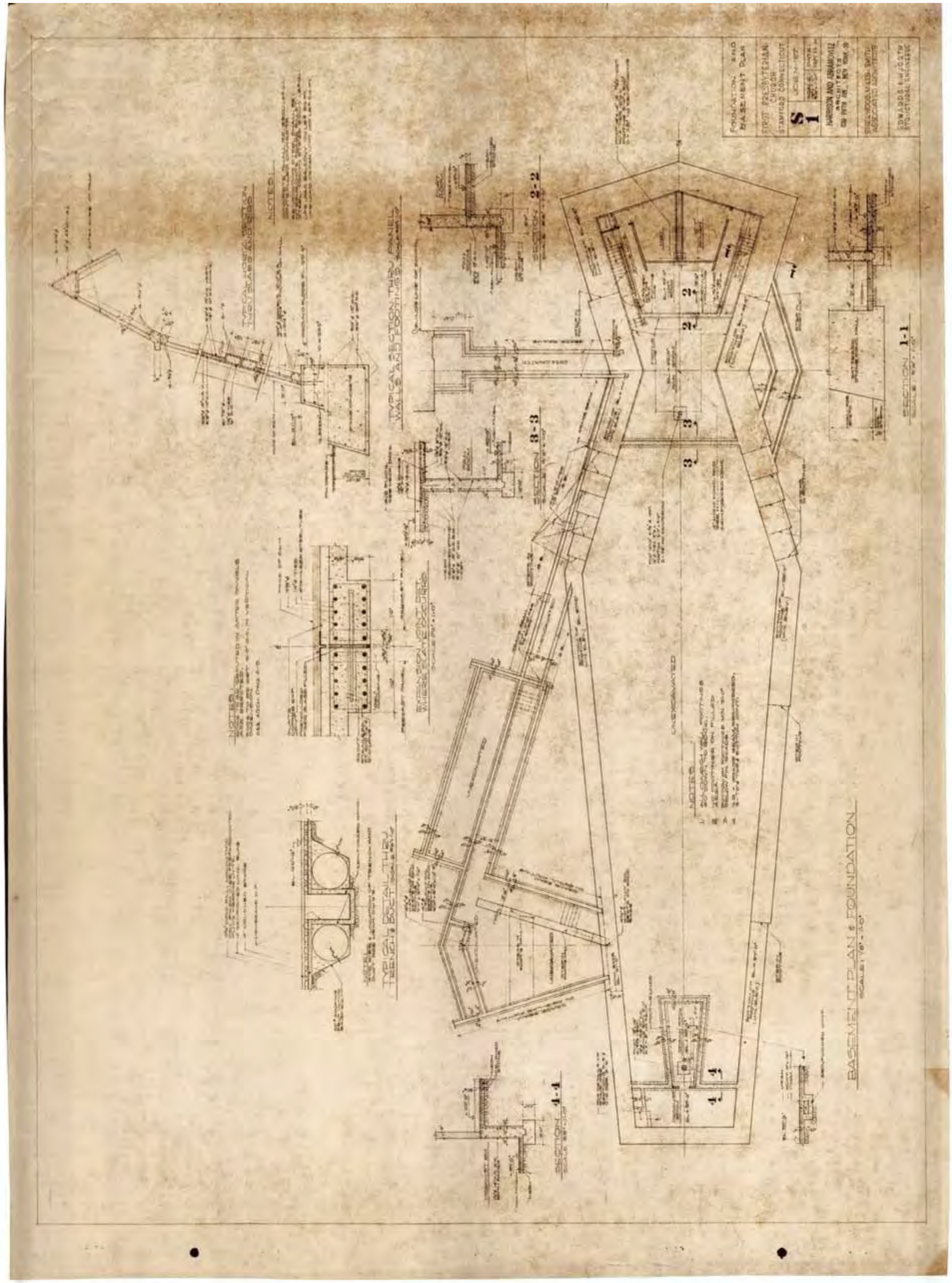
ROOF PLAN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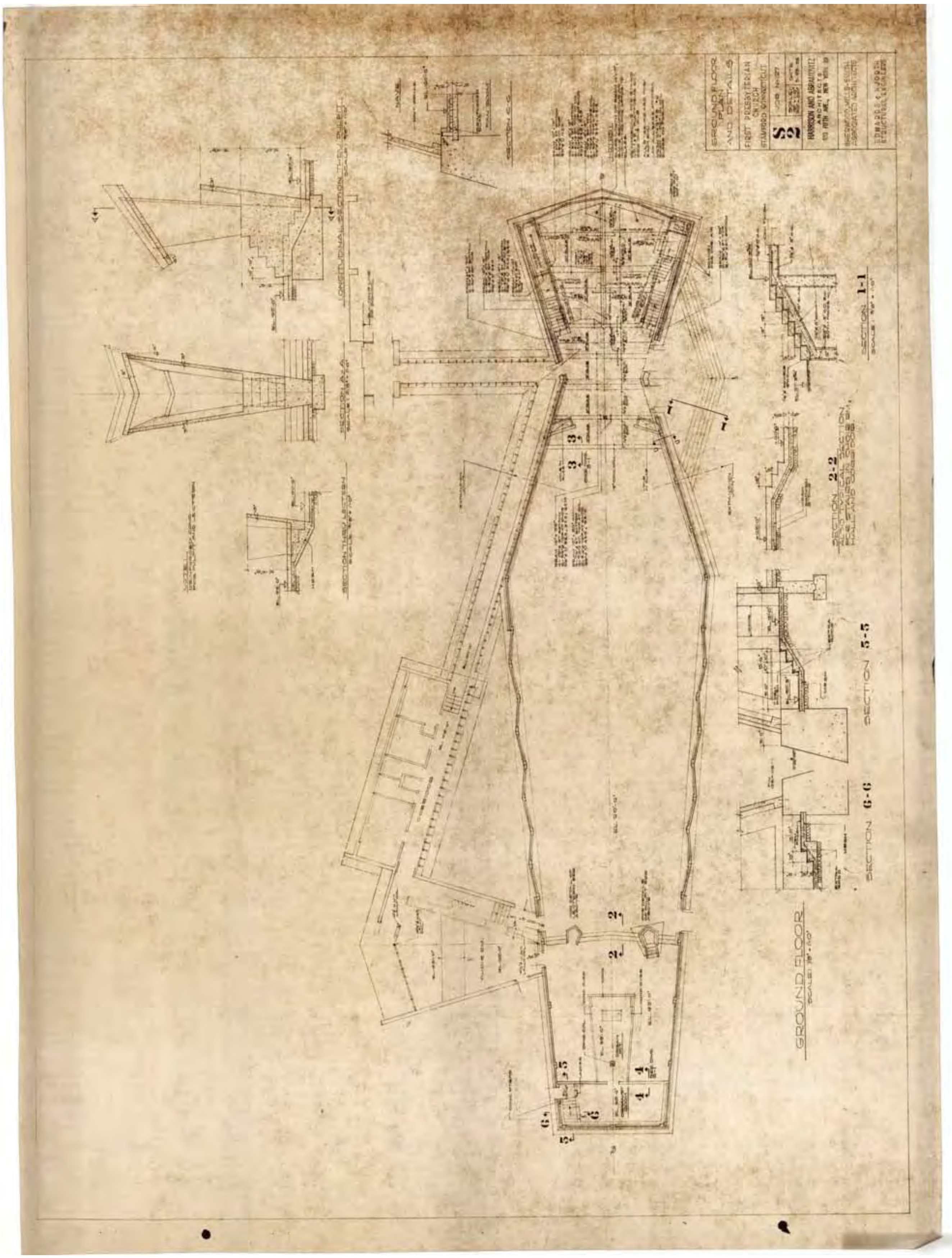
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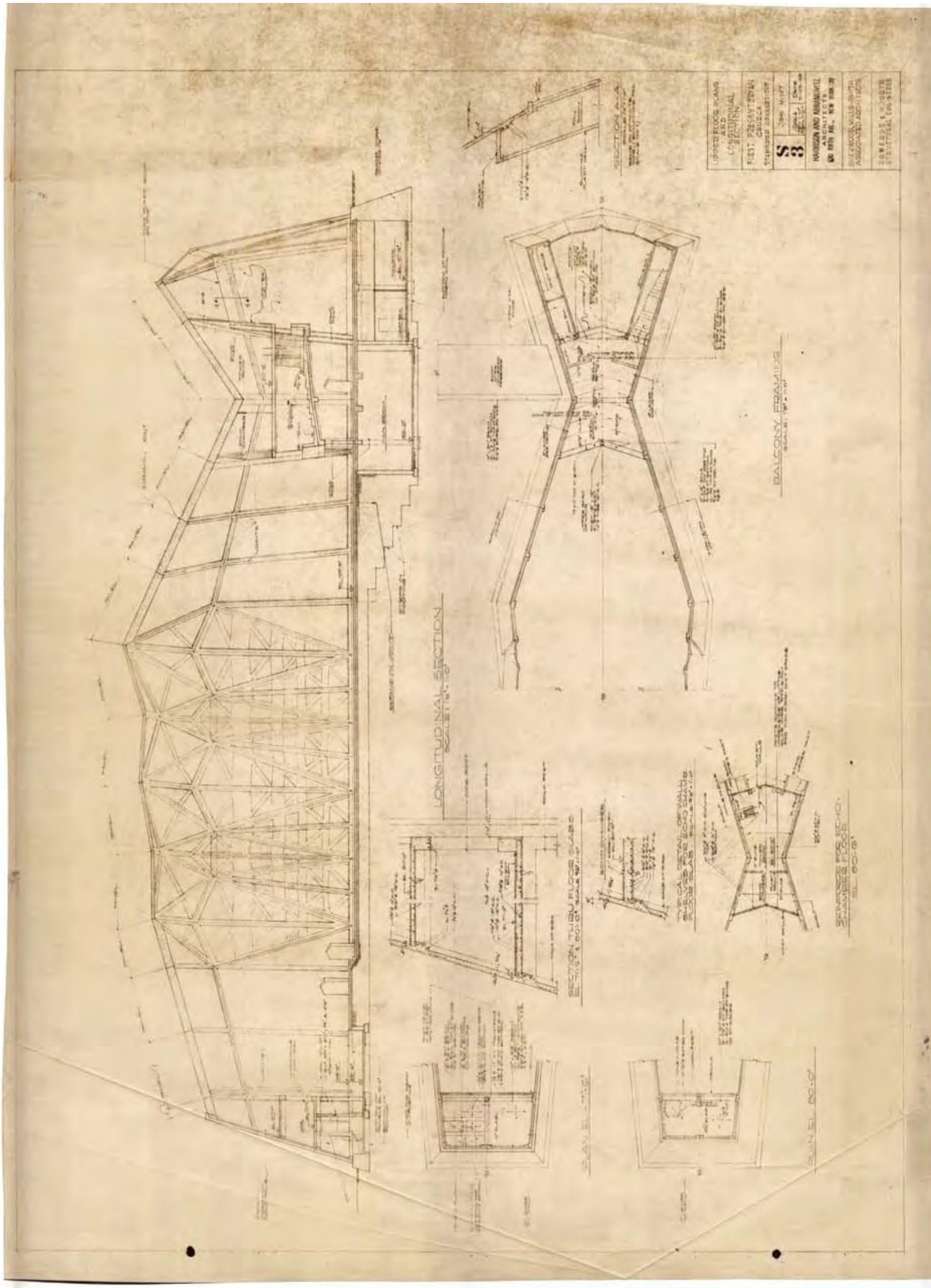
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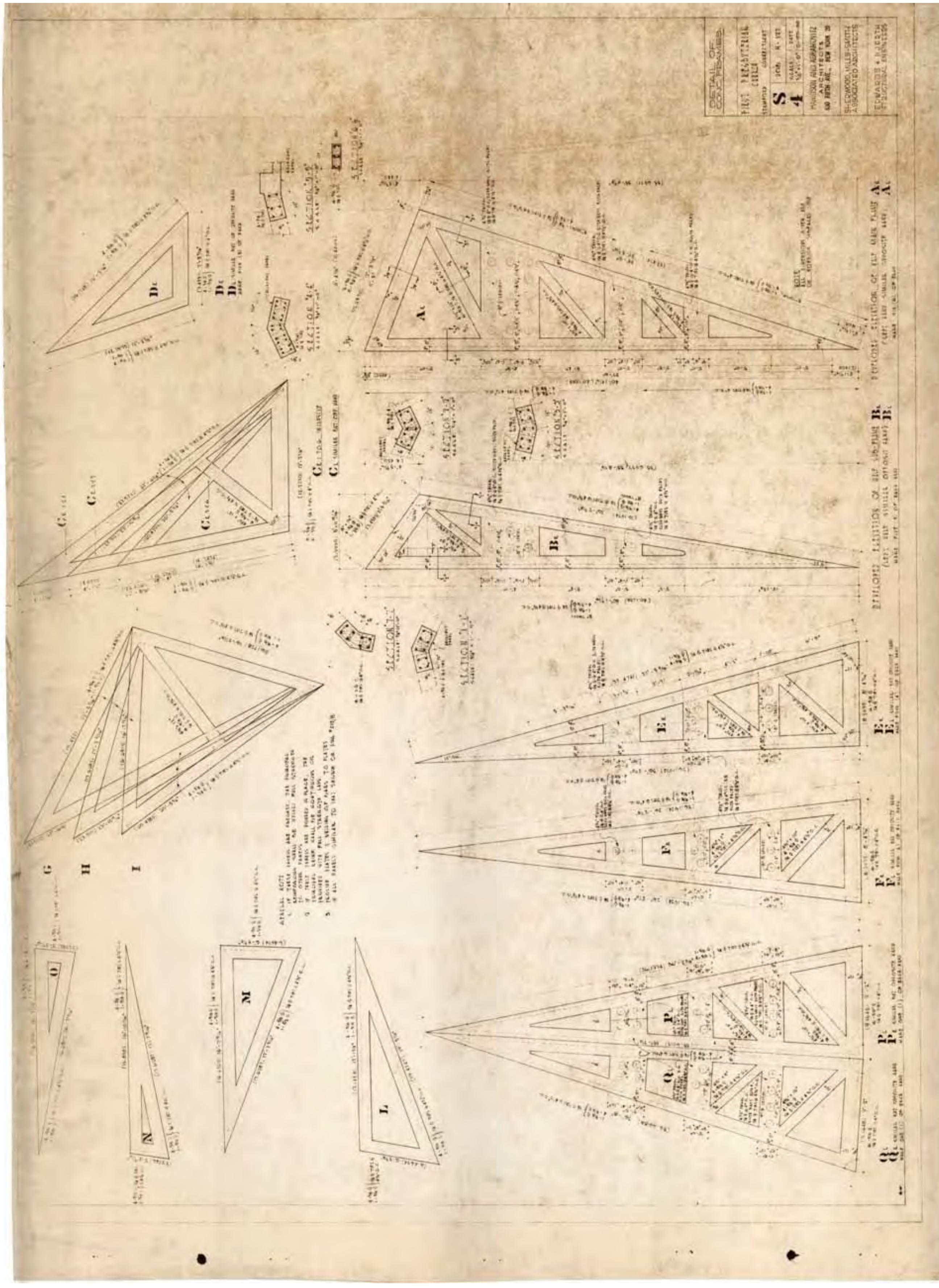

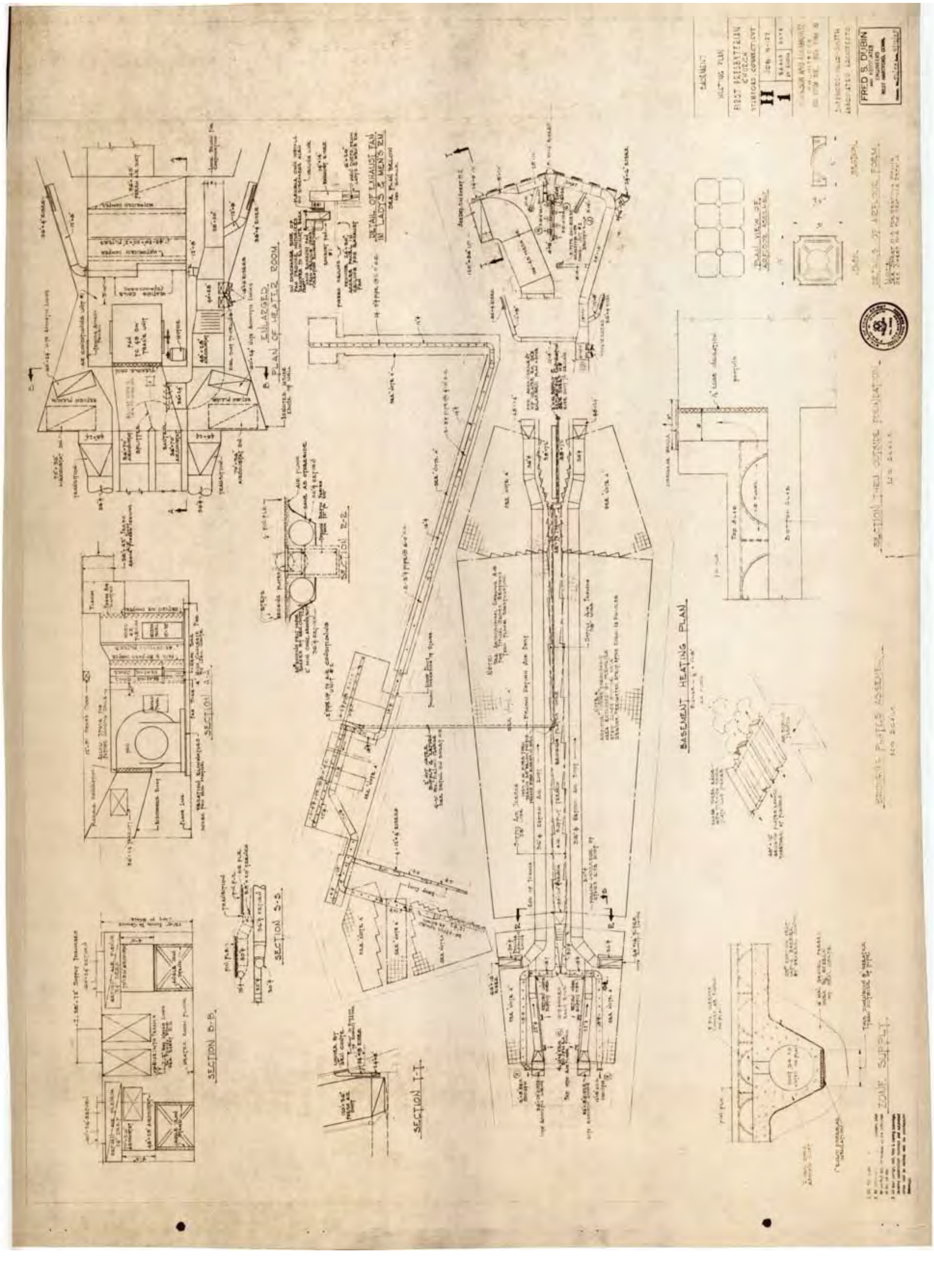
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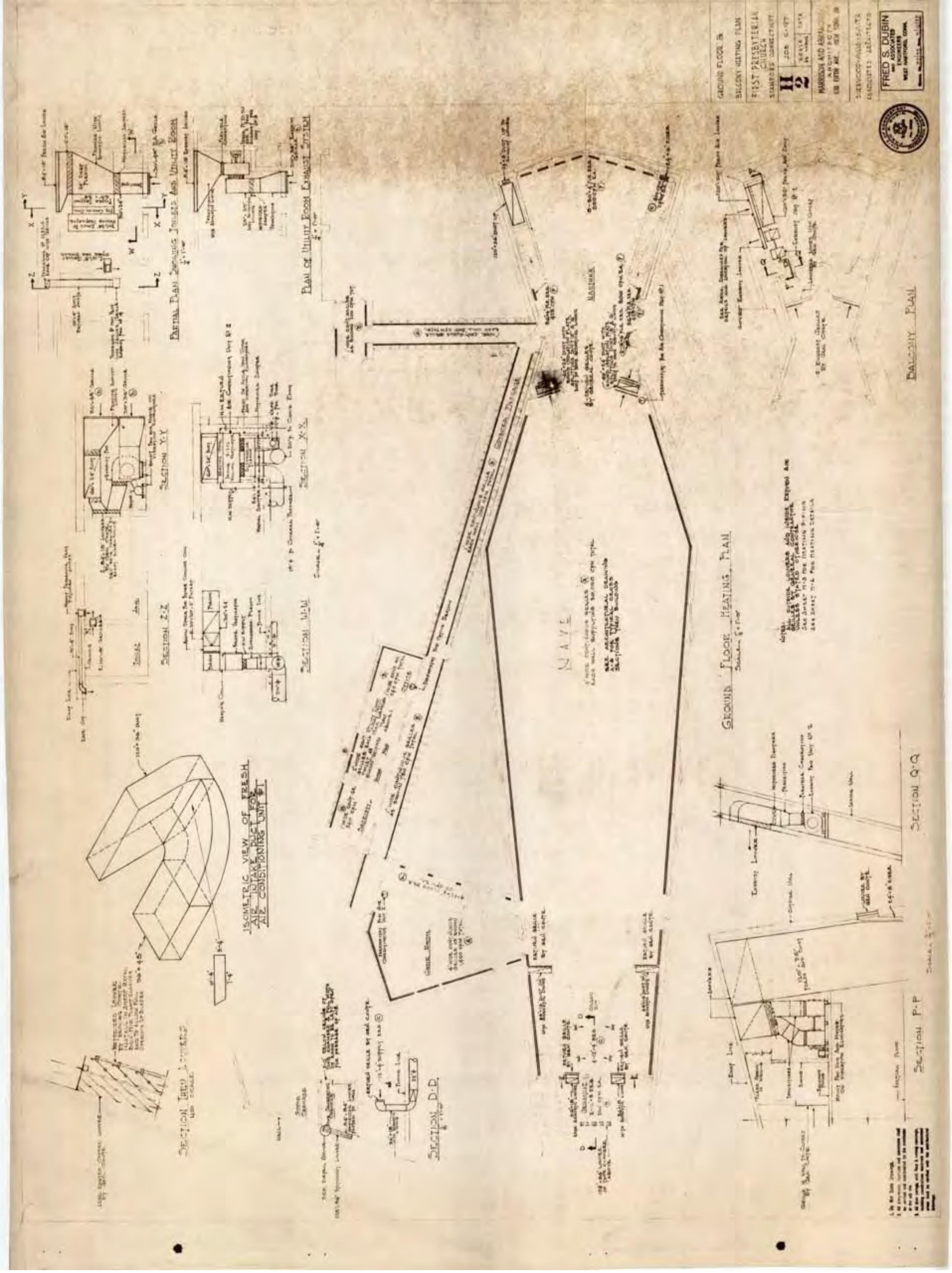
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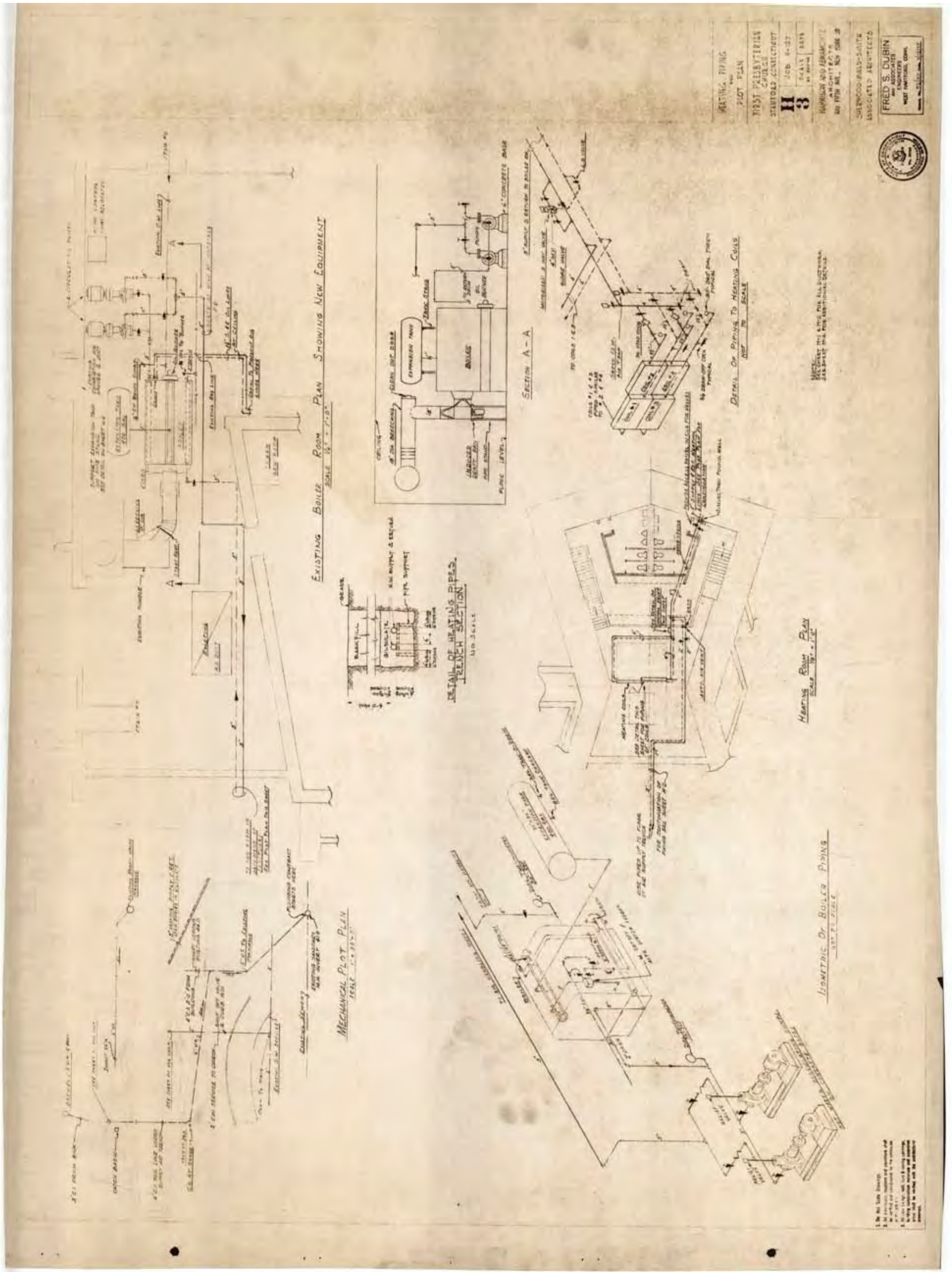
Plan of Utility Room Exhaust System
First Presbyterian Church
Fred S. Dubin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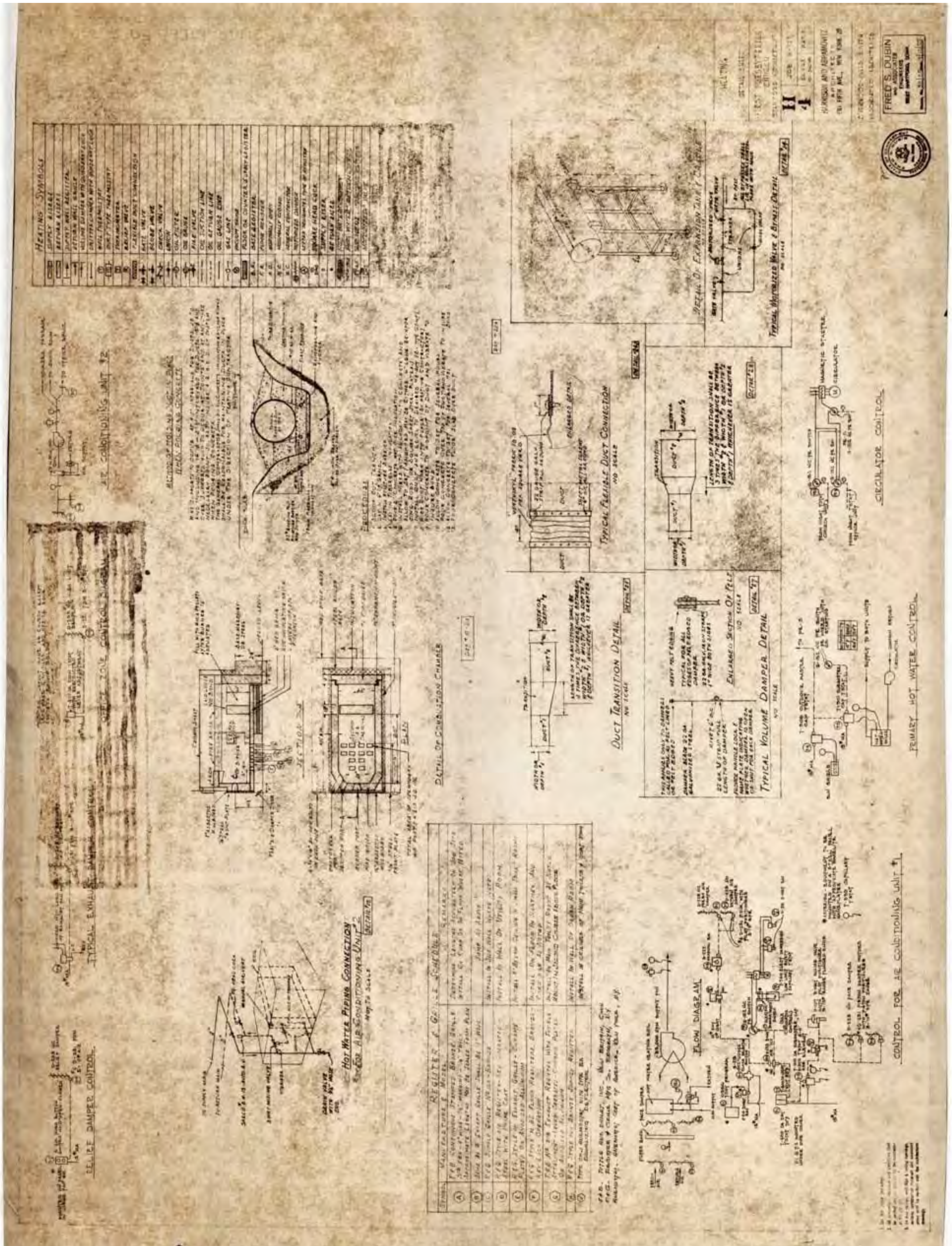
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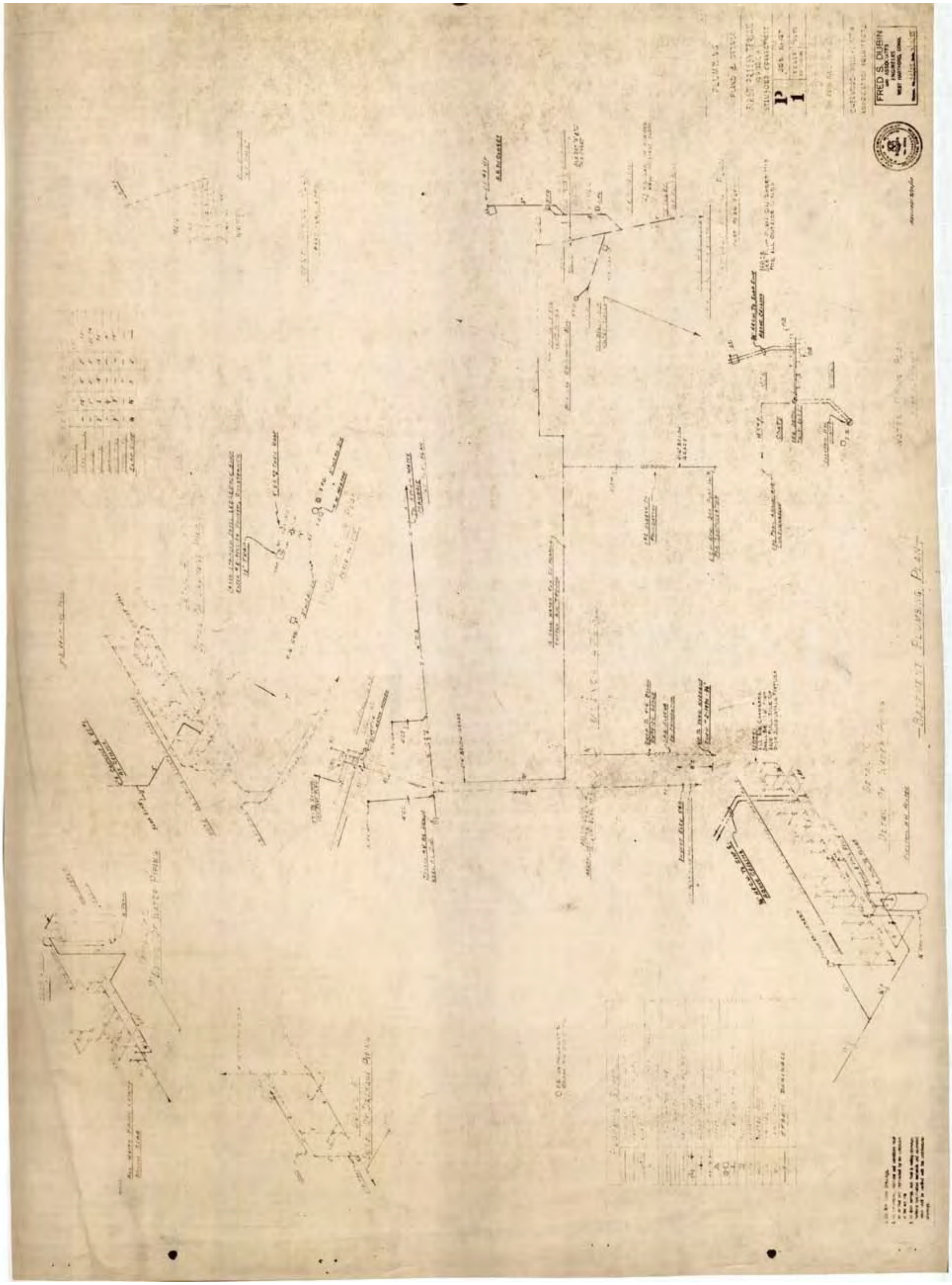
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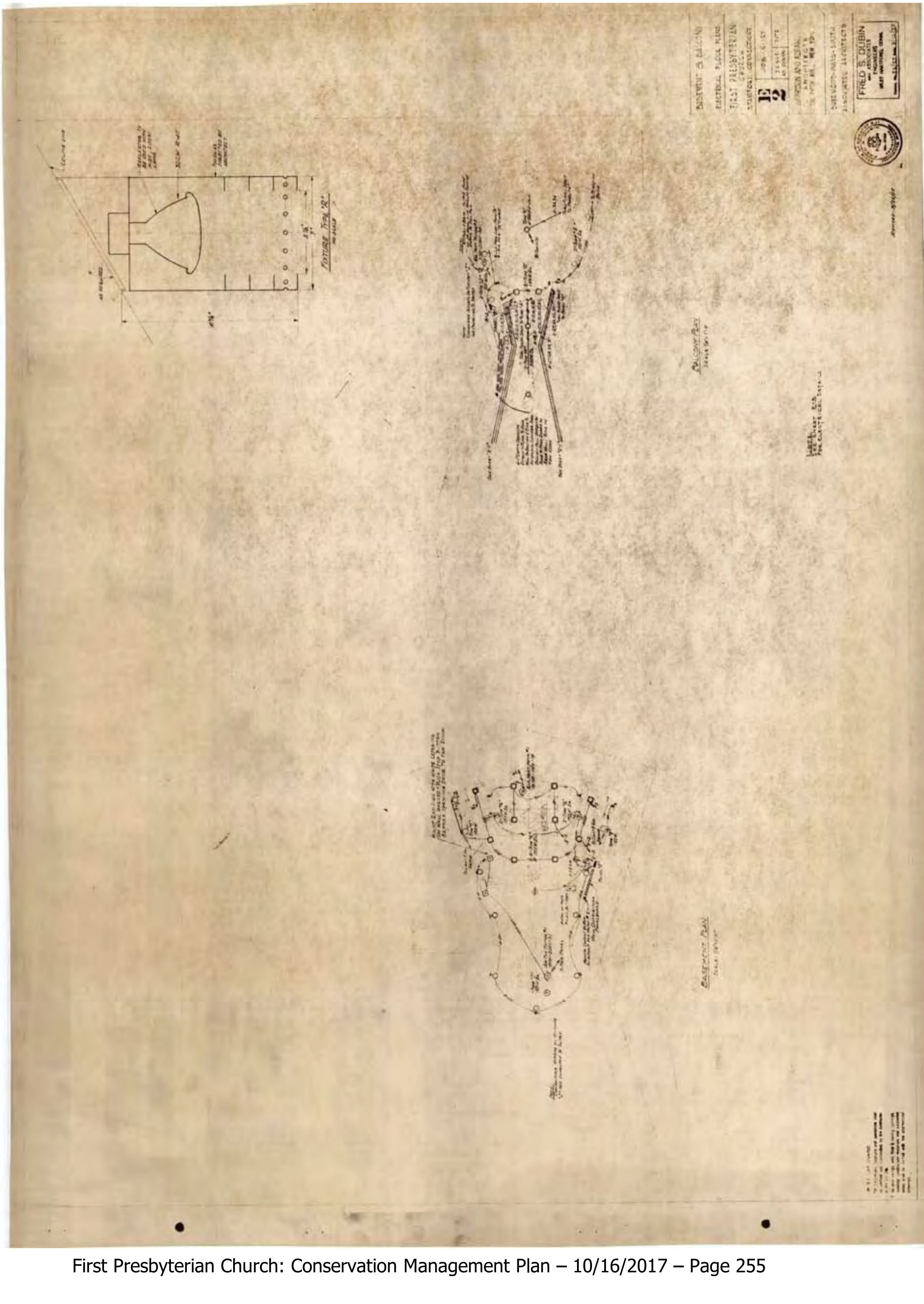
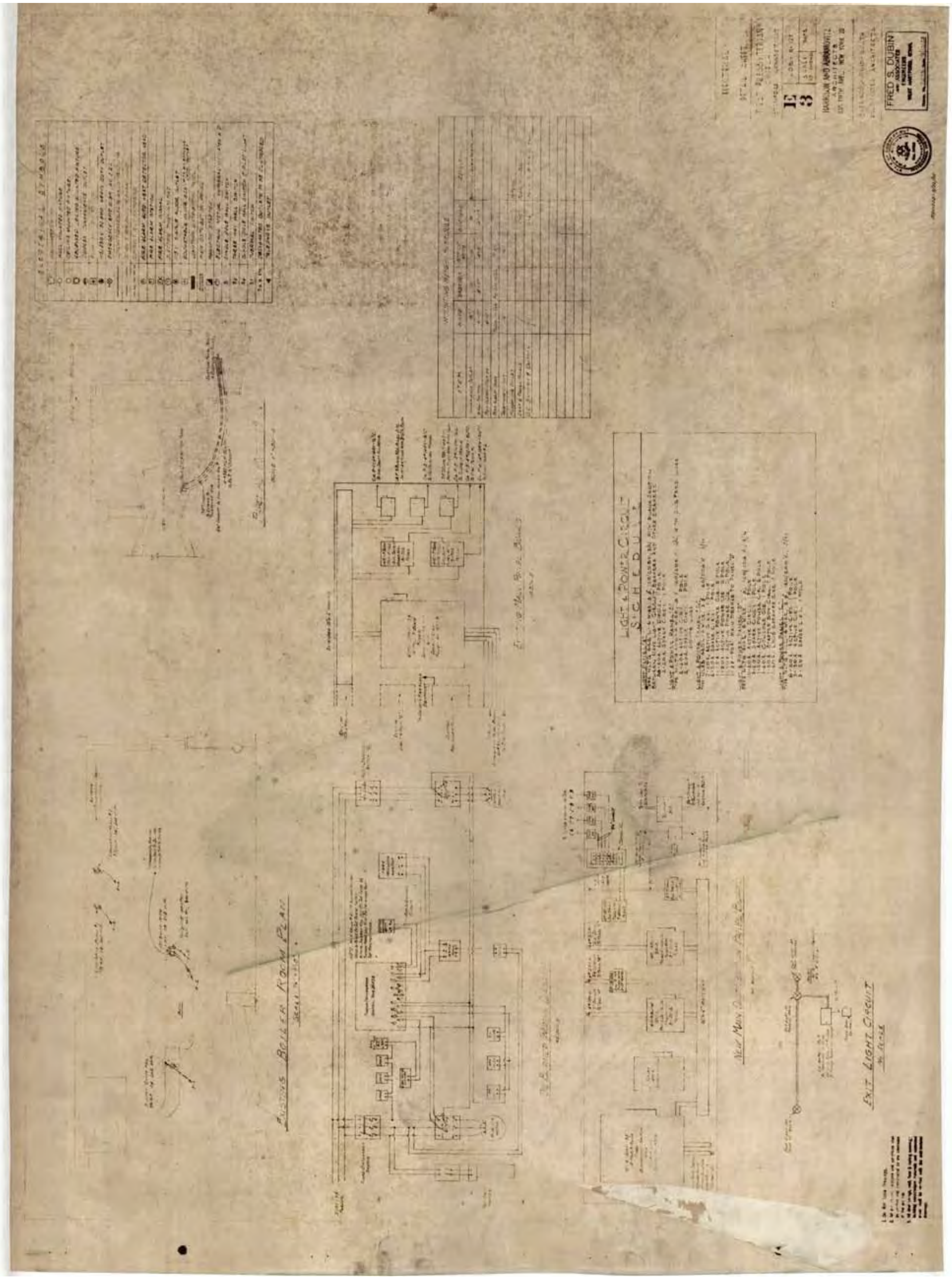
TYPE 'A' FIXTURE DETAILS
FRED S. DUBIN



BALCONY PLAN
BASEMENT PLAN
FIRST PRESBYTERIAN CHURCH
FRED S. DUBIN



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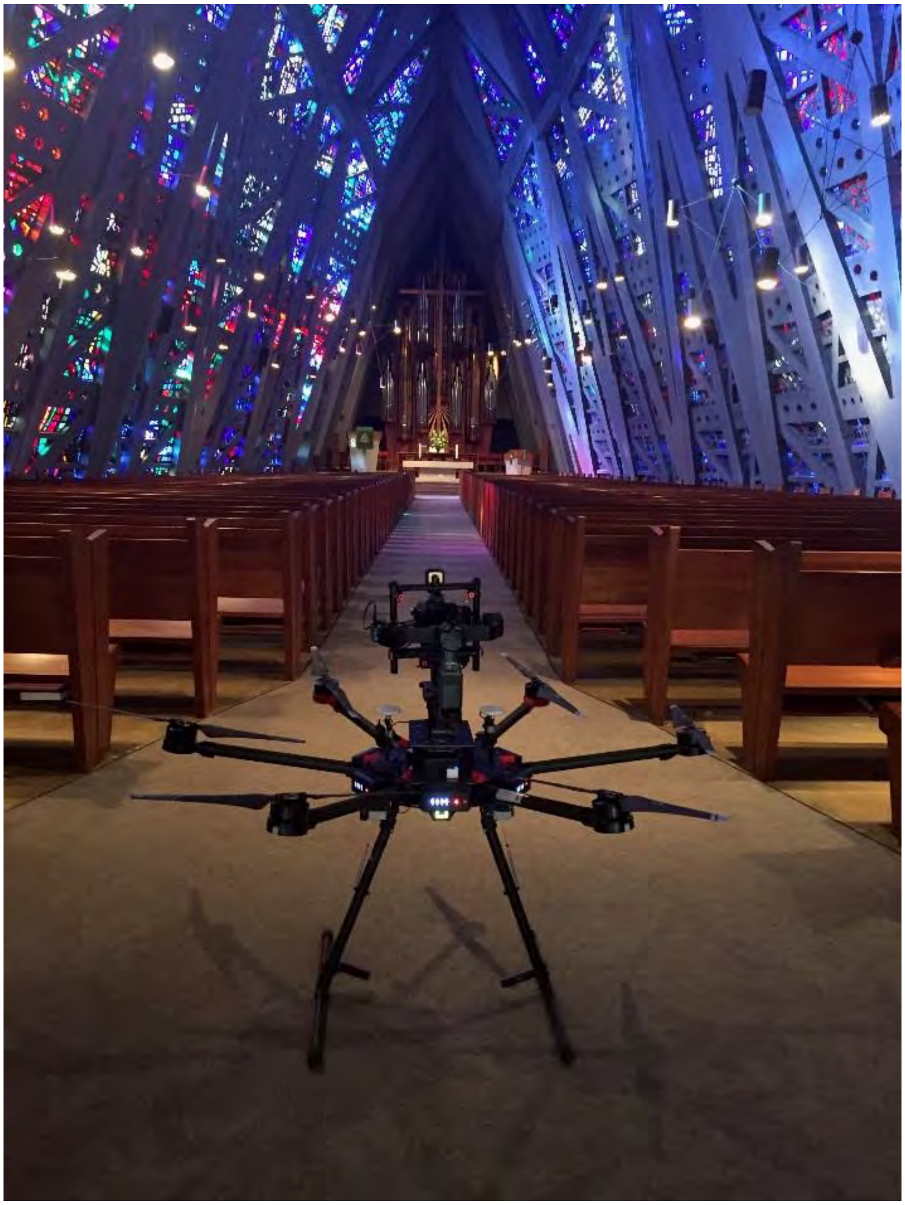
Appendix 3 Select Drone Survey Images



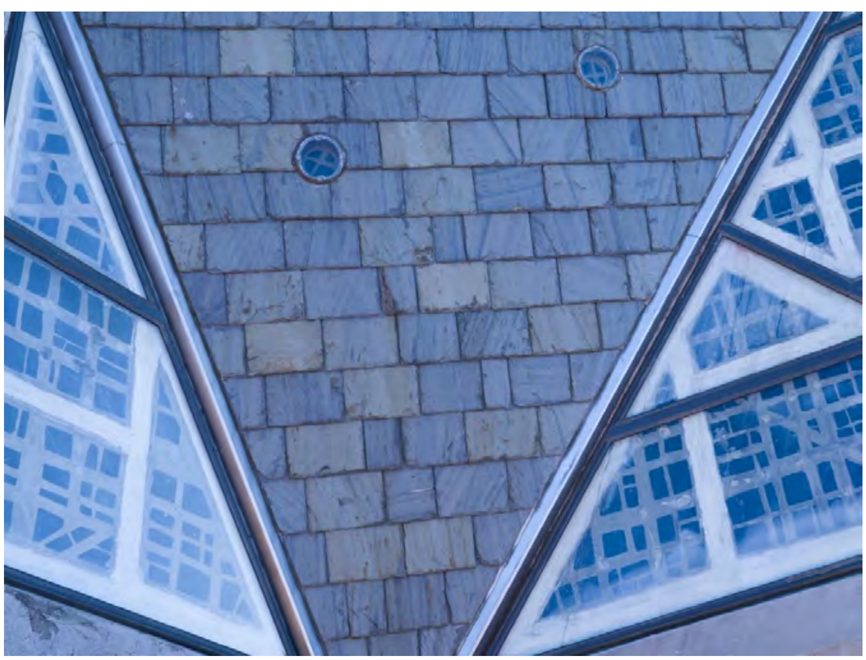
Sony A7R II (42-megapixal camera with a 50-mm lens) mounted on a DJI Matrice 600 drone; positioned at the rear of the nave facing the chancel.
Photo by Prudon & Partners, November 2016.

Above: Aerial image of the Sanctuary, corridor, choir room, and connecting link.
Photo by Propellerheads, November 2016.

Below: Aerial image of the Sanctuary, showing slate roof and protective glazing installed over roof *dalle de verre*.
Photo by Propellerheads, November 2016.

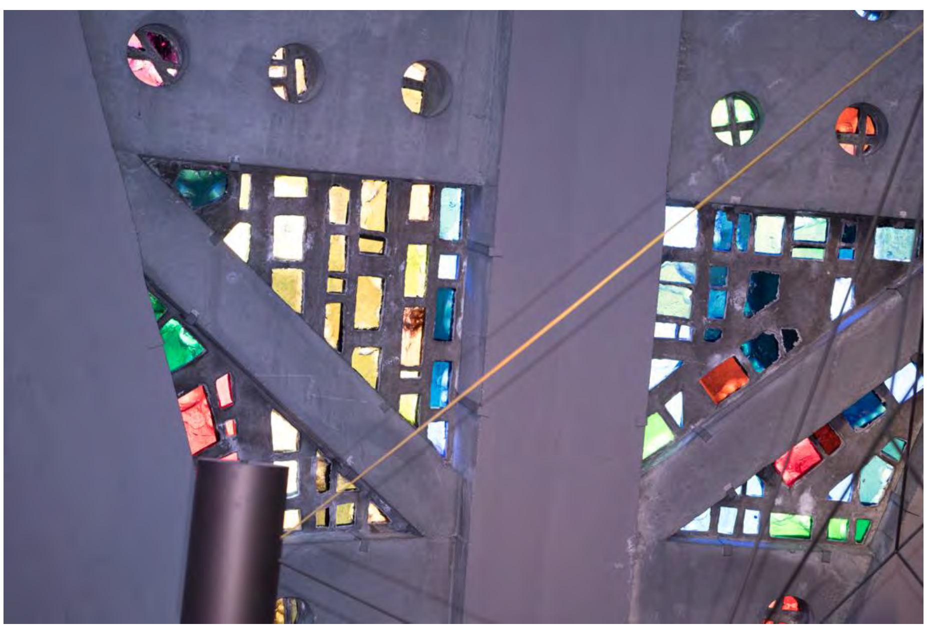
Above: Aerial image of the east elevation (narthex), panel E1, showing replacement *dalle de verre* in epoxy matrix.
Photo by Propellerheads, November 2016.

Below: Aerial image of the north elevation (nave), between panels N21 and N20, showing condition of roof slate, original *dalle de verre* in concrete matrix with secondary glazing, and *dalle de verre* portals.
Photo by Propellerheads, November 2016.



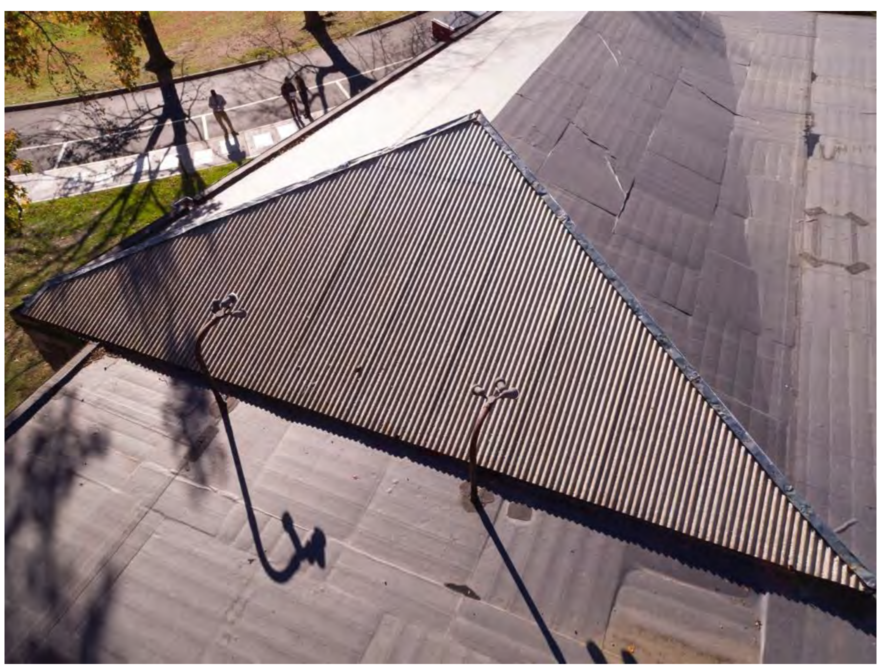
Above: Interior image of the south elevation (nave), panel S7C, showing efflorescence on the poured-in-place concrete, condition of replacement *dalle de verre* in epoxy matrix.
Photo by Propellerheads, November 2016.

Below: Interior image of the north elevation (nave), panel N9C, showing condition of the original *dalle de verre* in concrete matrix, original suspended lights in foreground.
Poto by Propellerheads, November 2016.



Above: Interior image of the east elevation (narthex), panels E5 and E6, showing condition of the replacement *dalle de verre* in epoxy matrix and condition of the poured-in-place concrete.
Photo by Propellerheads, November 2016.

Below: Image of the exterior of the chapel, showing condition of the original corrulux protective material and lighting.
Photo by Propellerheads, November 2016.



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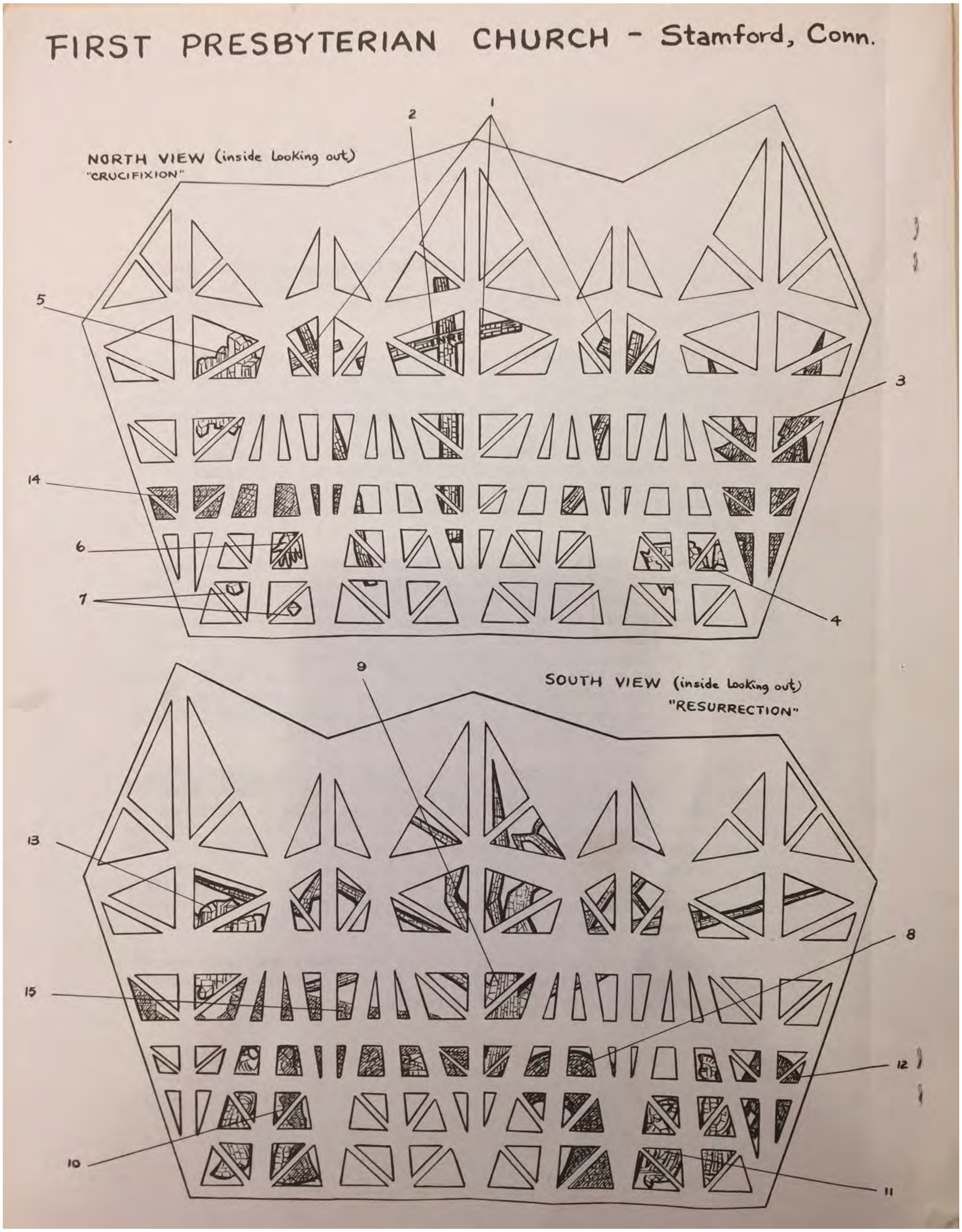


Figure 1: Interior north and south views of the *dalle de verre* scenes in the nave of the Sanctuary. From a Church pamphlet (n.d.)

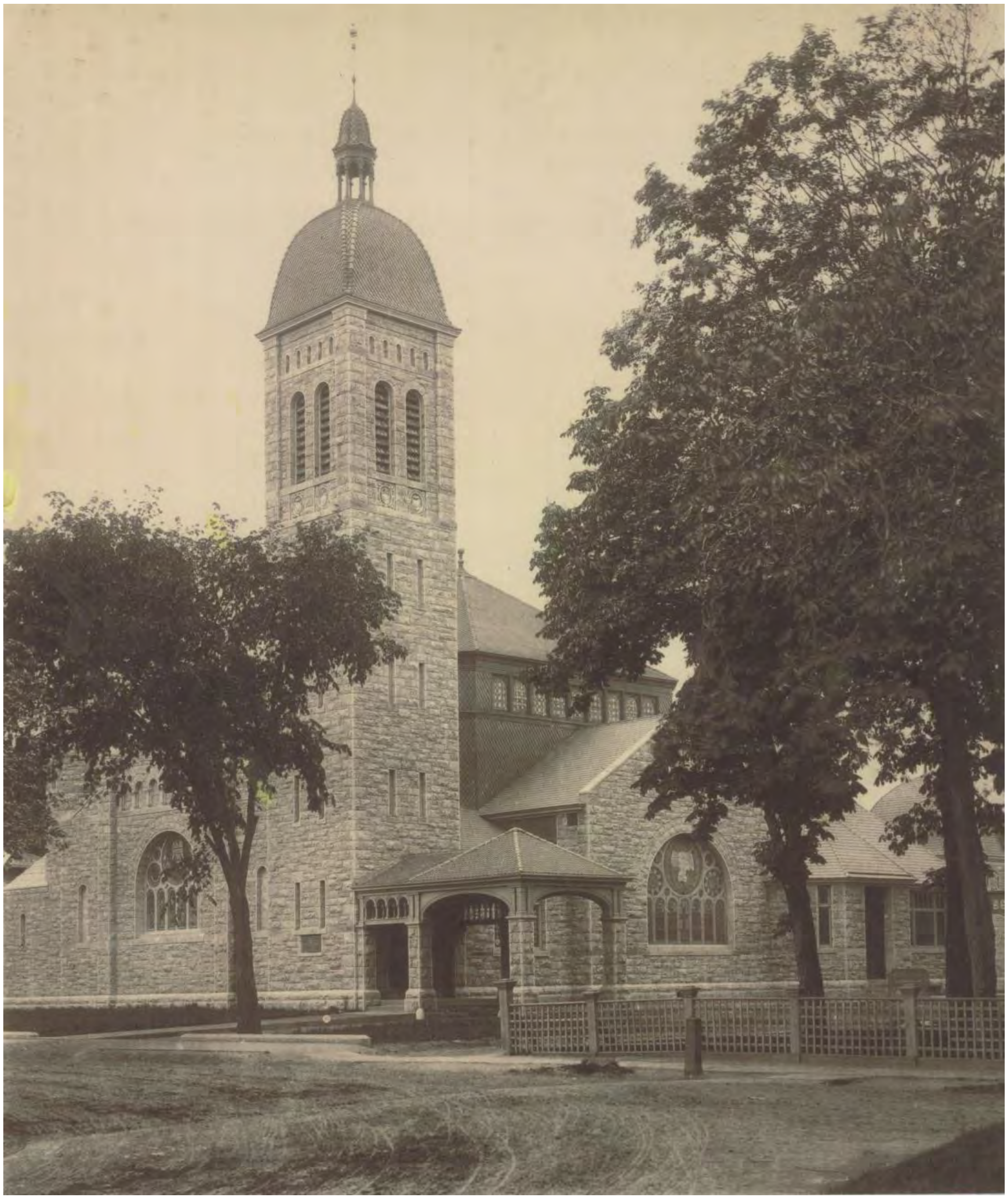


Figure 2: First Presbyterian Church on Broad Street with bell tower. Date and photographer unknown. Source: FPC Archives.

Figure 3: First Presbyterian Church on Broad Street. Date and photographer unknown. FPC Archives. Source: FPC Archives

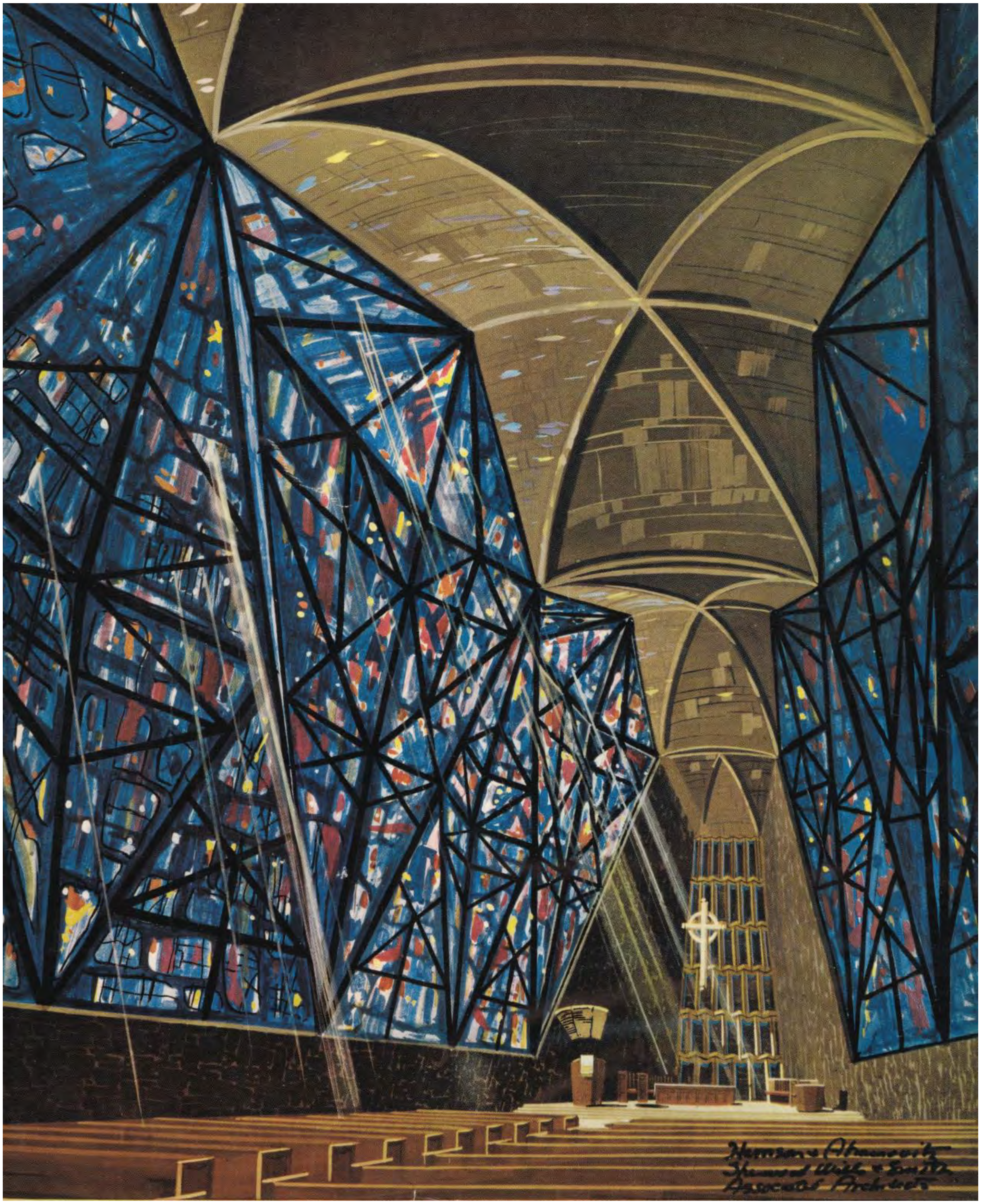


Figure 4: Rendering of Harrison’s early design for the Sanctuary by Hugh Ferriss.
Source: FPC Archives, 1953.

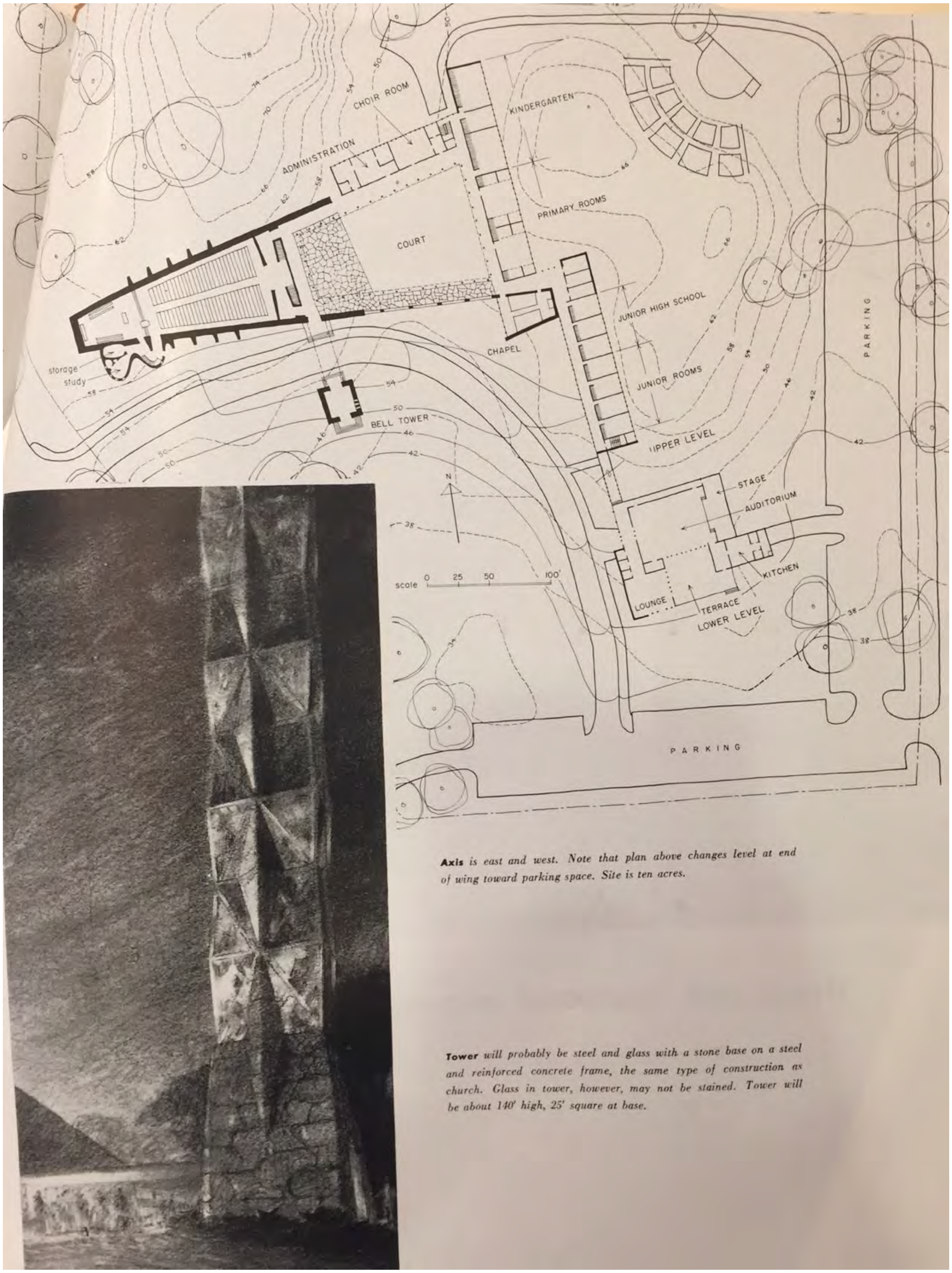


Figure 5: Early site plan and rendering of Harrison's design by Hugh Ferriss.
Source: *Architectural Forum,* December 1953.

Figure 6 (above): Rendering of Harrison's early design for the Sanctuary by Hugh Ferriss.
Source: FPC Archives, December 1953.

Figure 7 (below): Rendering of Harrison's early design for the Sanctuary and its main entrance.
Source: *Architectural Record,* November 1957.

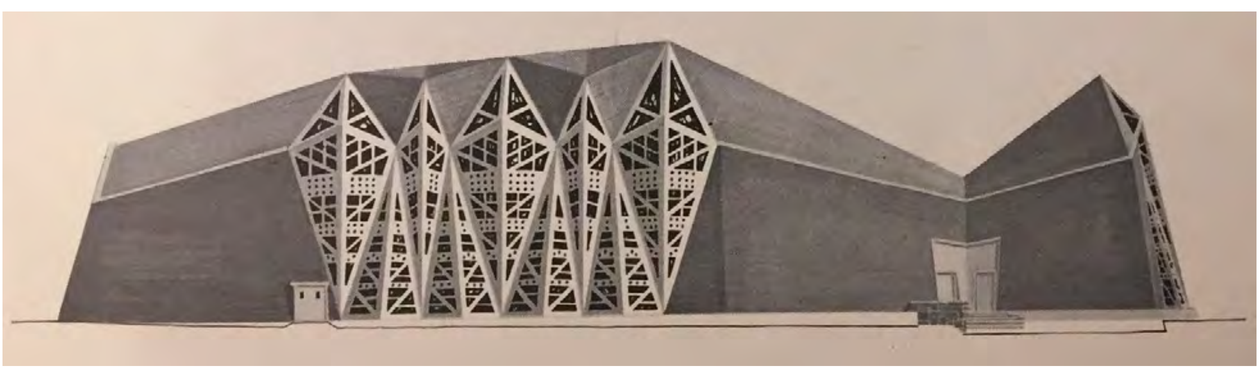
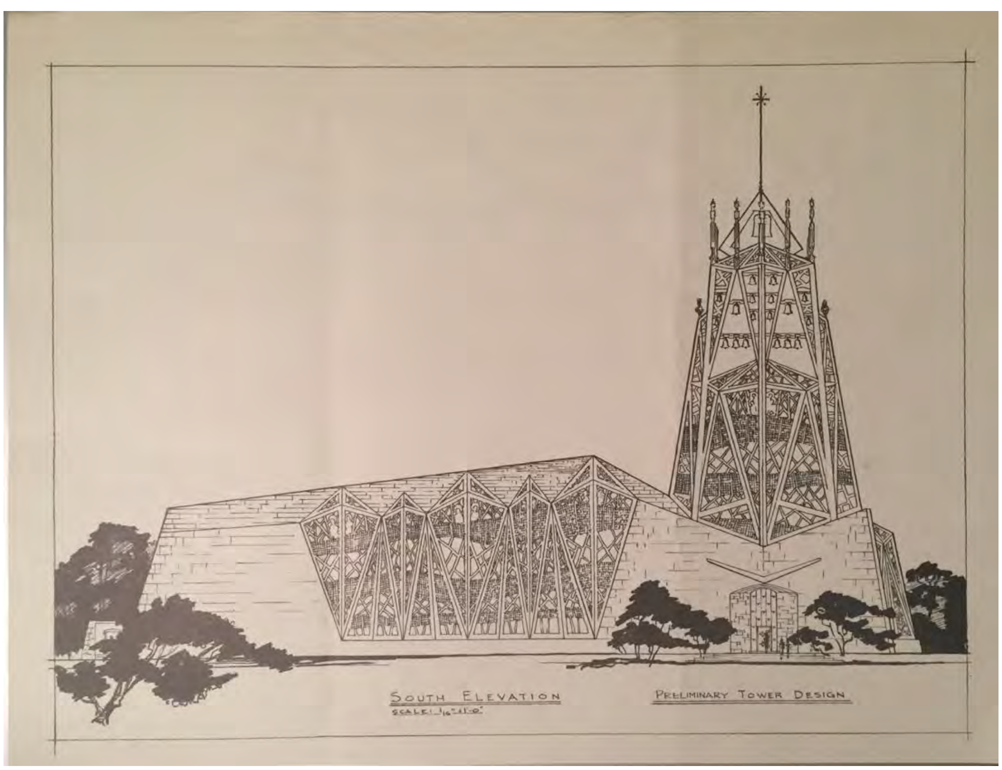


Figure 8 (above): The Parish Unit’s Fellowship Hall construction framework.
Source: FPC Archives.

Figure 9 (below): Preliminary design showing glass installed on the Sanctuary and Tower.
Source: FPC Archives.



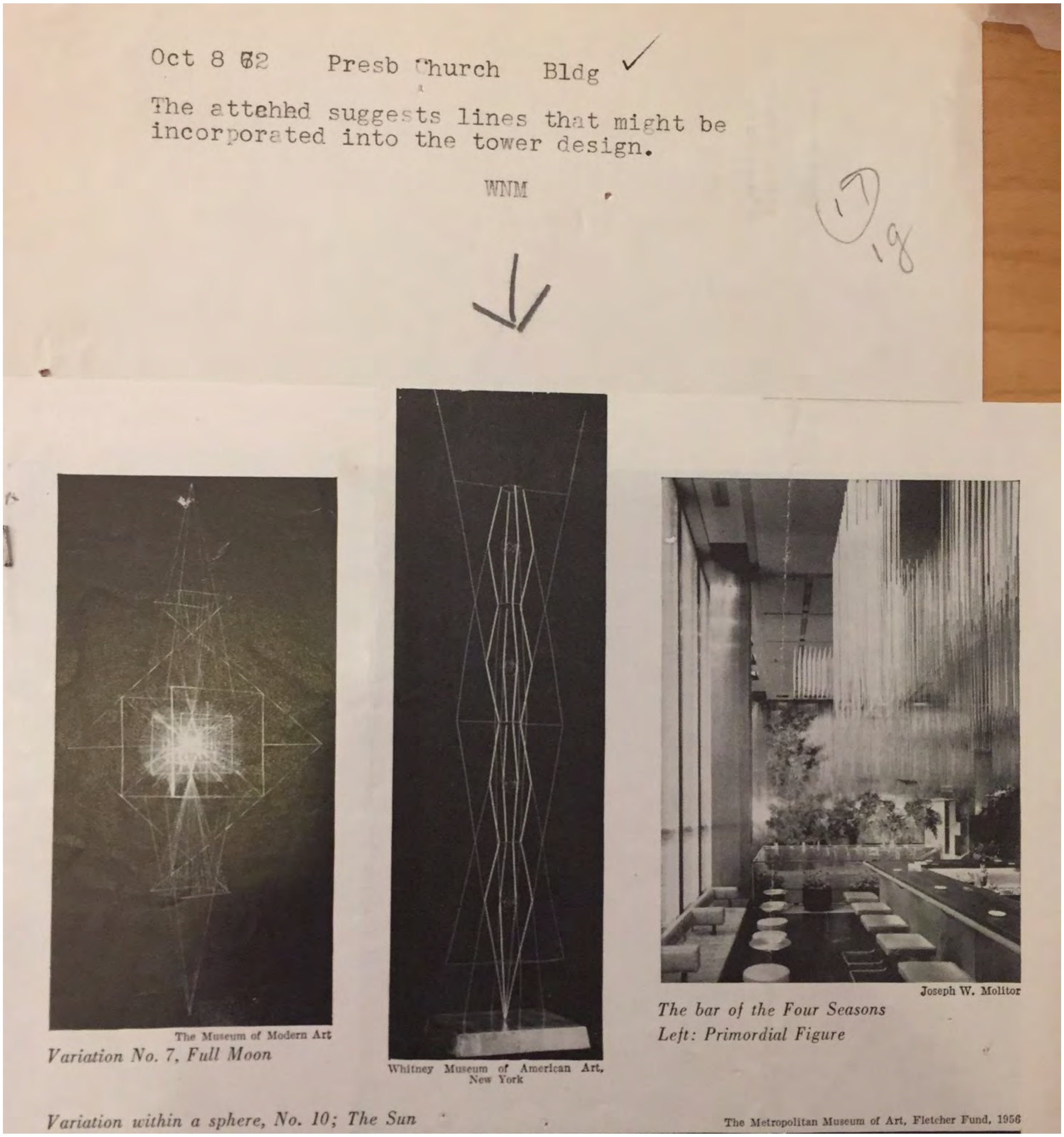


Figure 10: Maguire's message to Harrison including a published photograph of sculptor Richard Lippold's work *Primordial Figure* (1948).
Source*:* Wallace K. Harrison Archive, Avery Library, Columbia University, New York.

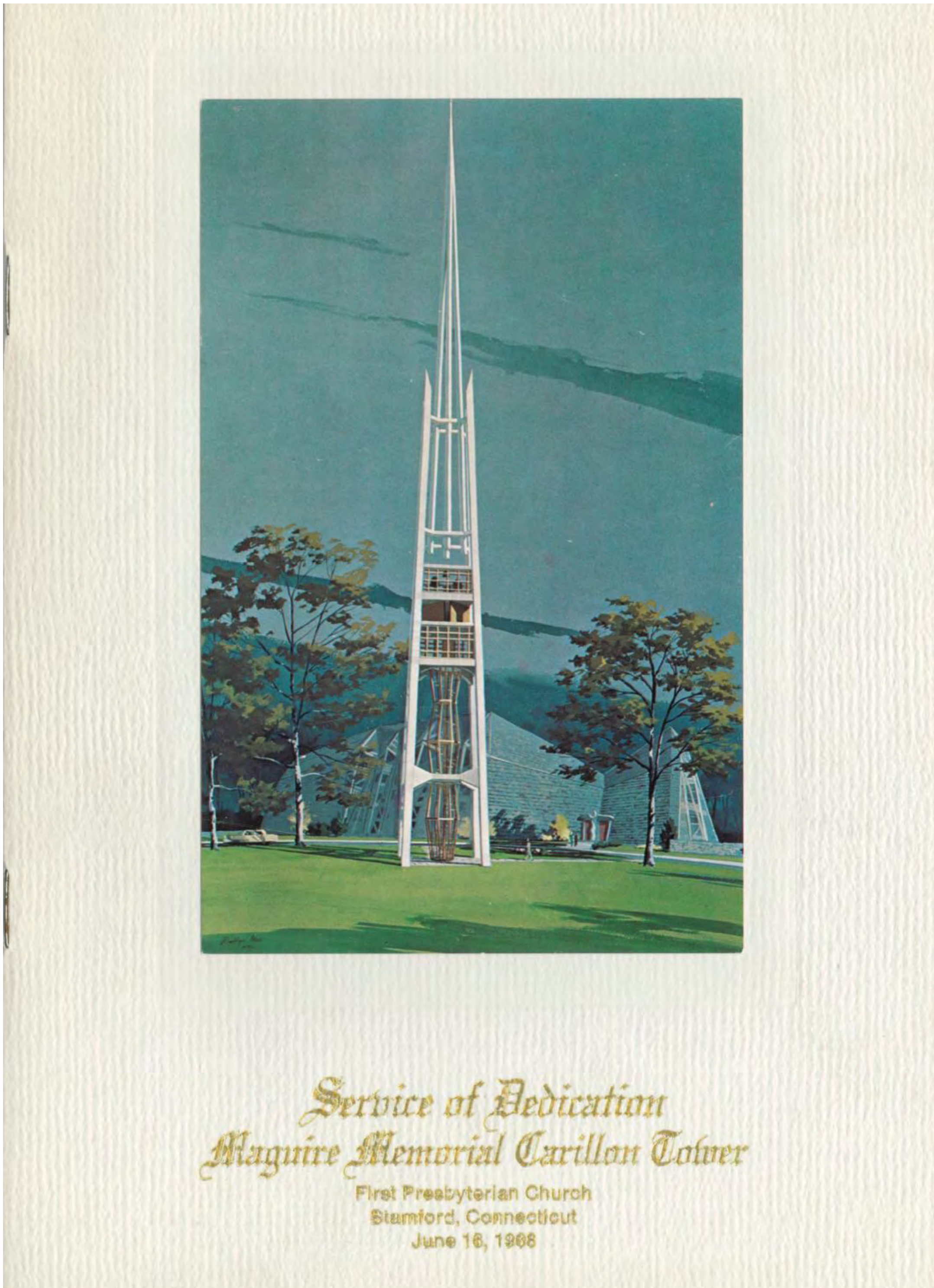


Figure 11: Program for the Service of Dedication: Maguire Memorial Carillon Tower, 1968. Source: First Presbyterian Church.

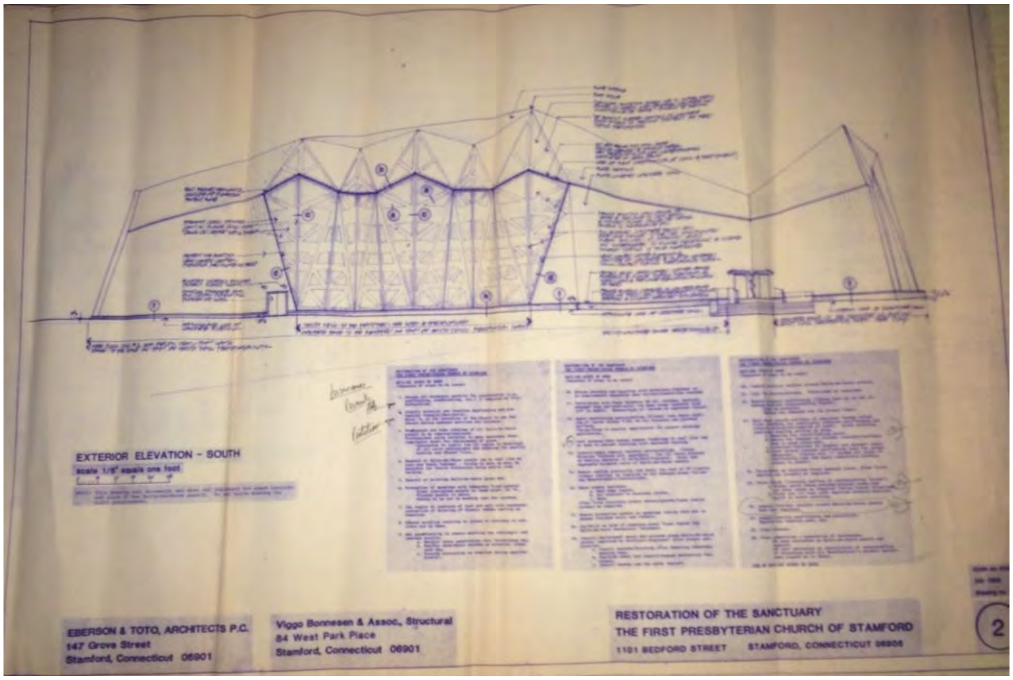


Figure 12 (above): Eberson & Toto Architects PC and Viggo Bonnesen & Associates produced drawings for the restoration of the Sanctuary. July 1986.

Figure 13 (below): Entrance at the south interior elevation.
Photo by Prudon & Partners.

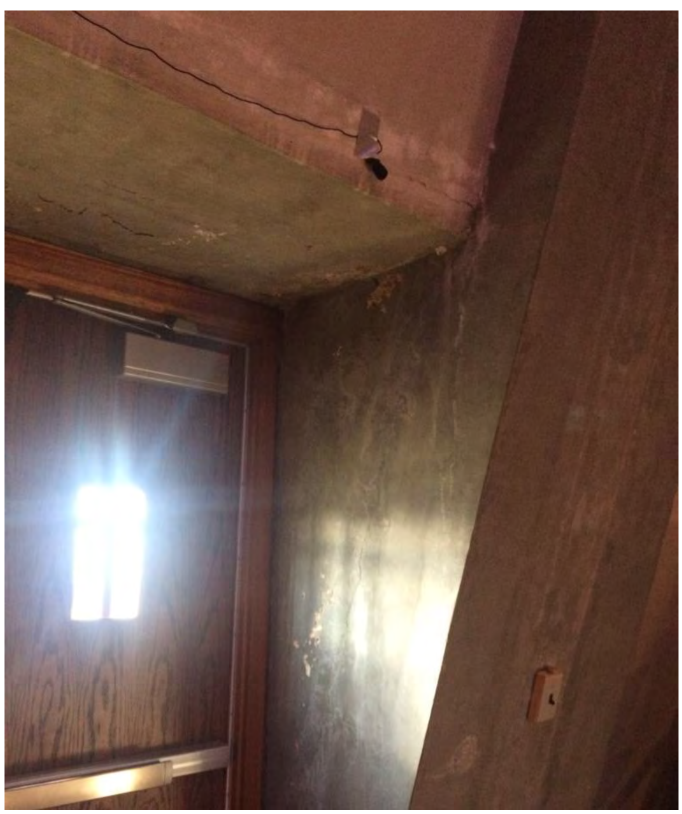


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Photo by Propellerheads.

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Photo by Prudon & Partners.

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Photo by Propellerheads.

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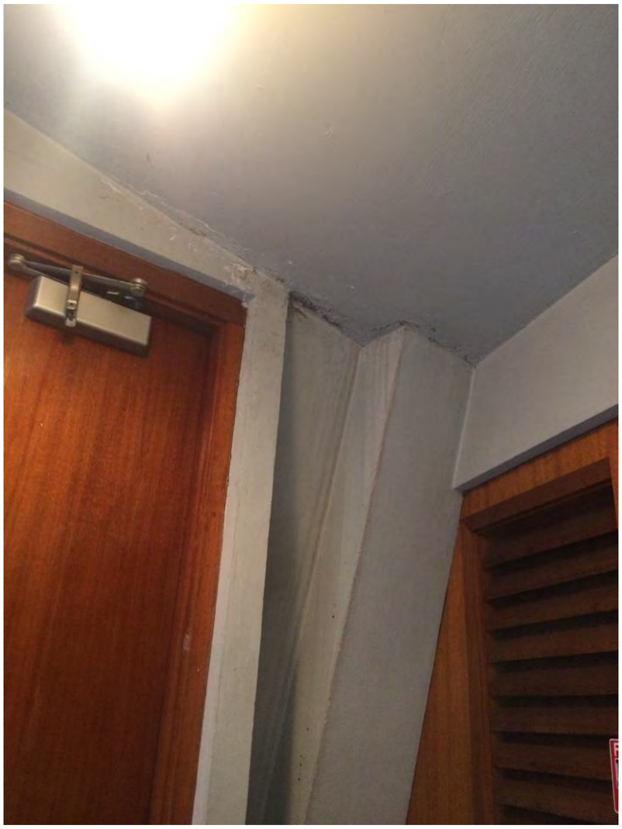

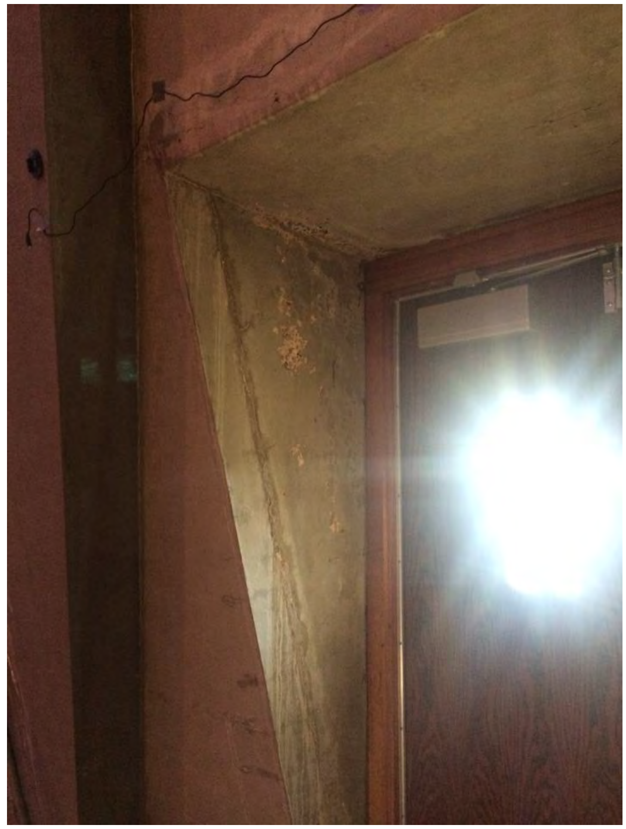

Figure 18 (above left): Conditions at interior entrance (SE Narthex).
Photo by Prudon & Partners.

Figure 19 (above right): Conditions at interior entrance (SW Nave).
Photo by Prudon & Partners.

Figure 20 (above left): Conditions at foundation wall.
Photo by Prudon & Partners.

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Photo by Prudon & Partners.

Figure 22 (above): Condensation at roof panel secondary glazing.
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Photo by Prudon & Partners.

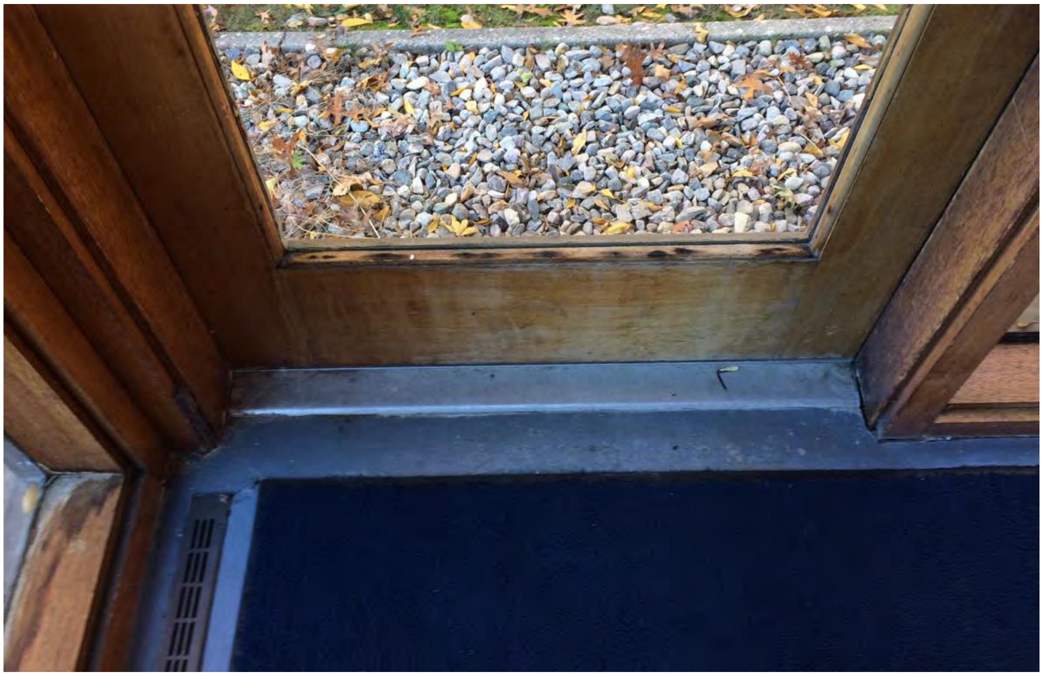

Figure 24: Conditions at connecting link. Exit to memorial garden (wood damage).
Photo by Prudon & Partners.

Figure 25 (above): Conditions at entry canopy (SE).
Photo by Propellerheads.

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Figure 36 (below): Delivery of precast panels onsite, November 1956.
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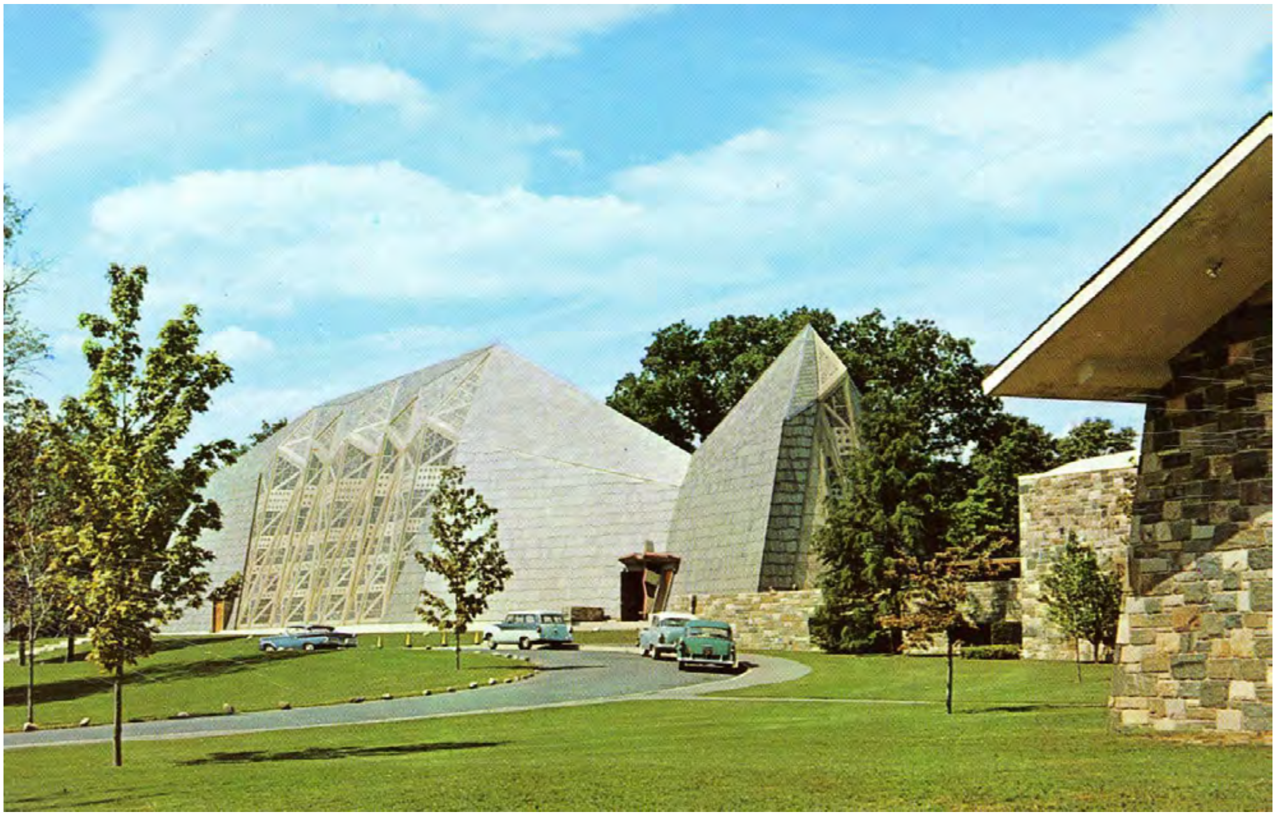

Figure 37: Completed Sanctuary, late 1950s (postcard).
Source: Ferguson Library Digital Archives**.**

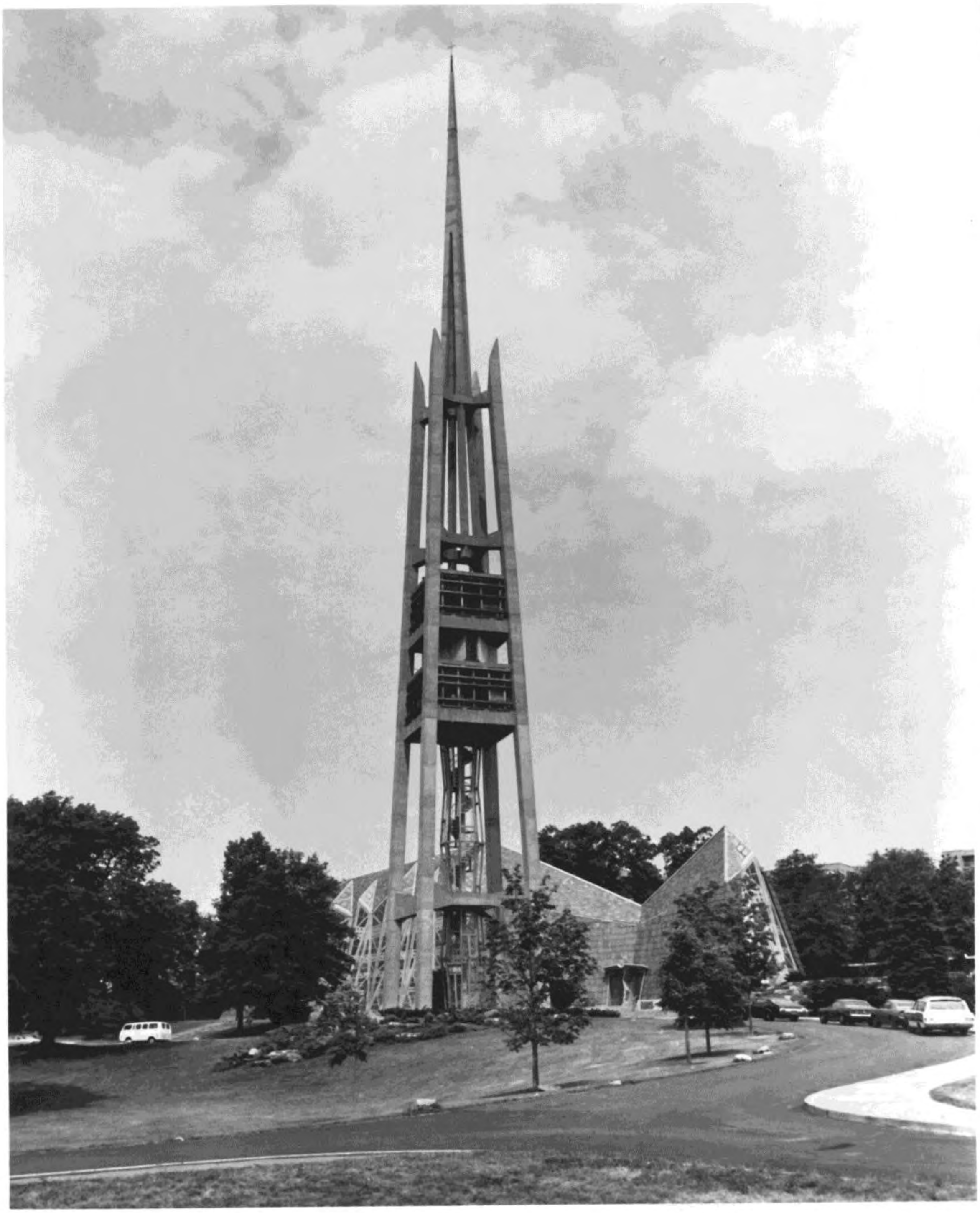

Figure 38: Completed Sanctuary and Tower, showing original landscape, unknown photographer, est. 1968.
Source: FPC Archives

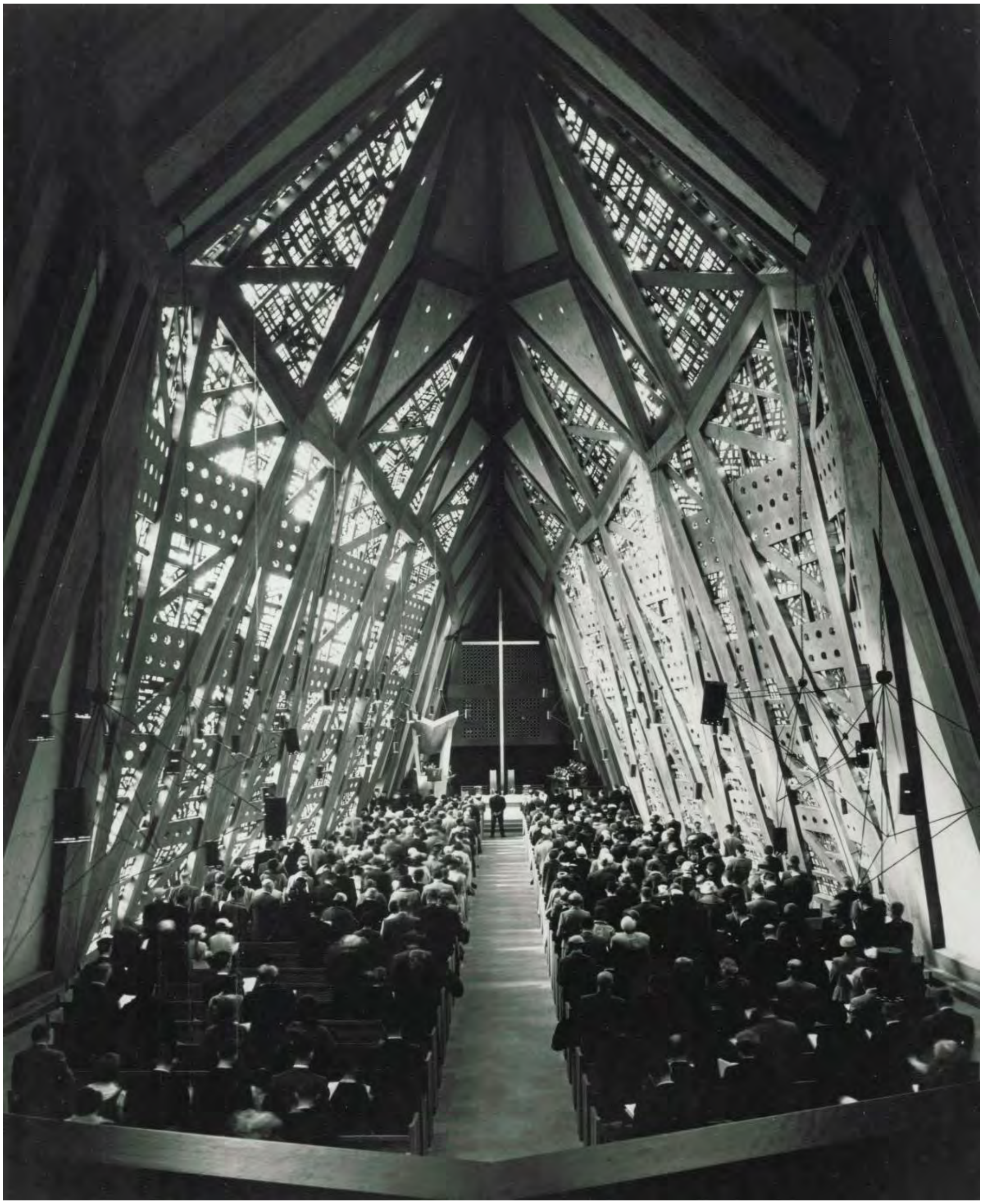

Figure 39: Service in the completed Sanctuary, est. 1958, photographer unknown.
Source: FPC Archives

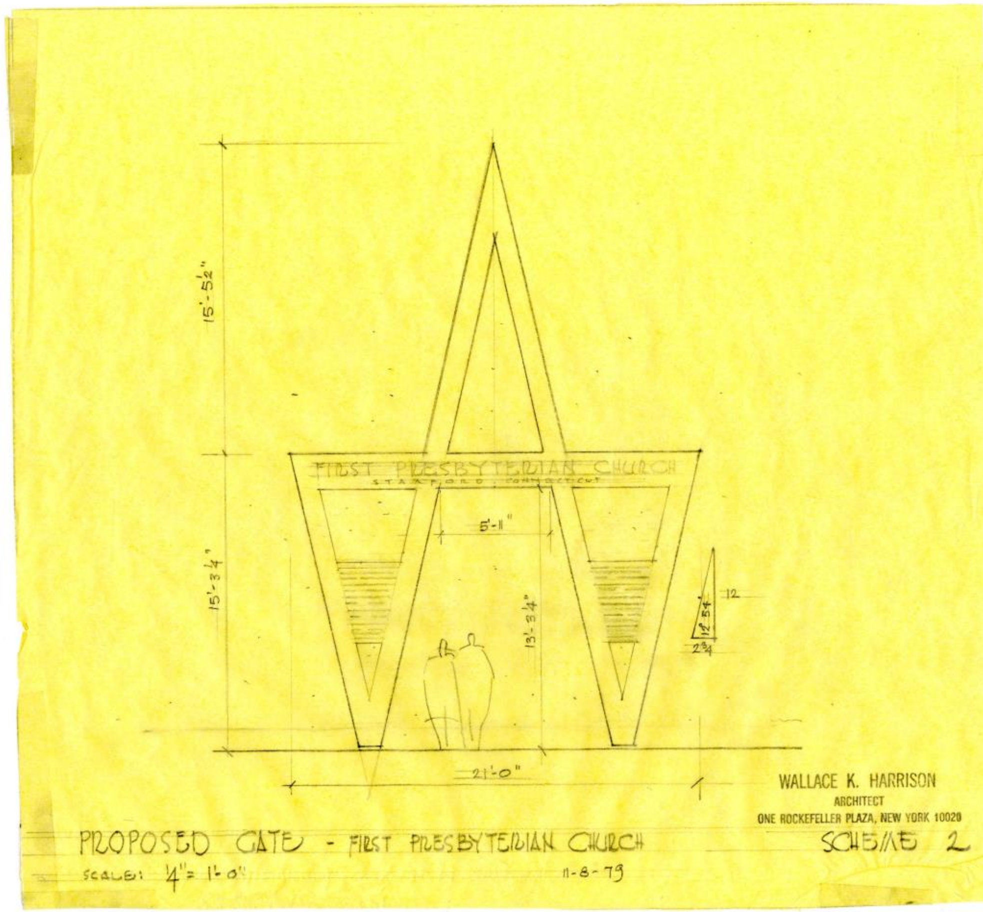

Figure 40: Church Gate, Scheme 2 (similar conceptually to Schemes 1-4). November 8, 1979. FPC Archives

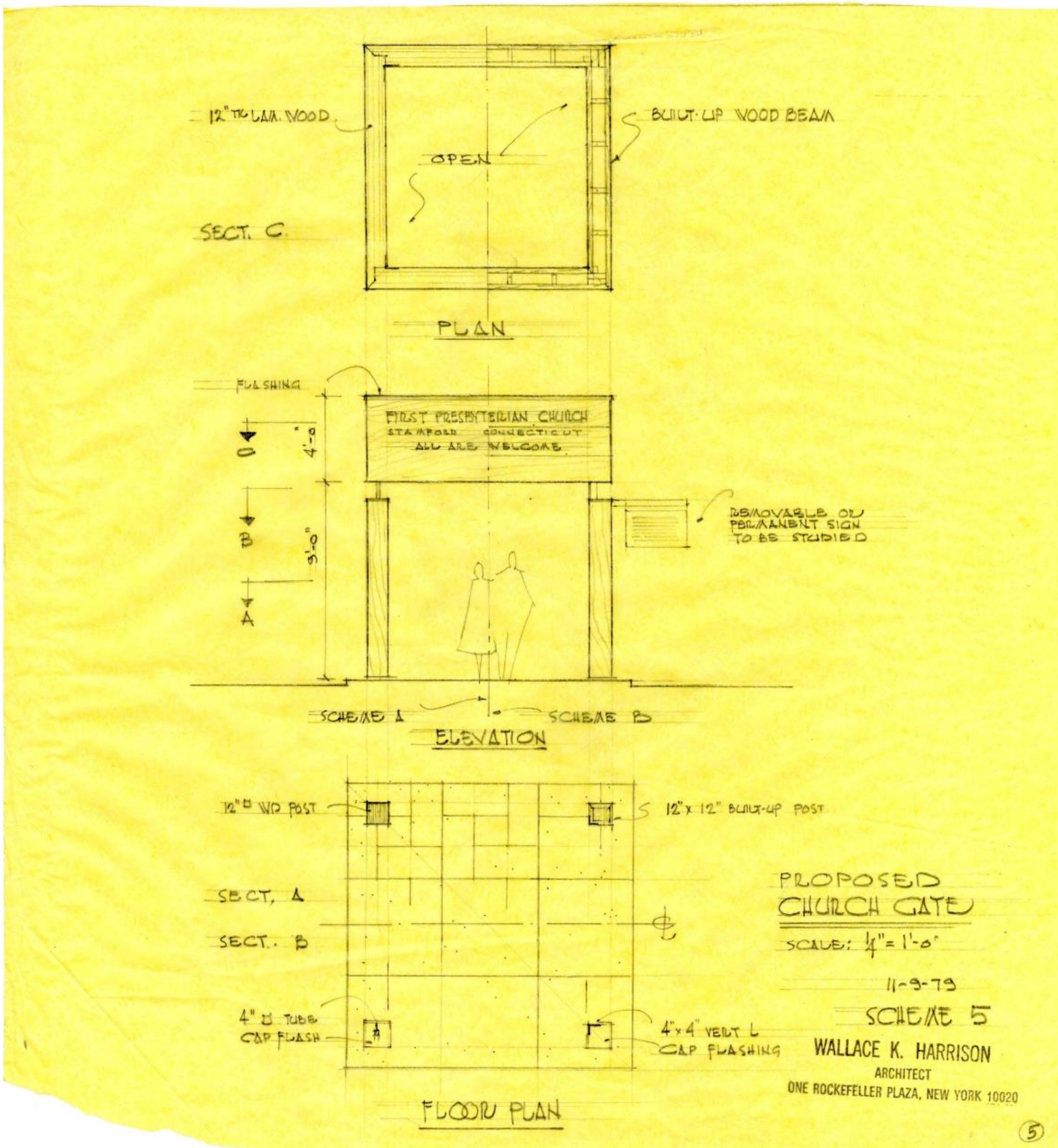

Figure 41: Church Gate, Scheme 5. November 9, 1979. FPC Archives

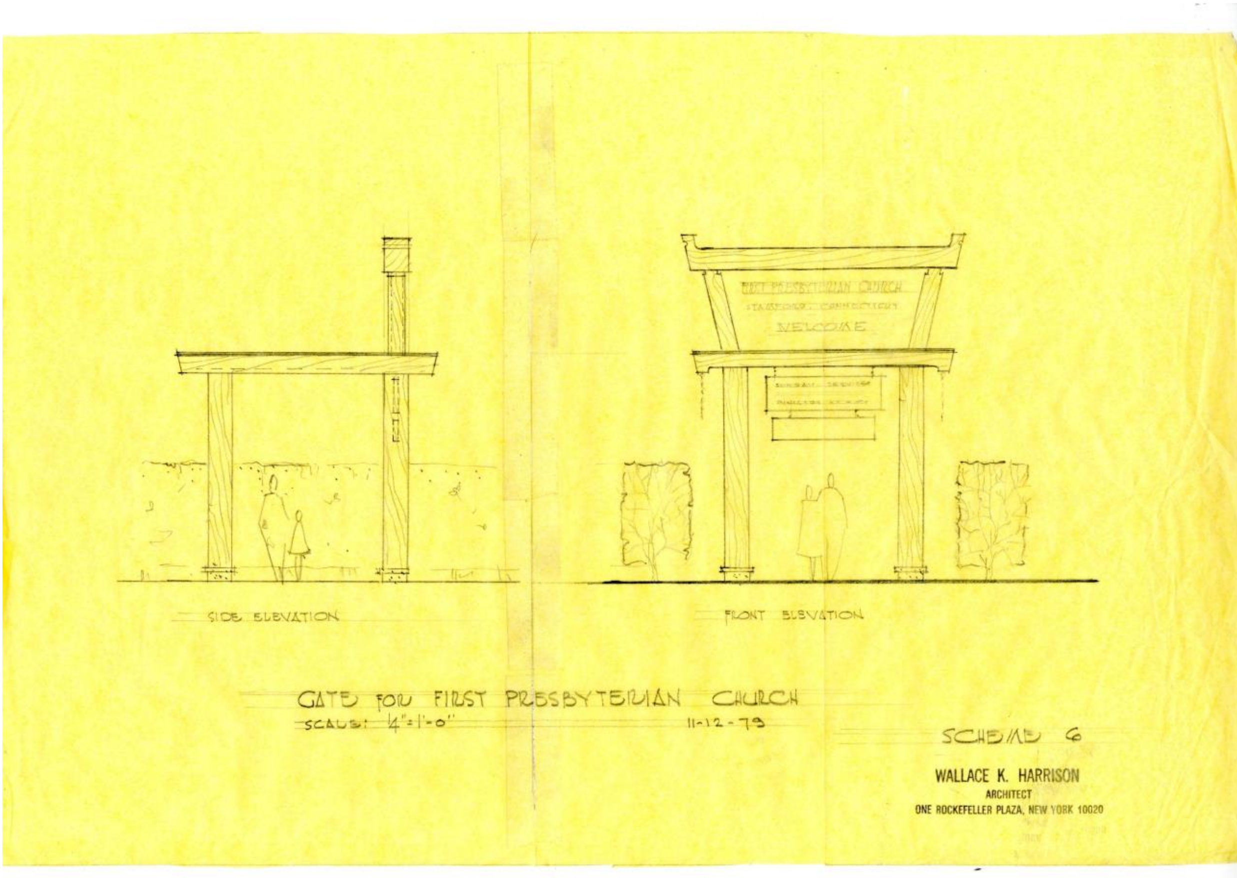

Figure 42: Church Gate, Scheme 6. November 12, 1979. FPC Archives

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Figure 44: Maquettes for Chapel Skylight. Source: Ateliers Loire Archive, Chartres, France

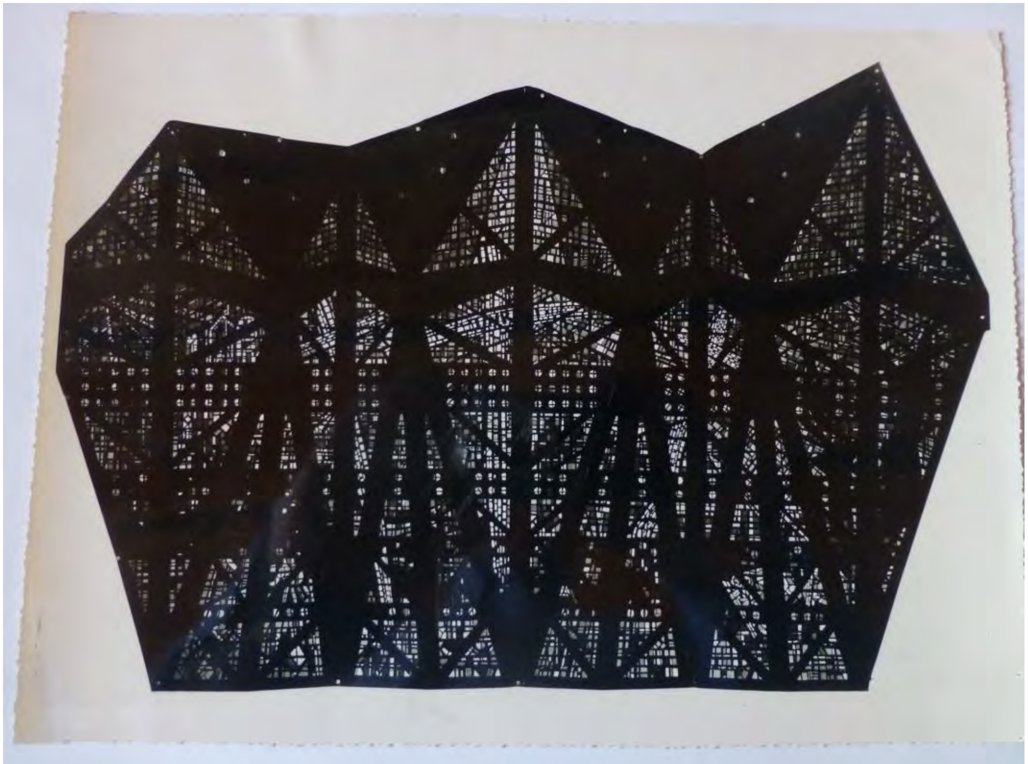
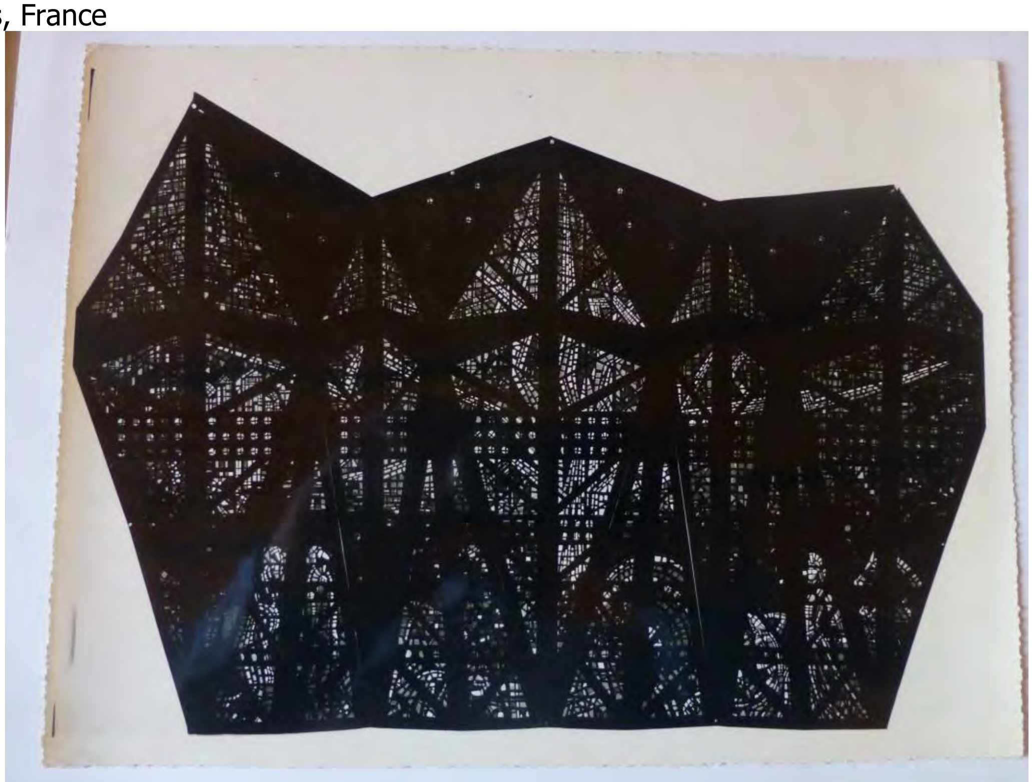


Figure 45: Above: Maquettes for Sanctuary north elevation. Source: Ateliers Loire Archive, Chartres, France

Figure 46: Below: Maquettes for Sanctuary south elevation. Source: Ateliers Loire Archive, Chartres, France



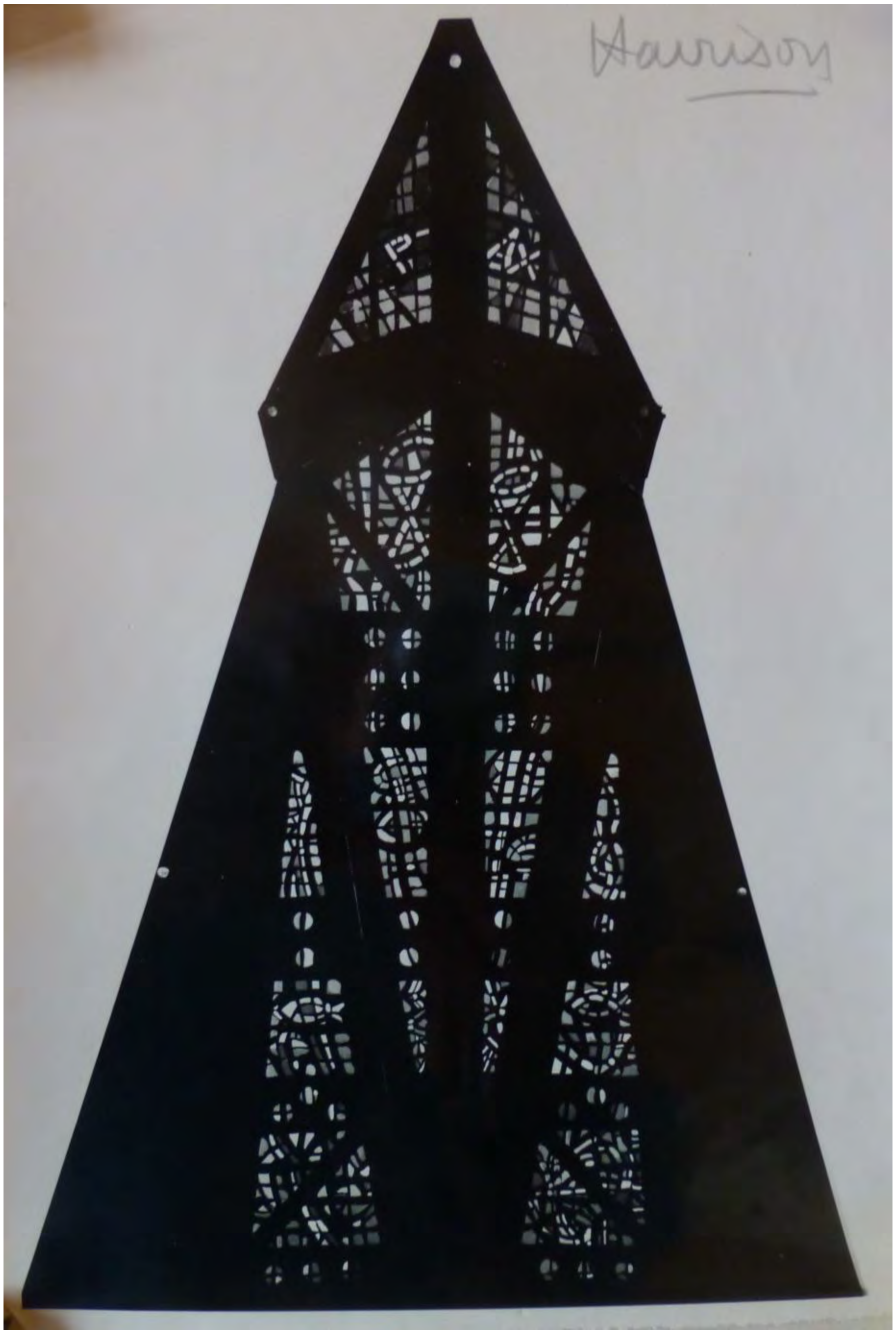


Figure 47: Maquettes for Sanctuary east elevation. Source: Ateliers Loire Archive, Chartres, France

Figure 48: Color design for panels in south elevation. Source: Studio Loire Archives

Appendix 5 Bibliography

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Appendix 6 Conservation Consultant's Report

First Presbyterian Church

Stamford, CT

Sanctuary and Chapel
Façade Conditions Assessment

October 2017

BCA

BUILDING CONSERVATION ASSOCIATES INC

First Presbyterian Church

Stamford, CT

Sanctuary and Chapel
Façade Conditions Assessment

Prepared For
Prudon & Partners LLP
135 West 70th Street
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BCA

BUILDING CONSERVATION ASSOCIATES INC

CONTENTS

EXECUTIVE SUMMARY

This report, prepared by Building Conservation Associates, Inc. (BCA), is a conditions assessment of the Sanctuary's building envelope and the dalle de verre in the Chapel of the First Presbyterian Church, located at 1101 Bedford Street in Stamford, Connecticut. Prudon and Partners, LLP. retained BCA to perform this investigation as part of the larger Conservation Management Plan.

This report is intended to serve as a planning tool to assist with the conservation management of the architectural materials of First Presbyterian Church, also known as the Fish Church. Materials and features examined as part of this survey included: cast-in-place concrete, pre-cast concrete panels, concrete and epoxy dalle de verre panels, exterior slate, and waterproofing. The investigation began in October 2016, and included:

- Review of archival information detailing the building construction and previous restoration campaigns
- A ground-based survey of the building materials and elements
- A review of high resolution photographs taken using cameras mounted to a drone
- Laboratory testing of materials

This study is comprehensive in that BCA reviewed every typical material and architectural feature within the limit of our assessment scope, but the level of detail is general. For example, a detailed examination of every dalle de verre panel was not performed. The surfaces and materials were inspected for major defects, but the result is a generalized survey with broad assumptions. Options for treating the historic materials are presented in the "Conditions Discussion and Recommendations" section of this report. Appendix D is comprised of a table with photographs that provides a visual overview of conditions affecting the historic fabric and their associated recommendations.

Overall, the First Presbyterian Church is in serviceable condition, with isolated areas of immediate concern, primarily related to water infiltration and art glass deterioration. The proposed treatment program is intended to address these conditions and retain as much of the original building fabric as possible. In addition, it includes interventions designed to maintain the appearance of the original façade on the most publicly prominent elevations using like or replacement materials. Some inherent material performance flaws of dalle de verre, such as minor leaks between glass and matrix materials are also discussed.

The building requires greater than normal maintenance to compensate for the innovative construction techniques and materials that are heavily affected by environmental conditions. The building envelope has undergone a variety of repair campaigns and interventions, restricted to portions of the façade during each campaign. As a result, the existing materials and conditions differ by elevation. This differential also affects in the interpretation of historic significance of the architectural materials. The recommendations presented in this report consider the complicated repair history of the building as well as inherent mechanisms for material deterioration and attempt to establish a baseline for future maintenance efforts by replacing dissimilar repair materials with like materials. Following a restoration campaign, a regular maintenance program, which includes inspection of the building fabric, will be beneficial for future planning, repairs, and budgeting.

Some of the recommended treatments in this report, such as the concrete patching and roofing repairs, can be performed using conventional construction and restoration technologies executed by qualified restoration contractors. Others, such as the glass stabilization techniques and cleaning methods, require additional field testing performed by conservators to determine the most appropriate method for treating the unique conditions and materials.

INTRODUCTION

The First Presbyterian Church, designed by Wallace K. Harrison of the firm Harrison and Abramovitz and referred to as the "Fish Church" due to the unique shape of its Sanctuary, was dedicated in 1958. The church complex consists of a Sanctuary, attached Parish House, and freestanding Carillion Tower. Prudon and Partners, LLP retained Building Conservation Associates (BCA) to perform a conditions assessment of the building envelope of the Sanctuary and the dalle de verre in the Chapel of the Parish House. See Figure 1 below for the location of the Sanctuary and Chapel. The Carillion Tower (also designed by Harrison) and the balance of the Parish House (designed by Willis Mills of Sherwood, Mills, and Smith) are excluded from this assessment. For a more detailed discussion of the building history and construction of the Carillion Tower and Parish House, see the Description section of the Conservation Management Plan, which is apart from BCA's report.

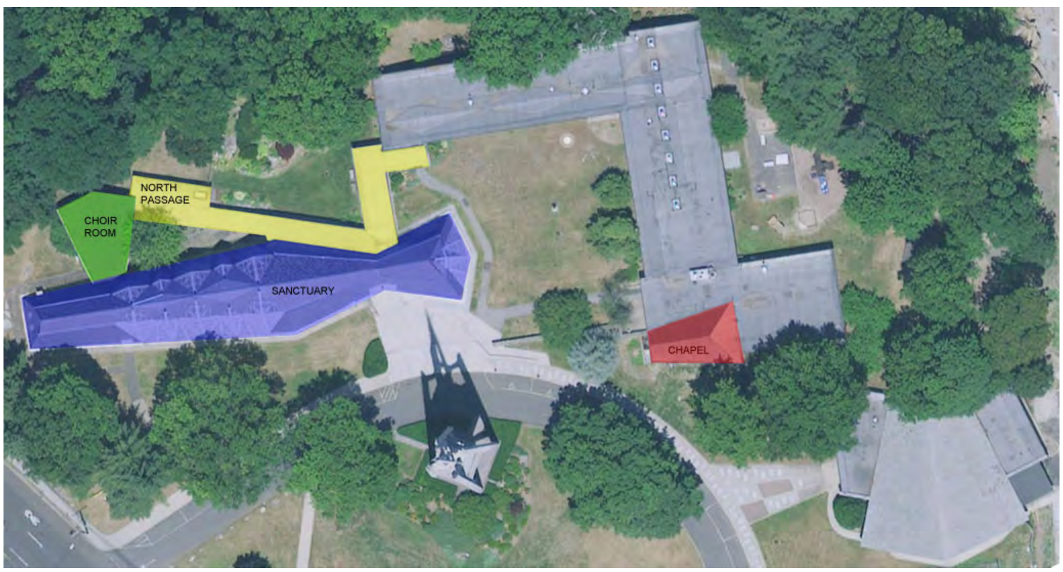

Figure 1. Aerial image showing the layout of the First Presbyterian Church. The Sanctuary is shaded in blue and the Chapel in red. The Choir Room and the North Passage, both of which are referenced in this report, are shaded green and yellow respectively. Image by Apple Maps, used under CC BY / Highlighted and labeled from original.

The length of the Sanctuary is 234 feet east-to-west. It measures 54 feet north-to-south at its widest and 60 feet at its tallest. Harrison initially selected the volume and shape of the Church to enhance acoustics. The popular symbolic association of fish iconography was eventually embraced. The altar is located at the west end of the Sanctuary and is backed by the organ: this end creates the envisioned head of the fish while the Narthex resembles a fish's tale.

Harrison referred to the Sanctuary construction as a new building technique that he called, "space construction." The structural engineer of record for the project was Edwards & Hjorth. The British engineer, Felix Samuely, consulted on the design. The concrete walls were designed to support each other and create a monolithic structure, "wholly different in its structural nature from the separate columns, vaults, and stained glass windows of Gothic architecture."[1] The façade was built with three concrete components: 152 large pre-cast panels anchored into

[1] "A Brilliant Canopy for Worship," *Architectural Forum*, April 1958, 106.

position to form the roof and sloping wall elevations; reinforced concrete poured between the panels to create a framework; and decorative concrete dalle de verre panels installed within openings in the pre-cast concrete units. The large pre-cast panels were set at angles to create structural rigidity. The wall panels lean inward 14 degrees.[2] Pre-cast panels containing dalle de verre were installed at the center of the north and south elevations as well as on the east elevation and extend up into the skyward-facing surfaces above the roofline in these areas. Solid pre-cast panels on the west elevation and at the east and west ends of the building (as well as portions of the roof) were clad with slate, reminiscent of scales on a fish.

Dalle de verre, also known as faceted glass, is a twentieth-century form of stained glass developed in Europe in the late 1920s and early 1930s employing thick slabs of glass ("dalles") set in a concrete matrix. The dalles are typically hand-chipped, or faceted, to produce variations in light transmission. During the 1960s, American studios began fabricating panels with an epoxy matrix as an alternative to reinforced concrete.

The dalle de verre at the First Presbyterian Church was fabricated by the stained-glass artist Gabriel Loire, whose studio was located near Chartres, France (Appendix A, Figure A1). Harrison learned about Loire from his friend, the artist Fernand Léger.[3] The Fish Church was not Loire's first commission in the United States, but with 276 square meters (2,791 square feet) of dalle de verre, it was the largest installation of the material in the United States at the time.[4] Each elevation of the Sanctuary was designed as a mural of stained glass depicting a scene from the bible. Harrison designed the north and south elevations, which represent the Crucifixion and the Resurrection respectively. The windows on the east elevation were designed by Loire to represent symbols of Christian teaching. All dalle de verre panels were fabricated in France and shipped to Connecticut. The building's bold design and use of glass was widely reported in newspapers and journals of the period.

A dalle de verre window in the Chapel, designed by Matthew Wysocki of New Haven, CT and fabricated by Loire, was produced in a similar fashion.[5] The dalle de verre installed at a skyward-facing angle in the Chapel's east elevation was installed before the construction of the Sanctuary walls. Known as the "Window of Creation," it contains abstract symbols such as "The plants that Grow," "A Flying Bird," and "The Stars of Heaven."[6]

In 1959, Harrison wrote in regard to the Fish Church, "Architecture is hard. New methods of construction, new materials and new designs create a multitude of unforeseen problems never met before. The roof of the church still leaks. We have not yet found the correct light fixtures. We are not quite satisfied with the design of the pulpit. And yet, on the other hand, there are also happy consequences too of new design…"[7] While the innovative form and stunning use of dalle de verre resulted in a masterpiece of modern architecture, it has required several restoration and maintenance campaigns, beginning almost immediately after its construction. The

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[2] "Joints Between Precast Panels Frame Church," CONSTRUCTION METHODS and Equipment, 102.
[3] Charles W. Pratt and Joan C. Pratt, *Gabriel Loire: Les Vitraux/Stained Glass,* Centre International du Vitrail (1996), 88.
[4] Ibid., 207.
[5] "New Concept in Churches," Fairfield County Fair, March 13, 1958, 5
[6] "Descriptive Tour: First Presbyterian Church, Stamford, Connecticut," from the "Wallace K. Harrison architectural drawings and papers, 1913-1986," Avery Architectural & Fine Arts Library, Columbia University, New York, 8.
[7] Wallace K. Harrison, "Wallace K. Harrison architectural drawings and papers, 1913-1986," Avery Architectural & Fine Arts Library, Columbia University, New York. Quote from a typed and hand-written document consisting of two paragraphs. The first paragraph of this document also appears in Harrison's Statement for the Museum of Modern Art, February 15, 1959.

most notable of these interventions, in the 1980s, replaced all the dalle de verre below the roofline on the south and east elevations with new dalle de verre fabricated with new glass and an epoxy matrix.

This study began with a review of archival information and was followed by a field survey. Hands-on access to the materials was limited to the ground level. The rest of the building was surveyed using binoculars. In addition, BCA reviewed conditions visible in high-resolution photographs of the interior and exterior taken from a drone. Laboratory testing was performed on select materials to further understand the mechanisms for deterioration.

The materials and features examined as part of this assessment include cast-in-place concrete, pre-cast concrete panels, dalle de verre panels, exterior slate, and waterproofing. Options for treating these materials are presented in the "Conditions Discussion and Recommendations" section of this report.

Following the body of this report are several appendices. Figures in each appendix are identified with the appendix letter in front of the image number (ex. Figure 1 in Appendix A is noted as Figure A1 in the main body of this report). Appendix A includes historic and contemporary photographs referenced in the main body of this report. Appendix B provides elevation drawings, with pre-cast panels numbered for reference. Appendix C includes select archival construction details. Appendix D is comprised of a table with photographs that provides a visual overview of conditions affecting the historic fabric and associated recommendations. Appendices E-K provide further details about the laboratory testing summarized in the main body of the report.

METHODOLOGY

Archival Information

Historic Documents Review

The project included a review of archival drawings, photographs, and architectural records relevant to the First Presbyterian Church held in the Wallace K. Harrison repository at Avery Architectural and Fine Arts Library at Columbia University.

This study also drew on the research compiled by others for the National Historic Landmark (NHL) Nomination of the structure, drafted in 2016. BCA reviewed the building history provided by Prudon and Partners and archival documents provided by Prudon and Partners, Rohlf's Stained & Leaded Glass, The Highland Green Foundation, and the First Presbyterian Church. The following documents proved particularly useful in understanding the previous façade interventions:

- Harrison and Abramovitz, "First Presbyterian Church, Stamford, Connecticut," Chapel Roof Plan Details. February 28, 1955.
- Harrison and Abramovitz in association with Sherwood, Mills & Smith, "First Presbyterian Church, Stamford, Connecticut," Construction Drawings. September 23, 1955.
- Harrison and Abramovitz, *Specifications for the First Presbyterian Church, Stamford, Connecticut*, September 23, 1955.

- Winthrop P. Moore, "Sanctuary Restoration 1976-1977," Maintenance Report. January 1978.
- Eberson and Toto, architects, P.C. and Viggo Bonnesen & Assoc. (Consulting Structural Engrs.), "Final Report: Investigation of the Sanctuary: First Presbyterian Church, Stamford, Connecticut," September 5, 1985.
- Eberson and Toto, architects, P.C. and Viggo Bonnesen & Assoc. (Consulting Structural Engrs.), "Restoration of the Sanctuary: The First Presbyterian Church, Stamford, Connecticut," Drawings 1-5. July 1986.
- Documents regarding the original construction and later restoration campaigns from the archives of DeLuca Construction Company of Stamford, CT.
- Hoffmann Architects, "Water Infiltration Investigation: First Presbyterian Church, Stamford, Connecticut," Assessment Report. April 8, 2003.
- Hoffmann Architects, "Building Envelope Rehabilitation: First Presbyterian Church," Drawings A1-A9. July 11, 2005.

Interviews

BCA and Prudon and Partners conducted interviews with Peter Rohlf of Rohlf's Stained & Leaded Glass, on December 19, 2016 and January 10, 2017. Rohlf's Stained & Leaded Glass was involved in the 1980s restoration and produced the epoxy dalle de verre panels installed on the south and east elevations. These interviews helped ascertain the extent of building alterations performed at that time and the progression of the visible façade deterioration.

Field Survey

BCA performed a ground-based survey during multiple visits between October 2016 and January 2017. Heavy rain during the visit on October 27 allowed BCA to observe and review the location of leaks in the Sanctuary. Bright lights and binoculars were utilized to review conditions during the investigation of the interior space. The conditions were documented using digital photography. Isolated conditions were also recorded by BCA on plans and photographs. Information such as existing materials and conditions was entered into an electronic database (Microsoft Access).

This report focuses on the material of the building envelope. It does not address site landscaping and drainage, nor does it include architectural issues such as code, egress, or accessibility. This study also excludes hazardous materials, and electrical, mechanical, and structural issues, including the condition of fire protection, security systems, and plumbing.

High Resolution Photographs

Prudon and Partners contracted Propellerheads Aerial Photography, LLC. to perform high-resolution photography of the interior and exterior of the church using the following camera equipment mounted to two drones:

- Exterior façade: Zenmuse X5 (16-megapixal camera with a 15-mm lens and a 30-mm focal length) mounted on a DJI Inspire 1 Pro drone
- Interior surfaces: Sony A7R II (42-megapixal camera with a 50-mm lens) mounted on a DJI Matrice 600 drone

BCA reviewed photographs for conditions not accessible from the ground. Conditions such as water infiltration, efflorescence, cracks, and previous repairs are visible in these images.[8]

Materials Testing

During the field study, BCA obtained material samples for visual examination and characterization in the laboratory. Laboratory testing was performed to characterize efflorescence and deteriorated glass present on the north and south elevations. In addition, cores taken from the concrete matrix of a dalle de verre panel previously removed from the south elevation and pre-cast and cast-in-place concrete on the north elevation were sent to Highbridge Materials Consulting, Inc. for materials testing and petrographic analysis. The findings of these analyses are summarized in the Laboratory Testing section below. See Appendices E-K for full testing reports.

Infrared Thermography

During the BCA site visit in November 2016 and in January 2017, we produced thermal images of isolated areas of the interior and exterior north and south elevations to document the extent of surface temperature variations present using a Fluke TiR32 IR Fusion Technology Thermal Imager. Infrared thermography detects infrared energy emitted from an object or material, converts it to temperature, and displays it as an image of temperature distribution. An Extech Instruments R201 Pocket IR Infrared Thermometer additionally provided data for the interpretation of the thermographic images.

SUMMARY OF ARCHIVAL DOCUMENTS AND MATERIALS TESTING

Building Construction

This section provides a brief description of the original materials used in the construction of the Fish Church.[9] The General Contractor for the original construction campaign was DeLuca Construction Company of Stamford, CT. The Caulking Applicator was Grenadier, Corp.

Sanctuary

Pre-Cast Concrete Panels and Cast-in Place Concrete

Precast Building Sections, Inc., located on Long Island, fabricated the pre-cast panels in a factory and transported them by truck to the site. The panels were fastened to the base and supported by false work until the roof panels were lowered into place.[10] Panels were installed within 1/8 inch of the locations specified in the plans to achieve the designed layout. The panels were installed on opposite sides of the Sanctuary at the same time to balance the structural load (Figure A2).[11]

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[8] Propellerheads Aerial Photography was unable to photograph the exterior of pre-cast panels N1-N8 because branches from a nearby tree did not allow for sufficient clearance. BCA photographed the interior dalle de verre at eye level in the Sanctuary because the pews prevented clearance for the drone in the side aisles.
[9] For a more detailed description of the building construction, see the Thematic History section of the Conservation Management Plan. Much of the information referenced in this report is also noted in that section.
[10] "Space enclosed 'archi-structurally' makes this new church stand alone," Lone Start Cement Corporation. n.d.
[11] "Joints Between Precast Panels Frame Church," 104.

Of the 152 pre-cast concrete panels used to construct the façade, eighty are triangles (some perforated and others solid) and seventy-two are solid quadrilaterals. The largest triangular panels measure 35 feet long and weigh 5 tons. The largest quadrangular panels measure 36 feet x 10 feet and weigh 10 tons.[12] The quadrangular panels at the ends of the church measure 4-1/2 inches thick (Figure A3).[13]

The edges of the triangular panels are 8-inch beams while the edges of the quadrangular panels are 12-inch square perimeter beams. These beams are heavily reinforced: four bars run the length of each. Lighter reinforcement is set perpendicular to the heavy bars in two rows (Figure A4). These protrude from the beam and are wrapped around the reinforcing bar (usually size 4 deformed steel) set in the joints between the panels (Figures C1 and A5). Steel plates also project from the edges of the panel beams and are welded to similar plates on adjacent panels. An 8-inch rib of reinforced concrete was poured in the joint between the panels to connect them and form a monolithic structure. The poured concrete reportedly keyed into the pre-cast panel perimeter beams by filling two rows of 6-inch x 6-inch x 1-inch pockets in the two sides of the pre-cast panels.[14] Pockets are visible at the edge of the quadrangular panels in archival images, but this detail appears inconsistent (Figure A6).

The ribs that comprise the cast-in-place concrete framework were placed in lifts 6-8 feet long and over lapped the panels 2 inches on each side (Figure A7).[15] The concrete was mixed with a Rex one-bag mixer and placed in small batches of less than one yard per day. The cast-in-place concrete was placed with hand shovels in the lower 20 feet. A crane with a small concrete bucket was used to pour the higher sections.[16]

The interior of the Sanctuary was reportedly painted "plasm gray and cement color."[17]

Concrete Dalle de Verre

The dalle de verre panels were fabricated from 20,000 pieces of 1-inch thick faceted glass set in 1-1/4-inch thick reinforced concrete.[18] The glass is flush with the concrete matrix on the side of the panel set to the exterior and recessed approximately 1/4 inch behind the surface of the matrix on the interior side. The size of the embedded steel reinforcement varies: 1/4-inch diameter steel rod was found around the perimeter of an original panel previously salvaged from the south elevation, while 1/8-inch diameter steel wire was found embedded in the center of the same panel. Over 700 triangular and quadrangular dalle de verre panels were fabricated in addition to more than 500 small circular dalle de verre panels. The circular portal panels were set in the exposed concrete elevations and installed in the skyward-facing areas clad with slate (Figure A10).

On the east elevation, solid concrete panels containing no glass filled the larger pre-cast concrete panel openings; these were likely fabricated by Precast Building Sections, Inc. (Figures A8-A9).

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[12] "Space enclosed 'archi-structurally'."
[13] "Joints Between Precast Panels Frame Church," 103.
[14] Ibid., 103-104.
[15] "Speech #2" in the DeLuca Construction Company archives, 4.
[16] "Joints Between Precast Panels Frame Church," 108.
[17] "Speech #2," 7. The type of paint applied, the paint manufacturer, and the surface preparation is not evident from available archival information.
[18] "New Concept in Churches," 9.

The dalle de verre panels were placed in rabbets in the larger pre-cast units. They appear to have been originally set in a hard grout material. A wire screen was installed under all triangular and quadrangular skyward-facing panels.[19] The triangular and quadrangular panels were also anchored to the interior with 1-inch wide lead straps. The straps lap the face of the pre-cast concrete panels by 1-2 inches (Figure A11). The original exterior "caulking" was specified as a "Thiokol" based caulking compound trade name "Del," manufactured by David E. Long.[20] According to an advertising brochure for Del, the joints were weatherproofed with Del Synthetic Rubber Compound. The liquid polysulphide sealant product was described as the "original sealant for the building industry based on Thiokol® Liquid Polymers."[21, 22] The material was applied with a conventional "caulking" gun and hand tooled to create a smooth surface.

According to the product literature, "Extra protection against buffeting of wind and rain is achieved by covering roof ridge areas with sheets of Plexiglas. A second bead of Del around the outside makes the Plexiglas installation leakproof." This indicates that a type of protective glazing system was originally installed at the skyward-facing dalle de verre.[23] Archival information suggests this system may have been replaced multiple times. The existing aluminum protective glazing system appears to date from circa 2005. The frames of the existing protective glazing do not fully align with the pre-cast panel grid design, which earlier systems appeared to do (Figures A12-A13). The current system therefore partially obscures the appearance of the dalle de verre from the exterior of the building.

Waterproof Coating

An acrylic coating was reportedly applied to the concrete façade, including the dalle de verre surfaces, at the time of construction to serve as a transparent waterproof coating (Figure A14).[24] Original specifications called for this coating to consist of two applications of Del W-97, manufactured by David E. Long Co.[25]

Slate

The entire west elevation and the east and west ends of the north and south elevations, are clad with gray slate. Slate is also installed between skyward-facing pre-cast concrete panels of the Sanctuary roof. The slate above the roofline are laid in uniform straight lines. Below the roofline, they are installed as wall shingles with variable widths and lengths, evoking the scales of a fish (Figure A15).

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[19] This was presumably installed as a safety measure to satisfy code requirements for skylights.
[20] Harrison and Abramovitz, "Caulking: Section 9," *Specifications for the First Presbyterian Church, Stamford, Connecticut*, September 23, 1955, 1.
[21] "DEL Synthetic Rubber Compound Weatherproofs the 'Fish'," David E. Long Corp., 2.
[22] Prior to about 1950, oil and resin based caulks were the only joint sealants available. These were sufficient for masonry joints but not curtain wall construction. Polysulfide sealants were the first widely used elastomeric sealants. Thiokol Chemical Corporation developed the first polysulfide polymer in 1929; the polysulfide sealants available in the 1950s were based on these products. Until 1961 they were two-component products. Michael J. Scheffler and James SD. Connolly "Building Sealants," in *Twentieth Century Building Materials: History and Conservation* (Los Angeles: Getty Conservation Institute, 2014), 241.
[23] "DEL Synthetic Rubber Compound Weatherproofs the 'Fish'," 2.
[24] "A Brilliant Canopy for Worship," 107.
[25] Harrison and Abramovitz, "Painting: Section 17," *Specifications for the First Presbyterian Church, Stamford, Connecticut*, September 23, 1955, 4.

The slate siding was specified to be rustic texture, unfading Buckingham-Virginia slate furnished by Buckingham Virginia Corporation.[26] An alternate in the specifications called for clear, rough texture, genuine Bangor Certificate slate from North Bango Slate Company.[27] Deluca identified the installed slate as simply "heavy Vermont black slate."[28] The exact source of the installed slate has not been determined.

Chapel

The dalle de verre laylight in the Chapel, which was installed before the dalle de verre in the Sanctuary, is protected with a skylight-type roof and backlit. An enclosure similar to the existing is visible in an archival photo dated 1966 (Figures A16-A17). Archival drawings identify the roof protection as Corrulux, which was a corrugated, translucent plastic panel with fiberglass reinforcement.[29]

The framing between the dalle de verre panels is painted a brown color (Figure A18). Archival drawings identify the framing as wood.[30] The current color scheme contrasts the light appearance in archival images (Figure A19). The exterior wall below the dalle de verre window is constructed of Connecticut fieldstone.[31] The current assessment only includes these two Chapel materials.

Previous Restorations and Alterations to the Sanctuary Facade

There are several known repair and alteration campaigns to the Sanctuary following the completion of the building in 1958. Additional interventions are visible, but documents detailing the associated work have not been located. Harrison remained closely involved with the church for the duration of his life, until his passing in 1981. Both DeLuca Construction Company and Grenadier, Corp. also remained involved with restoration work through the 1970s.

1959 Concrete Deterioration

The Buildings and Grounds Committee observed erosion of the cast-in-place concrete framework between the pre-cast panels. Harrison hired consultants, who determine that the deterioration was due to issues associated with the concrete composition. Under Harrison's direction, the condition was reportedly corrected at no expense to the congregation.[32] No record has been located regarding the analysis performed, locations of the identified deterioration, or types of completed repairs.

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[26] Harrison and Abramovitz, "Membrane Waterproofing, Roofing and Sheet Metal Work: Section 8," *Specifications for the First Presbyterian Church, Stamford, Connecticut*, September 23, 1955, 6
[27] Harrison and Abramovitz, "Alternates: Section 19," *Specifications for the First Presbyterian Church, Stamford, Connecticut*, September 23, 1955, 1.
[28] "Speech #2," 7.
[29] Harrison and Abramovitz, "First Presbyterian Church, Stamford, Connecticut," Chapel Details. February 28, 1955. Corrulux Corp. "Corrulux: translucent structural panels, a new idea in building. Brochure (1950). https://archive.org/details/CorruluxTranslucentStructuralPanelsANewIdeaInBuilding. (Accessed March 24, 2017).
[30] Harrison and Abramovitz, Chapel Details. Hands on access was not available at the time of our survey.
[31] "New Concept in Churches," 9.
[32] National Historic Landmark Nomination form for the First Presbyterian Church, Stamford, CT. Draft 2, September 15, 2016, 13.

1976-77 Foundation Restoration

Concrete Repairs

Wallace K. Harrison, DeLuca Construction Company, and engineering consultant, Viggio Bonnesen, reviewed concrete damage the foundation of the Sanctuary. Six samples of concrete were analyzed, and the cause of the deterioration was deemed the result of an alkali silica reaction (ASR) in the concrete.[33] ASR is a chemical reaction between water, the alkali components of the concrete, and specific silica in the aggregate. Where a chemical gel forms between constituents, the resultant stress fractures both the aggregate and matrix material, causing characteristic cracks in the concrete.

This restoration reportedly began after, "Large areas of distressed concrete were observed including a section adjacent to main entrance, where we had previously applied a protective covering of metal lath with cement plaster. Interior wall cracks were transmitted clear through this coating."[34] No record has been located regarding the application of the referenced lath and cement plaster.

DeLuca performed a restoration to the foundation on the south, east, and west elevations beginning in October 1976. It does not appear that work was performed on the north elevation as part of this campaign. Areas of distressed concrete were excavated, and the horizontal shelf was dressed down to have a pitch of 1-foot to 12-feet away from the building.[35] Sound areas of concrete were bush hammered to remove a previously applied "grout coating of concrete" and the exposed areas were sandblasted to remove loose material. Exposed steel was "bright-cleaned" by hand and sandblasted.[36]

The concrete and reinforcing bars at the existing vertical walls of the foundation were coated with a liquid epoxy adhesive (Brush-Bond 1001 by Adhesive Engineering Co.) in an attempt to provide a weatherproof seal and bond new concrete to the foundation. Deep losses in the concrete were built up with layers of a cementitious material. A 3/4-inch stucco coating was applied to the face of Narthex base (except for the north side) using High Early cement anchored with the epoxy bonding adhesive.[37]

The horizontal shelf of the base was coated with a two-part epoxy (Floor Fix, 1180 LPL, by Adhesive Engineering Co.) mixed 1:2 with ottowa [*sic*] sand to create a paste like consistency. Grenadier reportedly applied this in borderline low temperatures. Application issues such as sagging were noted, and rough areas were ground down with a disc sander. Within forty-five days, shrinkage cracks were noted in the coating at roughly 5-foot and 10-foot intervals. By mid-summer of 1977, these had increased and the material was delaminating from the substrate. The coating was subsequently removed from the foundation at the south elevation. Deluca applied "cement adhered to the freshly exposed concrete with Brush Bond 1001," like the work previously performed at the vertical foundation walls. Liquid epoxy was injected under pressure at "about eight" cracks in the existing coating on the Narthex foundation.[38]

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33 Winthrop P. Moore, "Sanctuary Restoration 1976-1977," (Memo Report, January 1978), 1.
34 Ibid., 1.
35 This work was specifically documented below the shingled portion of the façade. The extent of work performed below the portions of the façade with dalle de verre was not recorded.
36 Moore, 2-3.
37 Ibid., 2.
38 Ibid., 3.

Construction of Trench and Retaining Wall

A three-foot trench was reportedly excavated from the landscaping surrounding the Chancel, Narthex, and along the south elevation.[39] An 8-inch concrete masonry unit retaining wall was constructed in the trench approximately 30 inches away from the exposed Sanctuary foundation on a new concrete slab. The exposed foundation and exterior of the cement block retaining wall were coated with a waterproofing material identified as Karnak.[40] The trench was filled with crushed stone to move rainwater away from the foundation.[41] A reinforced concrete slab was then poured at grade level over the crushed stone and concrete block wall.[42]

Waterproofing Coating and Sealant Deterioration

A 1978 report describing the campaign identified a problem on the north elevation in the form of the partially failed original clear acrylic coating, which could not be removed to facilitate the application of a new coating. Presumably, it had largely weathered from the south and east elevations.[43] The report does not include a record of applying any new coatings above the concrete base on any elevation.

The report stated a two-part "Thickol [*sic*] based" product that matches the description of the originally specified caulking material exhibited adhesion issues and allowed water to enter and penetrate the concrete. Water infiltration reportedly damaged concrete and rebar in several areas. The report referenced extensive excavation to the base of the central column at the interior of the Narthex in 1974 and its repair in 1977.[44] However, no reference was made to the deteriorated caulk being replaced as part of the work.

1980s Restoration of the South and East Facades

Concrete Deterioration Documentation

By 1985, the 1978 coating applied to the base of the building exhibited delamination, which resulted in "minor damage" to the concrete substrate. Despite areas of material failure, the previous treatment was considered to have generally halted the large-scale concrete deterioration.[45] Additional analysis during this campaign reported the presence of ASR in the concrete framework and the foundation where samples were tested.[46]

In addition, the inspection found that numerous patches "done over the years (some quite large)" were deteriorated. Efflorescence and a failure of "almost all of the protective coatings"

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[39] Archival records to not indicate similar work was performed on the north elevation.
[40] Karnak Corporation still exists and manufacturers waterproofing products. The specific product applied to the façade in 1977 is undetermined.
[41] Based on available archival information, it is not known whether a French drain or other drainage system was installed to direct the water away from the base of the building.
[42] Moore, 2. Note that the extent of this slab installation around the building is not evident from the report.
[43] Ibid., 4.
[44] Ibid., 5. No further information about the referenced interior interventions has been located.
[45] This finding was part of a larger investigation that determined that the building was structurally sound with no evidence of settlement. Eberson and Toto, architects, P.C. and Viggo Bonnesen & Assoc. (Consulting Structural Engrs.), "Final Report: Investigation of the Sanctuary: First Presbyterian Church, Stamford, Connecticut," September 5, 1985, 6.
[46] Sidney Diamond, Ph. D (Sidney Diamond and Assoc.), letter to Viggo Bonnesen (Vigo Bonnesen and Assoc.), March 21, 1985.

were identified.[47] One pre-cast panel was noted as exhibiting unusual deterioration, and an analysis of a core taken from the concrete showed it had a high level of calcium chloride, presumably added to accelerate its cure.[48] The report identified the south façade as being in the most critical need of restoration, followed by the east and then the north.

The report partially attributed the visible damage at the cast-in-place concrete to its lack of air entrainment additives, which were recommended to minimize freeze-thaw damage.[49] The report additionally postulated that some of the cast-in-place concrete had been poured late in the season and had not been allowed sufficient time to cure before the acrylic coating was applied and sealant was installed. These coatings were said to have interfered with both the concrete setting and subsequent applications of maintenance coatings.[50]

Dalle de Verre Conditions and Replacement

Deterioration of the dalle de verre prompted Rohlf's Stained & Leaded to test the installation of an epoxy dalle de verre panel in the Sanctuary in 1983.[51] The skyward-facing dalle de verre panels above the roofline were considered in "good condition" though; a couple of years earlier a "urethane rubber membrane" system pigmented to match the concrete was applied in this area.[52] A 1985 report recommended that, "no removal of top coatings/plexiglass be done at this time."[53] Deterioration of the dalle de verre elsewhere, including glass cracking and discoloration, was attributed to the large temperatures variations experienced by the south wall over the course of a day, the rigid connection of the panel and framework with hard grout, and the minimally pitched walls retaining moisture rather than shedding it.[54] The clear acrylic coating originally applied to the entire facade had weathered away from the south wall but remained on the north wall, where it had begun to degrade, darkening the appearance of the glass.[55] The study discredited the use of dalle de verre constructed with concrete and favored fabrication with an epoxy matrix following consultations with three American stained glass studios: Rohlf's Stained Glass Company; Willet Studio; and Cummings Studio.[56]

The 1986 restoration called for the replacement of all concrete dalle de verre below the roofline on the south and east elevations with epoxy dalle de verre. Rohlf's Stained and Leaded Glass Company performed this major work. Tests to remove the panels indicated that some would be lost during the process due to existing cracks opening further and compromising the

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[47] Eberson and Toto, "Final Report," 7.
[48] Sidney Diamond, Ph. D (Sidney Diamond and Assoc.), letter to Viggo Bonnesen (Vigo Bonnesen and Assoc.), June 29, 1985. Also explained in minutes from "Meeting with Mike Toto for his findings, opinions, recommendations re. PFC [*sic*] Sanctuary problems," August 29, 1985, 1. The location of the deteriorated and tested pre-cast panel has not been determined.
[49] Petrographic analysis performed by Highbridge Materials Consulting, Inc. during the current study indicated that the cast-in-place concrete comprising the façade framework is air entrained, but the cast-in-place concrete at the base and the pre-cast concrete units are not. See the "Laboratory Testing" section of this report for additional information.
[50] Eberson and Toto, "Final Report," 4.
[51] Rohlf's Stained and Leaded Glass Studio, Letter to Members of the Building Committee, April 26, 1984, 2. The location of this test is undetermined.
[52] George Grenadier (The Grenadier Corporation), Letter to Michael Toto (Eberson and Toto Architects, P.C.), August 29, 1985. No additional records of this application have been found to date. It is assumed that this was just applied to the pre-cast panels, but it may have also been applied to the cast-in-place concrete in this area.
[53] Eberson and Toto, "Final Report," 8.
[54] "Meeting with Mike Toto," 1.
[55] Grant Annable, Letter to Capital Fund Drive Contributors, June 22, 1986.
[56] Eberson and Toto, "Final Report," 8.

integrity of the panels. Rohlf's Studios estimated that 70% of the panels suffered from severe cracking and that 5-10% more would crack during removal and would require replacement.[57] Eventually the panels proved easier to remove than expected, but all panels were replaced rather than repaired. This decision appears to have been made in part to address the challenge presented by sandblasting the adjacent concrete to clean the building, which would have etched the glass if it was not properly protected.[58] The solid concrete panels set in the larger pre-cast concrete units on the east elevation were initially scheduled to remain in place, but these were eventually replaced with epoxy panels as well; the reason for this change is unknown.[59]

Dalle de verre panels were photographed, and rubbings were taken to identify the exact size and position of the glass in the concrete.[60] The panel removal procedure consisted of cutting joints with a diamond blade; chiseling out corners by hand; loosening the panel; and removing it by pushing outwards from the interior and lying the panel on piece of plywood.[61]

The Contract Documents required that a "professional color selector" make a drawings/color chart for replacement of glass, but no record has been located regarding how replacement glass was matched to the original.[62] Most the replacement dalles were reportedly Blenko glass, but where appropriate color matches could not be found, French Saint Gobain glass was used. Heritage produced the new glass containing color streaks.[63] No record identifying which colors each manufacturer produced or which panels contain the different types of glass was found.

Archival documents suggest the new dalle de verre panel matrix was fabricated with Thermoset 116 Epoxy Resin for Faceted Glass, manufactured by Thermoset Plastics, Inc.[64] Extra effort was made during the new epoxy panel production to recess the interior of the glass dalles relative the matrix material by 1/4 inch to match the appearance of the original dalle de verre.[65] New panels were cast in two pours without internal reinforcement. A black aggregate finish was applied to the interior side of the epoxy matrix to simulate the dark appearance of the interior face of the concrete panels. A tan sand finish was applied to the exterior side of the epoxy panels, perhaps to match the appearance of the exterior cast-in-place concrete framework, which is currently obscured by a coating.

Archival information suggests the new panels were fabricated 3/8 inch smaller in height and width to allow for thermal and moisture expansion and contraction and set on neoprene blocks against Tremco butyl tape.[66] The sides of the existing rabbeted panel frames were modified and

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[57] Michael Love (Rohlf's Stained & Leaded Glass, Inc.), Letter to Michael Toto (Eberson and Toto Architects, P.C.), March 31, 1986, 1.
[58] Eberson & Toto Architects, P.C., "Report to the Building and Maintenance Committee on the Status of Corrective Work to the Sanctuary of the First Presbyterian Church of Stamford, CT," May 28, 1986.
[59] Eberson and Toto, "Restoration of the Sanctuary", 3.
[60] Ibid., 1. Work was confirmed by Peter Rohlf in a discussion with Laura Buchner (BCA) and members of Prudon & Partners on December 19, 2016. It is assumed that all panels were documented with this method. Attempts to take apart a salvaged panel in the BCA laboratory for the purposes of materials testing found that evenly severely cracked concrete is firmly held together by the embedded steel wire, which suggests that it was possible to document the configuration of the glass in significantly cracked panels removed during the restoration.
[61] Michael Love, March 31, 1986, 1.
[62] Eberson and Toto, architects, P.C. and Viggo Bonnesen & Assoc. (Consulting Structural Engrs.), "Restoration of the Sanctuary: The First Presbyterian Church, Stamford, Connecticut," July 1986, 2.
[63] Laura Buchner (BCA) and Members of Prudon & Partners in discussion with Peter Rohlf of Rohlf's Stained & Leaded Glass, December 19, 2016.
[64] Thermoset 116 Product Data Sheet, Located in Archival Project Records of Rohlf's Stained & Leaded Glass.
[65] Rohlf's Stained and Leaded Glass Studio, April 26, 1984, 5.
[66] Michael Love, March 31, 1986, 1.

drilled for new mechanical fasteners, which were embedded in the epoxy matrix and specified to withstand 85 mph wind loads (Figure C2).[67]

1986 Restoration Scope

The 1986 restoration drawings by Eberson & Toto Architects P.C. and Viggo Bonnesen & Associates, Structural Engineer designed the restoration work to wrap the north elevation only to southwest entrance on the west and the enclosed walkway on the east (Figure A20). No work was specified at the entrances, in the courtyard on the north elevation, or on the interior of the north or west elevations. The restoration documents included the following work in addition to the replacement of the dalle de verre:

- Exterior of South and East Elevations:
    - Concrete below the roofline was to be sandblasted clean to remove existing coatings of Preco, Thoroseal, and the original acrylic coating.[68]
    - A reglet was to be cut into the concrete along the roofline on the south and east and filled with sealant after the installation of a new waterproofing coating (Figure A21 and C3).[69]
    - Drawings initially called for all spalls greater than 1/4 inch deep to be patched with Preco Renderoc HB. The concrete was then to be coated with silane penetrant (Fosroc Silane P-20) followed by two coats of masonry topping (Fosroc Pliotone with aggregate).[70] Records indicate that in lieu of this coating system, STO BTS-B was applied over the concrete substrate with an embedded STO Mesh. STO Primer and STO Superlit K2 were then applied (all products by STO Industries, Inc.). The STO aggregate finish was selected to match the aggregate on the epoxy matrix of the new adjacent dalle de verre. Sikaflex 15LM, a one component polyurethane sealant that was not recommended by STO Industries, was initially used to seal the joints, but this was installed improperly and quickly failed.[71] The sealant was removed and Dow Corning 790 silicone sealant was recommended in its place.[72]
    - Lead coated copper flashing was coated to prevent further staining.[73]
    - Existing coatings were removed from the concrete base along the south, east, and west elevations and the concrete was patched before applying the same coatings as selected for the concrete wall surfaces.[74]
    - Sealant was replaced at wall joints and waterproofing was addressed at the base of the building (Figures C4-C10).[75]
- Interior of the South and East Elevations:
    - All concrete surfaces below the roofline were to be wire-brushed; patched/grouted as necessary; primed using Fosroc Nitoprime; and coated with a masonry/concrete paint to match the existing concrete.[76] The interior scope of work was only up to the roofline; repainting stopped at that level (Figure

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[67] Eberson and Toto, "Restoration of the Sanctuary", Detail A/5.
[68] George Grenadier, August 29, 1985. No record has been found regarding when the Preco or Thoroseal products were applied.
[69] Eberson and Toto, "Restoration of the Sanctuary", 2 & Detail B/5.
[70] Ibid., 2.
[71] Jan Nogradiz (STO Industries, Inc.), Letter to Arnold DiGregorio (STO of New York), Sept. 18, 1987.
[72] Jan Nogradiz (STO Industries, Inc.), Letter to Arnold DiGregorio (STO of New York), Nov. 23, 1987.
[73] Eberson and Toto, "Restoration of the Sanctuary", 2.
[74] Ibid., 2.
[75] Ibid., 5.
[76] Ibid., 2.

A22).[77]

- New sealant was to be installed around the new replacement epoxy panels.[78] (There is currently no interior sealant installed in these joints; the flexible foam expansion joint filler is visible).

Plexiglass protection panels set in monel metal frames with weeps over the dalle de verre at the roof were scheduled to remain.[79] The EP Elastic rubber coating on the concrete roof panels containing dalle de verre was also scheduled to remain and be protected (Figure C3). Where the coating was damaged by the protection or restoration work, it was to be re-applied.[80]

1990s Maintenance Campaigns

A 2003 Water Infiltration Investigation report by Hoffmann Architects, Inc. references series of interior and exterior repairs performed in the early 1990s.[81] These documents were not available for review by BCA, and the extent and details of the work executed is undetermined.

- Memo and Specs by Ben Dondlinger (Sept. 10, 1992)
- Masonry Repairs Proposal by The Grenadier Corp. (April 20, 1993)
- Interior Grouting and Coating Proposal by The Grenadier Corp. (July 14, 1993)
- Interior Concrete Repair and Painting Proposal by Porto, Inc. (July 21, 1993)
- Interior Concrete Painting Specification by Walls/O'Keeffe Assoc., Inc.
- Letter Quote for Touch-up Painting by Richard Porto (August 23, 1993)
- Letter Report on Exterior Wall Water Leakage by John O'Keeffe (December 15, 1993)
- Letter Report on Exterior Water Leakage Church Nave by John O'Keeffe (May 2, 1994)

The Hoffman report noted that an elastomeric coating called COMAX was applied to the north elevation circa 1994.[82] No information was provided regarding who applied this coating or what cleaning and repairs were performed in conjunction with its application. The appearance of the coating in report images suggests that it is the same one that is currently visible on the north elevation.

The Hoffman report also stated that the sealant in concrete joints on the south and east elevations, where the STO product was previously installed, was replaced with a silicone sealant circa 1995 (a possibly erroneous date since replacement of the sealant with a silicone based material was recommended in 1987).[83]

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77 Ibid., 4. No documentation was found of work being performed on the north interior elevation during this campaign.
78 Ibid., 2.
79 Ibid., 3.
80 Ibid., 2, Detail B/5. The nature of this coating is not evident from archival information. Direct access was not available for review of the existing coating.
81 Hoffman Architects, "Water Infiltration Investigation: First Presbyterian Church, Stamford, Connecticut," April 8, 2003, 40-41.
82 Ibid., 18.
83 Ibid., 20. Nogradiz, Nov. 23, 1987.

Circa 2003-2007 Waterproofing Campaign

Exterior Conditions

In 2003, continuing moisture penetration prompted a waterproofing study followed by repairs to the Sanctuary and areas of adjoining Parish House. Water infiltration was noted primarily at the south and east elevations of the Sanctuary.[84] A report by Hoffman Architects stated that the STO product applied in the 1980s had deteriorated and exhibited cracks, spalls, and delamination, and silica gel was weeping through cracks in the coating at the foundation wall.[85]

The coating on the north elevation differed from the other elevations, and two types of existing sealant were identified. An older polyurethane sealant, found primarily between the concrete, slate, and metal flashing and at the skyward-facing panels on the north side, had lost its elasticity and was splitting. A silicone sealant present on the east and south elevations, between concrete units where the STO material was applied and at the plexiglass over the skyward-facing panels on the south and east, was typically well bonded to its substrate; however, some adhesive failure was noted.[86]

The existing low sloping roofs over the North Passage and the Choir Room were also identified as issues of concern since they pitched towards the Sanctuary walls.[87]

Interior Conditions

The following interior conditions were noted in the Nave because of water infiltration:

- Blistered paint and spalled concrete at the cast-in-place concrete on both the north and south elevations.
- Water stains at the sound insulation boards at the east end.
- Efflorescence on the concrete on the north wall and the underside of the roof deck.

Interior concrete deterioration visible above the Narthex vestibule doors on the south elevation was attributed to the previous removal of flashing at the roof over the main entrance and installation of sealant in its place. In addition, a drain in this area was found clogged with debris. Deterioration was similarly noted at the interior concrete surrounding the southwest entrance doors.[88]

Glass Deterioration

On the south elevation, the glass was described as "generally free of defects." On the north elevation, the dalle de verre exhibited cracked glass, water stains, and efflorescence.[89] Following consultation with Rohlf's Stained & Leaded Glass, Hoffman recommended replacing individual units of broken glass with new glass set into the existing concrete matrix with sealant.[90]

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84 Hoffman Architects, "Water Infiltration Investigation," 2.
85 Ibid., 15
86 Ibid., 20.
87 Ibid., 24.
88 Ibid., 4, 24.
89 Ibid., 24.
90 Ibid., 33.

Scope of Waterproofing Campaign

Construction drawings by Hoffmann Architects, Inc. specified the following scope of work:

- Replacing existing STO coating on concrete on the south and east elevations.[91] A new coating was also recommended for the uncoated concrete at the northwest and southwest entranceways.[92]
- Cleaning and "repairing" the elastomeric concrete coating on the north elevation, which was well adhered but exhibited biological growth and some cracks.[93] The coating was splitting apart at several locations where it had been applied over the sealant joints.[94]
- Removing the metal roofing over the northwest and southwest entrances and providing an elastomeric coating.[95]
- Replacing all protective glazing at skyward-facing triangular dalle de verre panels with new aluminum framed protective glazing (Figure C11).[96] A detail was also included in the Construction Drawings for aluminum framed protective glazing over the colored glass portals (Figure C12)[97]
- Repairing cracks in the concrete with an epoxy gel, and patching spalls in concrete with a patching material.
- Temporarily removing and reinstalling slate as necessary for flashing replacement. Lead coated copper edge flashing was to be replaced in isolated locations.[98]
- Repairing the existing cracks and routing out a new control joint at both sides of the granite plaque near the main entrance on the south elevation.[99]

No work was called for at the Narthex entrance canopy on the south elevation, where a previous elastomeric coating was applied and reported to be in good condition.[100]

The current observations indicate that:

- Individual glass dalles were not replaced during this campaign.
- The existing coating on the south and east elevations appears to be elastomeric, but the brand and manufacturer is unknown.
- The metal roof at the southwest entrance was coated rather than removed; the northwest entrance roof was not accessible for review at the time of this survey.
- Where flashing was replaced, the new flashing appears to be stainless steel.
- Interior water damage was not addressed following the exterior waterproofing campaign.

2015-2016 Mechanical System Upgrades

The building was designed with floor vents at the perimeter of the Sanctuary. In 2015, the

[91] Hoffman Architects, "Building Envelope Rehabilitation: First Presbyterian Church," July 11, 2005, 2.
[92] Hoffman Architects, "Water Infiltration Investigation," 33.
[93] Ibid., 18. Hoffman Architects, "Building Envelope Rehabilitation," A3
[94] Hoffman Architects, "Water Infiltration Investigation," 18, 34.
[95] Hoffman Architects, "Building Envelope Rehabilitation," A2, A5.
[96] Ibid., A3-A4.
[97] Ibid.," Detail 7/A6.
[98] Ibid., A3-A4. The NHL Nomination draft narrative identifies this work as completed in 2007. National Historic Landmark Nomination, 6.
[99] Ibid., A3.
[100] Hoffman Architects, "Water Infiltration Investigation," 19.

original boilers were replaced with gas-fired heating system.

An air condition system is planned for installation in the Sanctuary, but work had not yet begun at the time of this survey. The new system is expected to affect the differential temperatures on the interior and exterior of the panels and the interior relative humidity. Its resultant impact on the dalle de verre glass and matrix conditions is unknown.

Laboratory Testing

Glass Characterization

BCA removed samples from cracked and delaminating glass on the interior of the north and south elevations for characterization using a scanning electron microscope with energy-dispersive X-ray spectroscopy (SEM/EDS). In addition, sound pieces of glass were removed from an original concrete dalle de verre panel previously removed and salvaged during the 1980s restoration.[101] See Figures 1-2 in Appendix E for sample locations.

The dalle de verre panels at the Fish Church are comprised of soda-lime-silica glass. Typically, such glass is comprised of 70% SiO_2, 10% CaO, and 20% Na_2O.[102] SEM/EDS confirmed that the composition of the glass at the Fish Church varies from this recommended formulation, which contributes to its instability and deterioration. Efflorescence analyses using SEM/EDS and X-ray Diffraction (XRD) identified the presence of sodium carbonate on the surfaces of the original and replacement glass.[103]

This evidence is consistent with a type of deterioration known as "glass disease" or "crizzling," a type of damage formed due to an unstable glass composition containing an abundance of sodium and potassium oxides. The oxides are soluble; exposure to moisture and carbon dioxide causes them to convert to sodium or potassium carbonate salts.[104] These carbonate salts, which are hygroscopic, meaning they absorb or attract moisture in the air, leach out of the glass and leave behind a fragile, porous hydrated silica network.[105] Crizzling progresses through the following five stages:[106]

1. "Initial" Crizzling: the glass takes on a cloudy or hazy appearance that can be removed with washing.
2. "Incipient" Crizzling: the glass appears cloudy like during Stage 1, but the haze does not completely disappear if the glass washed. In addition, very fine cracks form, which are difficult to discern with the naked eye.

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[101] The dalle de verre panel was originally located in precast panel S12 on the south elevation. Rohlf's Stained & Leaded Glass provided this panel to The Highland Green Foundation.
[102] Stephen P. Koob, *Conservation and Care of Glass Objects*, (London: Archetype Publications Ltd., 2006), 11. In her dissertation, "The Consolidation of Architectural Glass and *Dalle de Verre*; Assessment of Selected Adhesives," Kristel De Vis described the common composition of soda-lime-glass as being comprised of the following ranges of material: 70-75% SiO_2, 5-10% CaO, and 13-17% alkali material. Kristel De Vis, "The Consolidation of Architectural Glass and *Dalle de Verre*; Assessment of Selected Adhesives," PhD diss., Universiteit Antwerpen, 2014, 184.
[103] See Appendix E for additional information about the SEM analysis of these salts and Appendix F for additional information about the XRD analysis.
[104] Koob, 118.
[105] Hamilton, Donny L. "Methods of Conserving Archaeological Material from Underwater Sites: Conservation of Glass," Nautical Archaeology at Texas A&M University, http://nautarch.tamu.edu/CRL/conservationmanual/File5.htm#SUMMARY (accessed March 1, 2017).
[106] Koob, "Atmospheric Deterioration of Glass: Crizzling," Chapter 12 in *Conservation and Care of Glass Objects.*

3. "Full-blown" Crizzling: uniform cracking is visible.
4. "Advanced" Crizzling: distinctive cracking, deep enough to create small surface losses.
5. Fragmentation Stage: cracking reaches a depth that affects the glass structurally and it separates into fragments.

This type of deterioration may not occur uniformly across the surface of the glass and symptoms of earlier stages may be present in later stages. The rate that a glass passes through these stages is considered essentially impossible to predict and can vary from within years of manufacturing to decades or centuries.[107]

Crizzling is most commonly observed in 16th-19th-century glasses, but has been identified in modern studio art glass.[108] Similar glass deterioration was documented in the dalle de verre at St. Theodore Church in Beringen (Belgium).[109]

See Appendix E for the laboratory report related to the compositional analysis of the glass.

Efflorescence Characterization

BCA removed samples of efflorescence present on the interior surfaces of glass on the north and south elevations; the concrete dalle de verre matrix material on the north elevation; and cast-in-place concrete on the north and south elevations. See Figures 1-2 in Appendix F for sample locations. All samples were subjected to X-ray Diffraction (XRD) for characterization. The salts removed from the glass were also examined using SEM/EDS.

The sodium carbonate salt present on the glass in the both the original dalle de verre panels and the replacement panels is forming from the interaction of the alkali material in the glass with moisture and carbon dioxide in the air.

The efflorescence removed from the concrete matrix that comprises the dalle de verre is gypsum (calcium sulfate). The efflorescence removed from the interior of the cast-in-place concrete framework and base is thenardite (sodium sulfate). Both salts are common deposits on concrete structures and form as the result of material constituents leaching out of the materials themselves.

See Appendix F for the laboratory report related to this efflorescence analysis.

Concrete Analysis

In order to compare the concrete used to fabricate the different façade components, four concrete cores were removed and sent to Highbridge Materials Consulting, Inc. for petrographic analysis and characterization. The cores locations were generally selected on the north exterior elevation based on archival research suggesting fewer interventions were performed in this area. See Appendix G for details regarding sampling methods and locations. See Appendices H-K for the full laboratory reports related to the analysis of each material. The following locations were sampled:

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[107] Koob, 125.
[108] Ibid., 127.
[109] De Vis, 186.

- The cast-in-place concrete framework on the north elevation (See Appendix H)
- A pre-cast concrete panel on the north elevation (See Appendix I)
- The concrete base on the north elevation (See Appendix J)
- An original concrete dalle de verre panel removed from the south elevation during the 1980s restoration (See Appendix K)

According to archival information, Lone Star "Incor" high early strength Portland cement was used throughout the original construction.[110] "Extra cement and thorough vibration" was reportedly used to fabricate the concrete ribs.[111] This analysis identified additional variations between the four types of concrete elements tested. See Table 1 below for a summary comparison of the analyzed samples.

Archival information suggested the presence of alkali silica reaction (ASR) in the some of the historic building materials; therefore, the petrographer reviewed each sample to determine the potential for this type of reaction.[112]

Table 1: Summary Comparison of Concrete Cores

<table>
<tr><th>Sample</th><th>Cement Binder</th><th>Aggregate</th><th>Permeability, Freeze-Thaw, and Air Entrainment</th><th>Carbonation Depth (mm)</th><th>ASR Susceptibility</th></tr>
<tr><td>Cast-in-Place Framework</td><td rowspan="3">Portland cement with no supplementary cementitious materials</td><td>Dolostone & Well-graded quartz</td><td>Modest permeability. Marginal freeze-thaw resistance. Evidence of air entrainment additive.</td><td>18-25</td><td>Dolostone may contain bands of chert and chalcedony.</td></tr>
<tr><td>Pre-Cast Panel</td><td rowspan="2">Quartz sand & Strained quartzite</td><td>Highly permeable. Susceptible to freeze-thaw. No evidence found of an air entrainment additive.</td><td>15-17</td><td rowspan="2">Strained quartzite is susceptible to ASR in moderate to long time scales.[113]</td></tr>
<tr><td>Cast-in-Place Base</td><td>Dense relatively water-resistant concrete matrix. Reduced susceptibility to freeze-thaw. No evidence of air entrainment additive.</td><td>1-2</td></tr>
<tr><td>Dalle de Verre Matrix</td><td>Calcium aluminate cement</td><td>Chert, Quartz grains, & Limestone</td><td>Highly porous and relatively soft</td><td>Not Measured</td><td>Chert not of concern in an aluminate cement-based mixture.</td></tr>
</table>

[110] "Space enclosed 'archi-structurally'."
[111] "Joints Between Precast Panels Frame Church," 108.
[112] ASR is a chemical reaction between water, the alkali components of the concrete, and specific silica in the aggregate. Where a chemical gel forms between constituents, the resultant stress fractures both the aggregate and matrix material, causing characteristic cracks in the concrete.
[113] "Moderate to long time scales" refers to a period of approximately 30 or more years. John Walsh (Highbridge Materials Consulting, Inc.) in conversation with Laura Buchner (BCA), February 2017.

Cast-in-Place Concrete Framework

The cast-in-place concrete is characterized as normal weight, air-entrained, portland cement concrete with no supplementary cementitious materials. There are no obvious deficiencies in the mixing, placement, or hydration of the concrete sample, nor are there signs of physical or chemical distress. Its aggregate is comprised of carbonate crushed stone, consisting of a relatively pure dolostone, and well graded quartz sand. The aggregates present are not normally considered susceptible to ASR. However, dolostone can sometimes contain bands of alkali sensitive chert and chalcedony that increase the risk of ASR.

An abundance of fine air-voids indicates the presence of an air entrainment additive. Its water-cement ratio is higher than desired for exterior concrete; although it is not considered excessive, it results in modest permeability. Carbonation was found to a depth between 18-25 mm from the outer surface.

Pre-cast Concrete Panel

The pre-cast concrete is characterized as normal weight, portland cement concrete with no supplementary cementitious materials and no air entrainment. There is no evidence of obvious deficiencies in the mixing, placement, or hydration exhibited in the concrete sample. The water-cement ratio is estimated as moderately high, resulting in a highly permeable concrete matrix that is not especially suitable for exterior applications. The drying and shrinkage during the first one or two years after casting may have been greater than anticipated due to the high water content. The lack of air-entrainment makes the concrete susceptible to freeze-thaw. Carbonation was found to a depth between 15-17 mm from the outer surface.

The fine aggregate is quartz sand. The coarse aggregate is natural gravel, comprised almost entirely of strained quartzite, which is known to be susceptible to alkali-silica reaction at moderate to long time scales.[114] However, the analyzed sample contains only trace evidence for early stage ASR, with no associated cracking. This reaction may be better developed elsewhere on the façade.

Cast-in-place Concrete Base

The concrete base is characterized as normal weight, portland cement concrete with no supplementary cementitious materials and no air entrainment. Its water-cement ratio is estimated to be moderately low. This mix results in a relatively dense water-resistant concrete matrix, which may reduce its susceptibility to freeze-thaw damage. Carbonation was found only to a depth between 1-2 mm from the outer surface. Two cementitious layers of repairs were noted at the surface of the concrete, followed by the application of an elastomeric coating.

The fine aggregate in the concrete is quartz sand. The coarse aggregate is a natural gravel, comprised mostly of strained quartzite, with the same reactive potential as the aggregate identified in the pre-cast panels. Like the pre-cast concrete sample, the sample from the

[114] "Moderate to long time scales" refers to a period of approximately 30 or more years. John Walsh (Highbridge Materials Consulting, Inc.) in conversation with Laura Buchner (BCA), February 2017.

concrete base exhibits only trace evidence of ASR. The dense matrix may reduce its susceptibility to alkali-silicate reactivity.

While the sampled concrete is in sound condition with no evidence of significant cracking or secondary mineralizations, ASR may be more developed in other areas of the façade.

Dalle de Verre Matrix

The original concrete dalle de verre matrix has a calcium aluminate cement binder, which exhibits characteristic of Ciment Fondu, produced in France and commonly used for castings and refractory purposes during the period of the Fish Church panels' fabrication. The hydrated cement paste is highly porous and relatively soft. This may be the result of mixing the matrix material with a high water-cement ratio. In aluminate mortars, metastable hydrates of calcium aluminate convert to stable and more compact cubic forms during curing. Variations in the-water cement ratio affect this conversion and result in differences in volume stability, permeability, and durability, potentially leading to cracks, which can allow water infiltration and facilitate corrosion of the embedded steel reinforcement.

The aggregate in the analyzed sample consists of 51% chert, 34% quartz grains, and 15% and limestone grains. Although chert is among the most alkali reactive rock types in portland cement-based concrete and mortar, in the aluminate cement-based mixtures it is stable because "the only hydroxide to form during hydration is gibbsite and this is not reactive with poorly crystalline forms of silica in the same way that calcium hydroxide is."[115]

A "cementitious skim coat" appears to have been applied to the exterior side of the sample; its date of application is undetermined. It obscures the surface so it cannot be determined if the aggregate was originally exposed on the panel surface. Under the skim coat, there is a thin layer of uncarbonated paste long the exterior surface of the sample. This may have resulted from the acrylic reportedly applied to the exterior façade at the time of construction; this coating may have inhibited the carbonation in the newly fabricated panels.[116]

ASR Susceptibility

Archival research reviewed as part of this study suggests that the pre-cast concrete panels and the cast-in-place concrete exhibit cracking due to ASR. The present petrographic analysis identifies the constituents of the original concrete, but does not include a comprehensive analysis of the ASR throughout the entire structure. The analysis confirms that the pre-cast concrete as well as the cast-in-place framework contain alkali reactive aggregate that makes the concrete susceptible to ASR, but the samples removed from the north elevation exhibit only minimal signs of such deterioration. ASR can occur in localized areas in a concrete structure. Concrete exposed to moisture or sun exposure is more susceptible to damage.[117]

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[115] Highbridge Materials Consulting, Inc. Material Analysis Report (Dalle de Verre), Report #SL113-01 (February 16, 2017), 7.
[116] For a description of this original coating, see the "Waterproof Coating" description on page 8 of this report.
[117] Michael D.A. Thomas, Kevin J. Folliard, Benoit Fournier, Patrice Rivard, and Thano Drimalas, "Methods for Evaluating and Treating ASR-Affected Structures: Results of Field Application and Demonstration Projects. Volume 1: Summary of Findings and Recommendations," Final Report. U.S. Department of Transportation, Federal Highway Administration (November 2013), 47.

Infrared Thermography

During site visits in November 2016 and January 2017, BCA produced thermal images of isolated areas of the interior and exterior elevations using a Fluke TiR32 IR Fusion Technology Thermal Imager.[118] The images included in this report take advantage of the Picture-in-Picture feature of the camera, which displays the thermogram at the center of a digital photograph to assist with interpreting the location of image.[119] In addition, during the January 2017 visit, we measured the surface temperature of the concrete and glass using a Extech Instruments IR201 Pocket IR Infrared Thermometer. See Table 2 below for the recorded information. See Figures A23-A27 for select thermograms taken during the January 2017 visit.

The thermograms illustrate the temperature variations across the wall surfaces of *like* materials only and should not be interpreted to reflect actual measurements of temperatures of all surfaces. The measured temperatures in the thermograms are affected by the varying emissivity of the materials being photographed, their texture, and color. Therefore, the temperature of the coated concrete, epoxy, and glass dalles within a single thermogram cannot be directly compared. All infrared images included in this report were computer corrected using Fluke SmartView Software (Version 3.2) to correspond to the approximate air temperature at the First Presbyterian Church at the time the images were taken and were processed based on assumed material emissivity of the coated concrete.[120]

Differential thermal expansion and contraction of the cast-in-place concrete frame, pre-cast concrete panel, and dalle de verre panel materials are expected to cause stresses in the system. The thermal readings were taken to begin to understand how the effect of this deterioration mechanism may vary across the façades.

The thermograms as well as the surface temperature measurements show wide fluctuation of environmental conditions across the façades, as well as disparities between the surface temperatures on the interior and exterior. These measurements are expected to vary throughout the course of a day and overnight, and from season to season. Further study is required to fully understand how these temperature variations impact the building fabric.

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[118] The Fluke TiR32 has a temperature measurement range of -20°C-150°C with an accuracy of +/-2°C or 2% (at 25°C nominal, whichever is greater). It has a minimal focal distance of 46 cm (approximately 18 inches) and a 320 x 240 focal plane array with a total of 76,800 pixels. The camera captures infrared thermogram of emitted thermal energy between 7.5 m to 14 m wavelengths. It also has the capacity to record images in visible light with a 2.0-megapixel camera.

[119] Fluke TiR32 Infrared Camera: Specs. http://en-us.fluke.com/products/infrared-cameras/fluke-tir32-infrared-camera.html#techspecs, Fluke. (Accessed March 20, 2017).

[120] The exterior air temperature was programmed as 45°F, based on regional recordings by Weather Underground. No interior air temperature reading was available, the interior images were therefore corrected with an estimated temperature of 60°F, which produced thermograms with temperatures similar to those measured by the Extech Instruments IR201 Pocket IR Infrared Thermometer (See Table 2). The emissivity of the substrates in the images was programmed in accordance with the typical emissivity of "concrete: dry," which is 0.92 in the "Emissivity Table," http://www.thermoworks.com/learning/emissivity_table (Accessed March 22, 2017). The emissivity of concrete was selected for this purpose because the emissivity of the light colored exterior elastomeric coating and the gray interior paint is unknown. The emissivity of glass is considered 0.92 (the same as concrete); however, the varying colors, textures, and reflective qualities of the glass dalles are expected to impact their emissivity.

Table 2: Thermal Readings for Building Envelope Materials between 12:00-1:00 PM on January 13, 2017

Recorded Weather for Region at Time of Measurements[121] Clear with northwest winds at 18.4 mph (Gust speed 26.4 mph) Air Temperature: 45.0°F (Dropping from recorded daily high of 60.1°F at 12:56 AM) Relative Humidity: 46% Wind-chill: 37.4°F; Dew Point: 25.0°F				
	Surface Temperature			
Location	Cast-in-Place Concrete	Pre-Cast Concrete Panel	Dalle de Verre Matrix	Glass
South Elevation: West End in Shade *(at eye level)*	±52°F	±53°F	±52°F *(Epoxy Matrix)*	51-57°F
South Elevation: East End in Sunlight *(at eye level)*	±73°F	±76°F	87-93°F *(Epoxy Matrix)*	86-91°F
North Elevation: East End (Entire Elevation in Shade) *(at eye level)*	±45°F	±48°F	±47°F *(Concrete Matrix)*	±46°F
North Elevation: East End (Entire Elevation in Shade) *(above roofline)*	±37°F	±39°F	*Obscured by Protective Glazing*	
South Elevation: West End Interior *(at eye level)*	±64°F	±65°F	±63°F *(Epoxy Matrix)*	±63°F
South Elevation: East End Interior *(at eye level)*	±65°F	±73°F	±82°F *(Epoxy Matrix)*	76-83°F
North Elevation: East End Interior *(at eye level)*	±59°F	±57°F	±55°F *(Concrete Matrix)*	±56°F

[121] Weather Underground. Weather History For White Plains, CT, Westchester County on January 13, 2017 at 11:56 AM. https://www.wunderground.com/history/airport/KHPN/2017/1/13/DailyHistory.html?req_city=White+Plains&req_state=CT&req_statename=&reqdb.zip=06901&reqdb.magic=1&reqdb.wmo=99999 (Accessed March 22, 2017).

CONDITIONS DISCUSSION AND RECOMMENDATIONS

Below is summary of conditions identified at the primary materials of the building envelope during this survey and recommended treatments. Appendix D provides a visual glossary of detailed conditions and the associated recommended treatments for each feature and material reviewed during this assessment. Within Appendix D, conditions have been prioritized as A, B, or C based on the following definitions to reflect the urgency of repairs.

Priority A): Potential Life Safety Issues, Waterproofing, or Loss of Material Integrity

These items relate to deficiencies posing potentially dangerous conditions that if left uncorrected could fail and possibly affect life safety and/or cause rapid deterioration of the materials, adversely affecting the physical integrity. Included in this category are issues related to waterproofing.

Priority B): Diminished Material Performance

These items relate to deficiencies affecting the integrity of the materials. Repairs may be delayed but are necessary to remedy the conditions compromising the performance of the architectural materials, which will eventually lead to further deterioration, damage, or potentially dangerous conditions. It is strongly recommended that these items be addressed within the next five years.

Priority C): Aesthetic (Restoration Treatment)

These items relate to deficiencies that are cosmetic and affect the appearance of the building but not the integrity or performance of a material or the construction system.

The recommendations in this report and Appendix D are not project plans and specifications and could easily be misinterpreted if given to a contractor, as such it should be anticipated that a qualified restoration architect or consultant will prepare precise specifications based on the findings of this report.

Sanctuary Conditions and Recommendations

Pre-cast and Cast in Place Concrete

Typical Conditions

All exterior elevations of the pre-cast concrete panels and cast-in-place concrete framework exhibit:

- General atmospheric and biological growth
- Isolated ferrous stains
- Isolated efflorescence
- Deteriorated waterproofing coatings that exhibits cracks, delamination (peeling), and erosion
- Isolated previous concrete patches
- Isolated cracks, spalls, and impending spalls

Archival information suggests that the elastomeric coating on the north elevation was installed circa 1994 and then repaired in isolated areas circa 2005, when the existing coating was applied to the south and east elevations. All elevations currently exhibit deteriorated coatings, which are allowing for moisture retention behind failed coatings and water penetration into the concrete. Moisture is being trapped behind the coating in areas, potentially exacerbating the deterioration of the concrete and corrosion of the embedded steel reinforcement.

The extent of previous repairs and underlying concrete deterioration is obscured by the existing coatings. It is currently undetermined how much of the visible network cracking is present in the coatings and how much is projecting from the concrete substrate.

Petrographic examination measured carbonation of the cast-in-place concrete framework at the base of the north elevation to a depth of 18-25 mm. The rebar in this area is estimated to have approximately 19-76 mm of concrete cover, indicating that some of the rebar is in the zone of carbonation and presently susceptible to corrosion. The depth of carbonation in the sampled pre-cast concrete panel measured 15-17 mm; the depth of concrete cover at the pre-cast panels at the base of the north elevation measured approximately 38-76 mm.[122] Although carbonation is not expected to result in corrosion damage in the pre-cast panels based on these measurements, some isolated spalls presently expose ferrous rebar, suggesting that the rebar is inconsistently covered and at some locations exists within the zone of carbonation.

The interior concrete exhibits:

- General atmospheric soil and heavy soil depositions on horizontal surfaces
- Isolated ferrous stains
- Isolated efflorescence
- Inconsistent paint finish applications
- Inappropriate skim coat repair materials visible in isolated areas where the finishes are failing
- Non-matching cementitious patches
- Cracks, spalls, and impending spalls in both the skim coat repair materials and concrete

[122] BCA surveyed the concrete using a Protovale Rebar Locator. This equipment can detect rebar within 6 inches of the surface.

- Cracks between the cast-in-place concrete framework and pre-cast panels, which may represent cold joints obscured by previous patching material

Ongoing water infiltration is evident on the north, south, and east interior elevations. This is compromising existing finishes, forming bubbles and resulting in flaking paint. Areas exhibiting interior water damage often correspond to areas of exterior sealant deterioration. This was observed along the juncture of the roof and wall panels in the Nave and at the vertical cast-in-place concrete framework and pre-cast panels on the east wall of the Narthex.

Treatment Recommendations

- Remove all exterior coatings.
- Remove deteriorated interior coatings.
- Remove efflorescence on interior and exterior concrete with poultice materials.
- Following the removal of coatings, remove deteriorated concrete. Clean, prepare, and coat exposed rebar and provide cementitious patches matching adjacent concrete.
- Following the removal of coatings, provide rout and fill cementitious crack repairs, where necessary.
- Following the removal of coatings, remove and replace existing concrete patches that exhibit deterioration or do not match adjacent original concrete.
- Provide new breathable silane waterproofing coating to exterior concrete. Testing is required to determine if one product can be applied to all elevations to simplify future maintenance.[123]
- While applying the new waterproofing coating, provide protection of the glass or methods to keep the coating from affecting the appearance of the glass.
- Further review of the cracks visible on interior between the cast-in-place concrete framework and the pre-cast panels is required by the engineer.
- Perform a finishes analysis of the interior concrete to identify the original color for future repainting campaigns.

BCA recommends performing the following additional investigation in advance of finalizing treatments:

- Strip all coatings from areas of exterior concrete on the north, east, and south elevation to evaluate the number and types of layers present and the appearance of underlying materials. Perform at least one test over an area of typical network cracks in the coating on the south elevation, to determine whether the cracks project from the concrete substrate. Test the following methods for exterior paint removal:
    - Micro-abrasive and sponge systems (avoid areas containing glass)[124]
    - Chemical paint strippers rinsed with a pressure washer/vacuum system to minimize water runoff over dalle de verre

  The system used on the south and east elevations might vary from that on the north elevation and skyward-facing panels, as removal and replacement of the epoxy dalle de

[123] A silane coating is recommended based on its success at other sites to reduce damage in ASR affected concrete and because of its ability to be reapplied as a part of future maintenance campaigns. Thomas and others, "Methods for Evaluating and Treating ASR-Affected Structures."
[124] Micro-abrasive cleaning is not recommended in areas where existing adjacent dalle de verre panels are scheduled to remain. Specifically, we recommend that it not be employed on the north elevation or on skyward-facing roof panels.

verre would eliminate concerns about damaging glass and therefore provides for more flexibility in cleaning materials and systems.
- Perform additional petrographic analysis on additional cores removed from the cast-in-place concrete on the south and east elevations, at areas exhibiting cracks and exterior efflorescence to establish variations in concrete composition and the presence of ASR, which was reported in archival documents.[125]

Dalle de Verre

Typical Conditions

Conditions noted in both original (concrete) and replacement (epoxy) dalle de verre panels:
- Minor leaks through hairline separations between isolated dalles and the adjacent matrix material
- Minor leaks through fine cracks in the matrix materials
- Leaks at the perimeter of panels
- Previous inappropriate glass repairs
- Isolated cracks in dalles
- Isolated dalles exhibit cracked and delaminating glass
- Efflorescence on dalles and adjacent matrix material in areas of significantly deteriorated glass

Conditions unique to the original concrete panels:
- Isolated interior metal anchors appear to be pulled away from the larger pre-cast concrete units[126]
- Deteriorated exterior waterproofing coating exhibits cracks, delamination (peeling), and erosion
- Exterior concrete coating overlaps the edges of the glass and is visible on the interior (Figure A28)
- Old coatings and adhesive residue on the exterior surfaces of roof panels
- Condensation between the existing protective glazing and the panels on all elevations
- Abraded exterior surface of glass in one panel affects light transmittance
- Efflorescence on the interior concrete matrix material where glass is sound

The deteriorated exterior coating on the original dalle de verre is allowing for water penetration into the concrete. The coating is trapping moisture, exacerbating the deterioration of the underlying concrete as well as the glass edges, and potentially corroding the steel reinforcement embedded in the matrix material. The existing coatings also obscure the extent of previous repairs and underlying concrete deterioration. Note that the replacement dalle de verre panels fabricated with an epoxy matrix are not coated.

Conditions unique to the replacement epoxy panels:
- Loose exposed flexible foam expansion joint filler between the interior edge of the dalle de verre panels and pre-cast concrete

[125] ASR is a chemical reaction between water, the alkali components of the concrete, and specific silica in the aggregate. Where a chemical gel forms between constituents, the resultant stress fractures both the aggregate and matrix material, causing characteristic cracks in the concrete.
[126] The reason that these straps were moved and the date of the associated work is unknown.

- Discolored exterior epoxy matrix surface adjacent to deteriorating glass
- Exterior disaggregation of isolated panel surfaces

Water infiltration and glass deterioration are the two greatest concerns at both the original and replacement dalle de verre. These conditions appear to be worse on the south and east elevations. The water infiltration visible at the juncture of the matrix material and glass is considered an inherent problem with dalle de verre construction. A more significant source of leaks appears to be the water infiltration around the perimeter of the panels though, where exterior sealants have failed. This is more of an issue on the south and east elevations, where there is no interior perimeter sealant; failure of the exterior sealant on these elevations allows a direct path of water ingress.

The areas of glass deterioration that have resulted from the unstable chemical composition of the glass are expected to further deteriorate with exposure to stresses, including ongoing water infiltration through cracks and variations in temperature and relative humidity. The glass foliations, soil deposition, and biological growth between the layers of deteriorated glass darken the interior appearance (Figure A29).

Reportedly, three manufacturers fabricated the dalles in the replacement panels, but no record is available identifying which colors each manufacturer produced or which panels contain the different types of glass; it is therefore unknown if this deterioration is associated with a single source of glass.

Members of the congregation reported small shards of the deteriorated glass falling, but the specific origins of that material were not determined. The cracked and delaminating glass occurs more frequently and in a wider range of colors on the south and east elevations and is visible more consistently over the full of height of the Sanctuary on those elevations. The 2003 report by Hoffman Architects described the epoxy panels as "generally free of defects." Efflorescence and delaminating glass are now prevalent though. This suggests that the panels, installed for roughly thirty years, have substantially deteriorated since the last restoration campaign, completed approximately ten years ago. It is suspected that the crizzling deterioration had already begun in 2003, but was in its early stages; crizzling is known to rapidly progress from Stage 2 to the higher stages.[127] Additionally hygroscopic biological growth and soil settled into the fractures of the glass and exacerbated the degradation, as did salt between foliations.[128]

Not all dalles exhibit signs of crizzling. The scope of this study did not include the documentation of specific deterioration panel-by-panel. Nevertheless, some patterns were evident from our general survey:

- High-resolution images taken by the drone suggest that the skyward-facing panels, which are original concrete panels with protective glazing, appear to exhibit less efflorescence and delaminating glass than the panels set in the walls.
- The original concrete dalle de verre on the north elevation generally exhibits less glass deterioration than the replacement epoxy panels on the south and east elevations.
- The glass deterioration on the south and east elevations is visible at all heights of the façade and in many colors.
- Glass delamination on the north elevation is predominantly found near the base of the building; although, it is visible in isolated locations higher on the façade. Crizzling seems

[127] Koob, 123.
[128] Ibid., 128.

to affect the original purple and blue glass more frequently on the north elevation, although other colors of glass exhibit similar deterioration.

Treatment Recommendations

Future study could potentially identify the glass colors that are consistently failing and if panel orientation affects the damage. Such a study, coupled with additional laboratory analysis and environmental monitoring could indicate if specific colors or panel locations and orientations are more subject to deterioration. Currently, it cannot be determined how many additional dalles that currently appear sound may be susceptible to similar deterioration.[129] The recommendations below therefore are intended to address the overall pattern of conditions and reduce the factors involved in the development of the deterioration.

Given the varying degrees of historic significance of the original and replacement panels, BCA recommends two different approaches to the conservation of the dalle de verre, based on the location of the panels, the previous interventions, and the visitor experience with the art glass and building.

<u>Original Concrete Dalle de Verre</u>

The dalle de verre in the north façade and skyward-facing panels can be considered of greater historical significance, because the glass and matrix material in these areas date from the original building construction. The original dalle de verre panels are comprised of a concrete matrix, which is no longer fabricated in the United States. Therefore, the material itself bears a technological significance in the development of dalle de verre production and furthermore presents insight into the changing techniques and expectations of modern materials in this era.[130] Conservation of as much of the remaining original material as possible in situ is advantageous. No known method of halting the crizzling of the glass exists today. This said, efforts can be made to slow the deterioration.

<u>Cleaning</u>

- Remove all coatings and residue from the exterior of dalle de verre and the pre-cast concrete panels under the existing protective glazing.
- Remove the existing coatings from the exterior concrete matrix.
- Clean the interior and exterior concrete matrix material.
- Carefully clean existing salts and dirt from the interior glass surfaces.
- Carefully remove dirt and biological growth from exterior glass surfaces.
- Remove efflorescence from concrete with poultice cleaners.

Testing is required to determine the most appropriate method for cleaning. Micro-abrasives are not recommended for cleaning the concrete due to their potential for damaging the glass. Minimal water is recommended to prevent further damage to the delaminated glass. BCA suggests testing laser cleaning to remove the concrete coatings from the dalle de verre matrix material. If chemical strippers are required, a pressure washer system with a vacuum attachment is recommended to minimize water intrusion.

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[129] Hoffman Architects, "Water Infiltration Investigation," 24.
[130] See the "Significance Discussion" in the larger Conservation Management Plan for a comprehensive discussion about the significance of the Fish Church and its materials.

Absorption tests are also recommended to further characterize the original dalle de verre panel matrix material and inform the selection of a cleaning method. Petrographic analysis characterized the original matrix material as highly porous; this was attributed to the use of calcium aluminate cement. The matrix material may exhibit a variable porosity depending on the original water content in the mix, which could have affected the conversion process that occurred when the cement cured. BCA recommends performing field testing on multiple panels across the north façade using RILEM Method 11.4, Measurement of Water Absorption Under Low Pressure. This comparative test method is relatively simple to execute in situ and can inform the variations in panel porosity.[131]

Protective Glazing

- Replace protective glazing at roof panels on the north, south, and east elevations with new protective glazing.
- Install protective glazing on the exterior north façade.

The skyward-facing roof panels have always had a protective glazing system installed, and this appears to have improved the performance of the dalle de verre in these areas. We recommend replacing the existing protective glazing on the roof facing panels with a new system, because the existing are not appropriately ventilated and the framework does not fully align with the pre-cast concrete panels.

The north facade is neither visible from the street nor accessible to the general public. The north passage construction blocks much of the elevation when the façade is viewed from a distance. The installation of protective glazing on this elevation would allow both the parish and visitors to continue to enjoy the visual impact of the original glass from the interior. The following should be considered in designing a protective glazing system for this site:

- Proper ventilation is required to prevent interior condensation.
- High light transmittance and low reflectance is required.
- Low solar gain type of Low-E glass is recommended.
- Large framework tracing the pre-cast concrete panels and not covering the dalle de verre panels or affecting the light transmission is desired to the greatest extent possible. Low profile design to reduce the potential for shadows on the dalle de verre is recommended.
- A framework compatible with the color of the adjacent cast-in-place concrete is recommended.

Concrete Matrix Repairs

- Repair cracks that allow light penetration or threaten to destabilize glass.
- Remove existing inappropriate patch material and provide new patch repairs at spalls and losses.

[131] RILEM tests consist of attaching graduated RILEM pycnometer tubes to uncoated concrete surfaces and sealing the edges to form a watertight seal between the tube rim and the concrete. The tubes are then filled with 5.0 mL of water and the absorption rate is measured as the elapsed time per every 0.5 mL of water absorbed.

After cleaning, we recommend the concrete matrix be examined for cracks. Embedded rebar holds together substantially cracked panels. The installation of protective glazing would eliminate water penetration and the need for repairs to address this issue. If cracks are wide enough to allow light transmittance or threaten to destabilize glass, BCA recommends injecting a flexible sealant. If a cementitious patching material is required for any repair purpose, further research can confirm the material does not react with the adjacent material.[132]

Glass Stabilization

- Stabilize delaminating interior surfaces
- Replace isolated glass dalles too deteriorated for stabilization with new matching the original.
- Replace missing dalles with new matching original, where information about the original glass is available.
- Provide gap fill repairs in glass.
- Remove existing inappropriate patching material, provide new patches or replace dalles with new matching the original depending on the extent of underlying damage.

The interior surfaces will require conservation treatments to mitigate the current threat of falling glass shards. BCA recommends testing the stabilization of the interior glass surfaces exhibiting multiple cracks by applying fiberglass tissue paper (20g/m^2) adhered with a reversible consolidant, such as Paraloid® B-72 or OR-G®.[133] This stabilization treatment is expected to have a minimum impact on the light transmission. Testing is required to determine the effectiveness of this treatment.[134] This work should be performed by a glass conservator familiar with this these materials.[135]

Replace isolated glass dalles deteriorated beyond stabilization with new stable glass installed with a flexible adhesive at the glass perimeter. Carefully match the translucency, color, and faceting of new glass to the original. Note that installing new glass dalles may require alteration to the adjacent concrete matrix. The 1986 panel removal process resulted in cracks in the concrete matrix material. Mock-ups are required to determine if dalle replacements can be performed in situ with less impact to adjacent materials.[136]

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[132] BCA considered the removal of the hard grout around the dalle de verre panels and make no recommendation for its removal at this time.

[133] Note that Paraloid® B-72 is permeable to water vapor. It will allow moisture to continue to the get into the glass and therefore still requires that the relative humidity be controlled. The benefit of the permeability of the B-72 is that it will not trap moisture in the glass. Koob, 129.

[134] This method of glass stabilization was reportedly employed with success at Theodore's Church in Beringen. De Vis, 331. The application of a consolidant and the fiberglass tissue paper, otherwise referred to as "glass silk," is considered reversible during future interventions. Testing is required to determine the extent of crizzling deterioration that can be stabilized with this method and its visual impact.

[135] During this survey, no glass was identified on the north elevation exhibiting wide singular cracks that threaten to destabilize the glass. Should such conditions be discovered during a full investigation, BCA recommends they be repaired using Paraloid® B-72 injection. This adhesive is recommended based on the adhesive testing performed by Kristel De Vis for completion of her PhD dissertation, "The Consolidation of Architectural Glass and *Dalle de Verre*; Assessment of Selected Adhesives," 276.

[136] Note that individual dalle replacement was explored as a repair option as early as 1979. See the Conservation Management Plan for more information about the procedure suggested at that time.

Environmental Monitoring

- Install equipment to monitor the air and surface temperatures as well as the relative humidity on the interior and exterior facades on different elevations.
- Design and install a system to measure differential movement between the façade elements.

Installing exterior protective glazing is expected to reduce the water infiltration and reduce the temperature variations between the interior and exterior surfaces of the panels. Regulating the relative humidity within the Sanctuary is still necessary. Moderately low humidity (about 40-45%) is recommended to slow crizzling.[137]

BCA recommends installing environmental monitoring equipment now so that underlying potential causes of deterioration, such as fluctuations of interior and exterior surface temperature, relative humidity, and air temperature at different heights within the building can be compared before and after the air conditioning system is installed. This monitoring can inform adjustments to the mechanical systems in order to create an environment that is more suitable for the preserving the glass. We recommend monitoring be continued for a minimum of one year after the new air conditioning system is installed. During this period, the building envelope can continue to be documented periodically with infrared thermography to supplement the findings of the monitoring equipment.

Replacement Epoxy Dalle de Verre

- Provide new dalle de verre panels matching the appearance of the original glass and matrix material.

The more recent replacement materials on the east and south elevations are considered of less historic significance, which allows for a wider range of treatment options. These elevations are more visible than the north elevation, both from the street and from different areas of the Parish House. BCA therefore recommends efforts be made to restore the original appearance of these elevations and maintain the building profiles intended by Harrison to the greatest extent possible. Protective glazing is therefore not recommended on these elevations.

Because the dalle de verre panels on these elevations were previously replaced with non-original glass and matrix material, BCA recommends fabricating and installing new panels using chemically stable new glass to match the color, translucency, facets, and layout of the existing.[138] Although epoxy is the standard matrix material in the United States, fewer stained glass studios currently produce dalle de verre. Further research is required to identify a stained glass studio that can produce new dalle de verre panels matching the glass configuration, color, and transparency as well as the appearance of the original matrix material, either in kind or with substitute materials.

[137] Higher humidity will contribute to the deterioration mechanism. Meanwhile, if the humidity drops lower than 30%, the glass that has hydrated and cracked will dehydrate and more severely crack. Koob, 127.
[138] We recommend previously salvaged concrete panels from the south and east elevations be used for this purpose where the material is available.

Slate and Waterproofing

Typical Conditions

Previous replacement slate varies from the original in color but appears to maintain the sizes and pattern of the original. The flashing is of inconsistent design and materials from different periods. Despite these irregularities, the slate and flashing addressed as part of the 2005 Waterproofing Campaign generally appear to be properly functioning.

The following slate and waterproofing conditions were noted:

- Isolated deteriorated slate repairs.
- Isolated loose, missing, and broken slate.
- Biological growth and general atmospheric soil deposition on slate.
- Pooling water was noted at the interior base of the south wall, as was carpet damage (Figure A30). Water infiltration primarily originates from deteriorated sealant at the exterior perimeter of the dalle de verre panels and at the exterior intersection of pre-cast concrete panels and cast-in-place concrete framework.
- Isolated areas of failing sealant at flashing.
- The sealant at the base of the building is typically deteriorating, allowing for biological growth in the joint and contributing to water infiltration into the concrete foundation.
- Grass abuts the concrete base on the west end of the north elevation and the west façade, which produces a moisture retention problem. Plantings are similarly present directly next to the concrete base within the north courtyard.
- On the north elevation, the downspout from the Choir Room drains directly adjacent to the base of the Sanctuary.

Treatment Recommendations

- Further assess the existing conditions of the various flashing materials and provide new flashings if necessary.
- Clean all slate free of general soil and biological growth using a biocide.
- Replace loose, missing, and deteriorated slate with new slate matching the original.
- Replace all exterior sealant between the pre-cast concrete panels and at the perimeter of the original dalle de verre panels following the removal of concrete coatings.
- Remove planting directly adjacent to the base in north courtyard.
- Install drainage system to separate the building and landscape at the west and north elevations, including in the north courtyard, to direct water away from building.
- Redirect downspouts away from the base of the Sanctuary.

Chapel Conditions and Recommendations

Typical Conditions

The dalle de verre in the Chapel is in excellent condition, exhibiting no significant cracks or glass deterioration. It is protected on the exterior with what appears to be the original corrugated translucent plastic panels. Heavy soil depositions exist at the topside of the dalles under the corrugated plastic roof, aesthetically marring their appearance.

The base of the fieldstone wall beneath the dalle de verre window exhibits approximately two square feet of efflorescence near the floor, at the southeast corner of the room.

Treatment Recommendations

- Clean the skyward-facing surfaces of the dalle de verre panels to remove heavy dust.
- Perform a finishes analysis of the wood framework to identify the original color of the wood for future repainting campaigns.
- Redirect exterior drainage away from the base of the building.
- After the interior masonry at the base of the wall has sufficiently dried, remove efflorescence with a poultice cleaner.

Recommended Additional Research, Probes, and Tests/Mock-ups

Archival Research

The Ateliers Loire, the stained-glass studio begun by Gabriel Loire, remains in operation, although Gabriel Loire passed away in 1996. BCA recommends contacting the studio to determine if they retain any records regarding the original materials utilized for the panel construction. Similarly, the three glass manufacturers whose materials were used to fabricate the epoxy replacement panels can be contacted to determine if they have any records regarding which glass dalles they provided.

Probes and Tests

The following comprehensive list of recommended additional testing, probes, and mock-ups is intended to more fully assess the conditions and provide information for future budgets:

- Perform a probe to remove a typical concrete dalle de verre panel on the north facade to determine and document its configuration and detail as built.
- Perform a probe to remove a typical epoxy dalle de verre panel on the east or south facade to confirm and assess its configuration and detail as built.
- Strip all coatings from areas of concrete on the exterior of the north, east, and south elevations to evaluate the condition of underlying materials.
- Perform additional petrographic analysis to establish variations in concrete composition and the presence of ASR
- Perform RILEM testing on original concrete dalle de verre panels to better understand range of porosities in advance of selecting a paint removal system.

- Perform tests on the exterior of original dalle de verre panels to determine an appropriate method for remove existing coatings and to evaluate the condition of the underlying matrix material.
- Mock-up fiberglass tissue paper and consolidant stabilization method to determine the extent of glass deterioration that can be stabilized using this method and the visual impact of the treatment.
- Mock-up replacement of significantly cracked glass dalles.
- Perform a finishes analysis of the interior concrete in the Sanctuary to identify the original color for future repainting campaigns.
- Perform a finishes analysis of the wood framework in the Chapel to identify the original color for future repainting campaigns.

Mock-ups

Explore conservation options through a large-scale mock-up that can be monitored over time, to determine efficacy and appearance. Design and install a new protective glazing system mock-up and perform glass stabilization work at the corresponding interior dalle de verre panels to further evaluate the protection system and the aesthetic qualities of the stabilization treatments as observed by the design team and the church congregation. Monitor the temperature, relative humidity, and behavior of the interior environment and materials at the mock-up location.

Appendix A
Archival & Contemporary Photographs

Figure A1. Dalle de verre panel installed in portal window near the base of pre-cast panel N7 (See Figure B2 for pre-cast panel location). Glass inscribed by a stained glass artist at Loire's studio in Chartres and dated 1956.

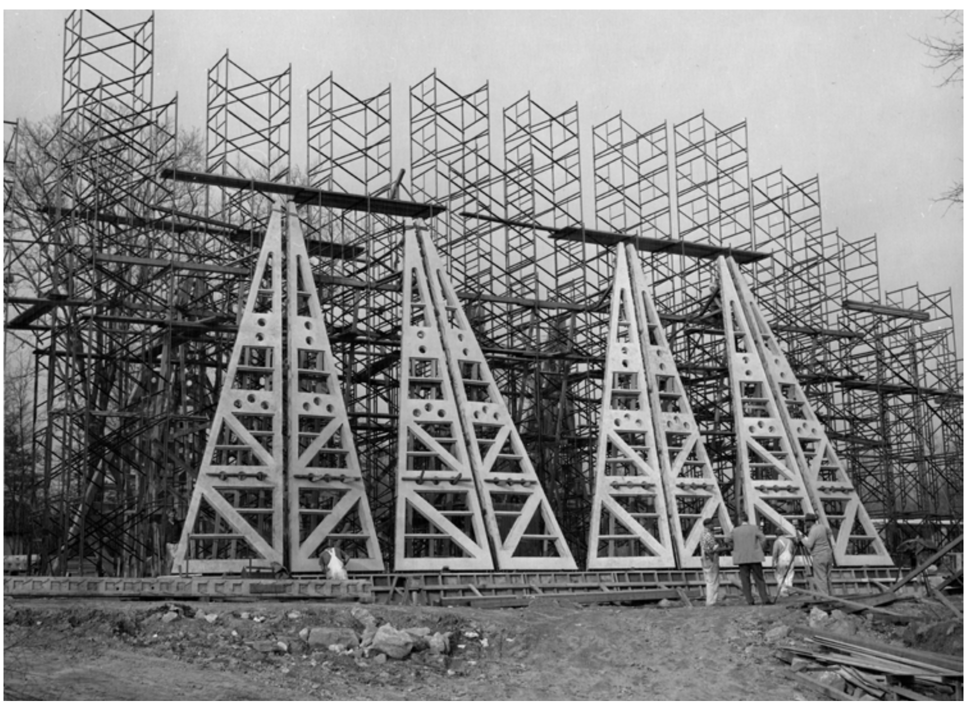


Figure A2. Triangular pre-cast panels set in place. Corresponding panels on opposite façade are also in place for structural balance. Courtesy of the DeLuca Construction Company archives.

Figure A3. Triangular and quadrangular pre-cast panels installed on site. The cast-in-place concrete is the process of being built up between the triangular panels, which are anchored to the concrete foundation. The concrete ribs were poured in lifts using a 6-foot long form. Courtesy of the DeLuca Construction Company archives.

Figure A4. Pre-cast concrete panel in the shop of the Long Island by Precast Building Sections, Inc. The two rows of rebar protruding from the edge of the panel were wrapped around the rebar installed between the panels when set in place on site. Courtesy of the First Presbyterian Church of Stamford archives.

Figure A5. View of rebar installed between the pre-cast panels. Formwork used to construct the cast-in-place concrete rib between the pre-cast panels is visible at the bottom of the image. Courtesy of the DeLuca Construction Company archives.

Figure A6. Installation of large pre-cast panels at the west elevation showing the shallow voids at the returns of the panels into which the cast-in-place concrete framework keyed. Courtesy of the DeLuca Construction Company archives.

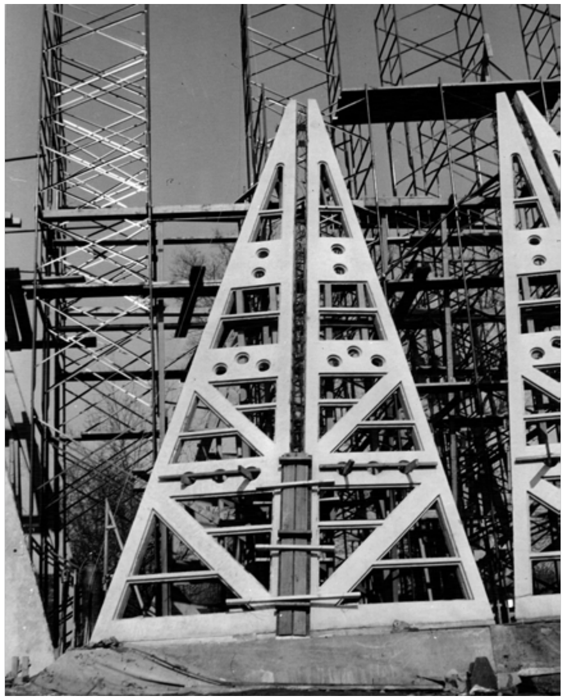


Figure A7. Formwork used to construct the cast-in-place concrete rib is visible between the pre-cast panels at the bottom of the triangular panels. The concrete ribs were poured in lifts using 6-8 foot long forms. Courtesy of the DeLuca Construction Company archives.

Figure A8. Construction of Sanctuary. The small solid panels installed at the openings in the east elevation match the larger pre-cast concrete panels and were installed before the dalle de verre. Courtesy of the DeLuca Construction Company archives.

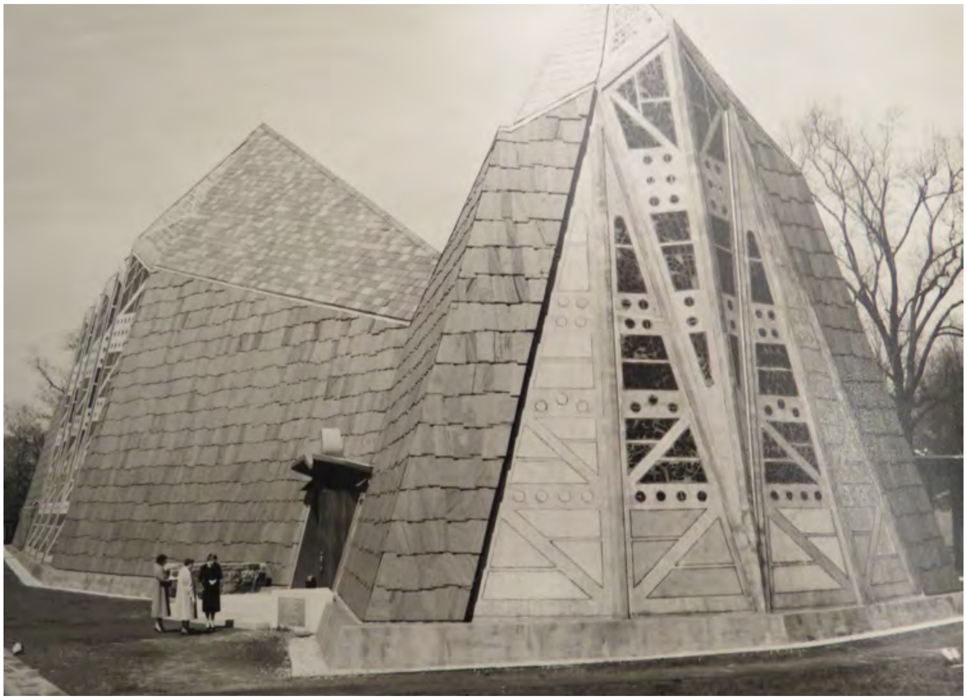


Figure A9. Archival image of completed Sanctuary. The color of the solid small concrete panels on the east elevation appears similar to the larger pre-cast concrete panels, suggesting that they were cast by Pre-Cast Building Sections, Inc. Note the color difference between the dalle de verre panels and the pre-cast concrete units and cast-in place concrete framework in comparison with the existing conditions shown in Figures A13 and A21. "Wallace K. Harrison architectural drawings and papers, 1913-1986," Avery Architectural & Fine Arts Library, Columbia University, New York.

Figure A10. Typical existing portal window with protective glazing, installed in area of roofing slate. Sealant at the perimeter of the protective glazing typically appears to be deteriorated.

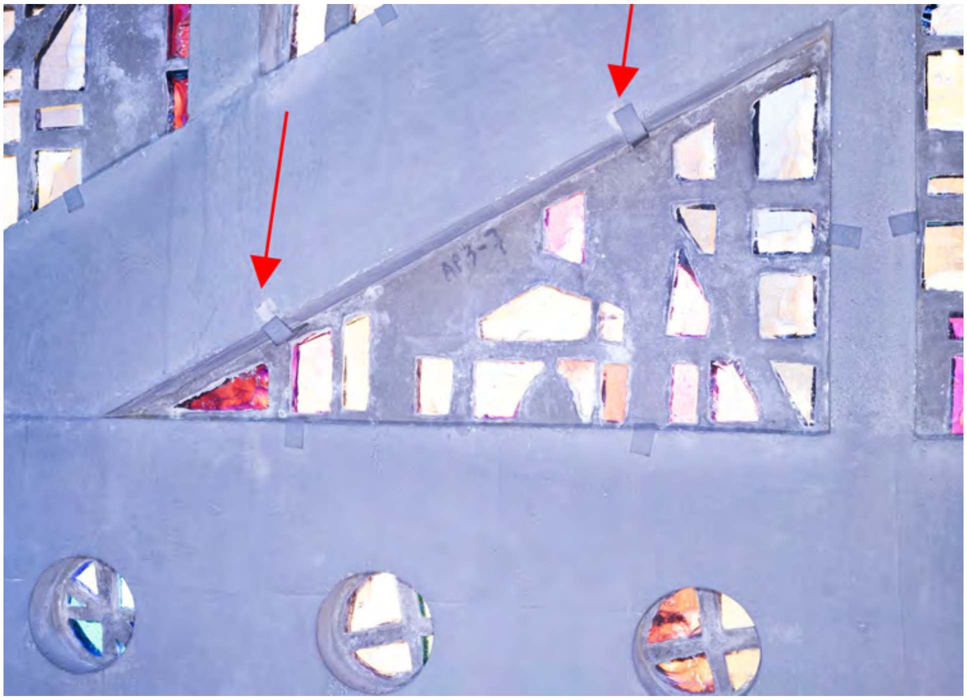


Figure A11. Typical lead straps at original concrete dalle de verre panels. It appears the anchors were used to hold the dalle de verre panels in place against the pre-cast panels while the perimeter grout set. The red arrows indicate areas of clean concrete adjacent to some of the straps, which suggests some of the anchors have been moved; the date and reason for this movement is undetermined.

Figure A12. Archival image of completed Sanctuary showing protective glazing panels at skyward facing dalle de verre. "A Brilliant Canopy for Worship," Architectural Forum, April 1958, 107.

Figure A13. Existing aluminum framed protective glazing on the north elevation showing that the frames do not fully coincide with the pre-cast concrete and dalle de verre patterns. The pre-cast concrete below the glass exhibits a previously applied waterproofing coating.

Figure A14. Completed Sanctuary façade coated with the original clear waterproofing coating and protective glazing at the skyward facing panels above the roofline. The dalle de verre appears darker than the adjacent pre-cast and cast-in-place concrete. Courtesy of the DeLuca Construction Company archives.

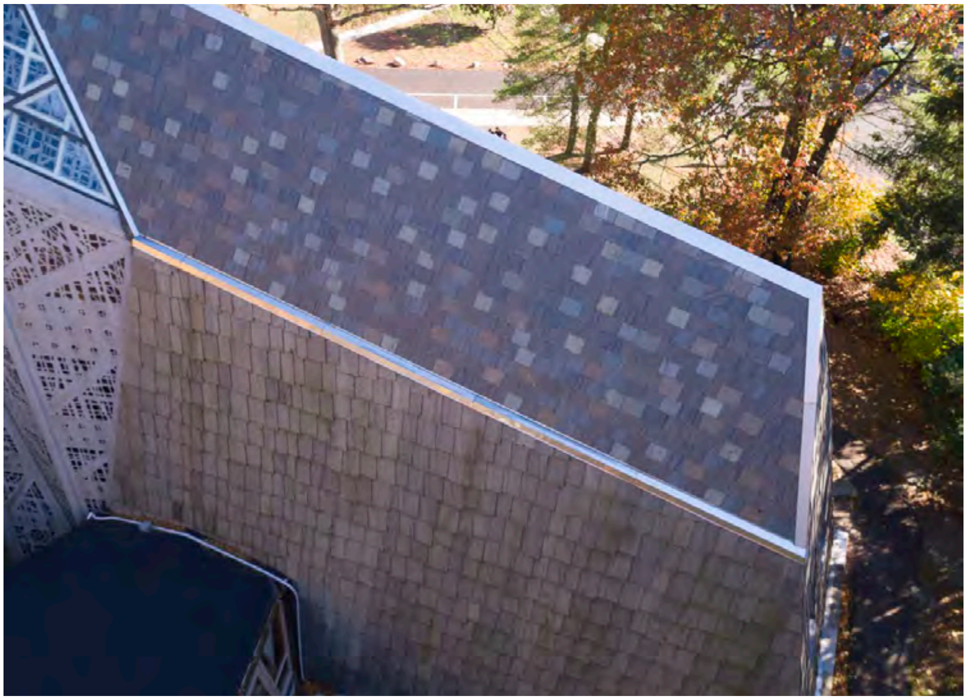


Figure A15. View of roofing and wall slate at the west end of the north elevation. The roofing slate in this area was previously replaced and varies in color from the slate over the Narthex; this work is assumed to be part of the 2003-2007 waterproofing campaign. In accordance with the original design, the roofing slate is laid in uniform horizontal lines while the slate wall shingles exhibit more variation.

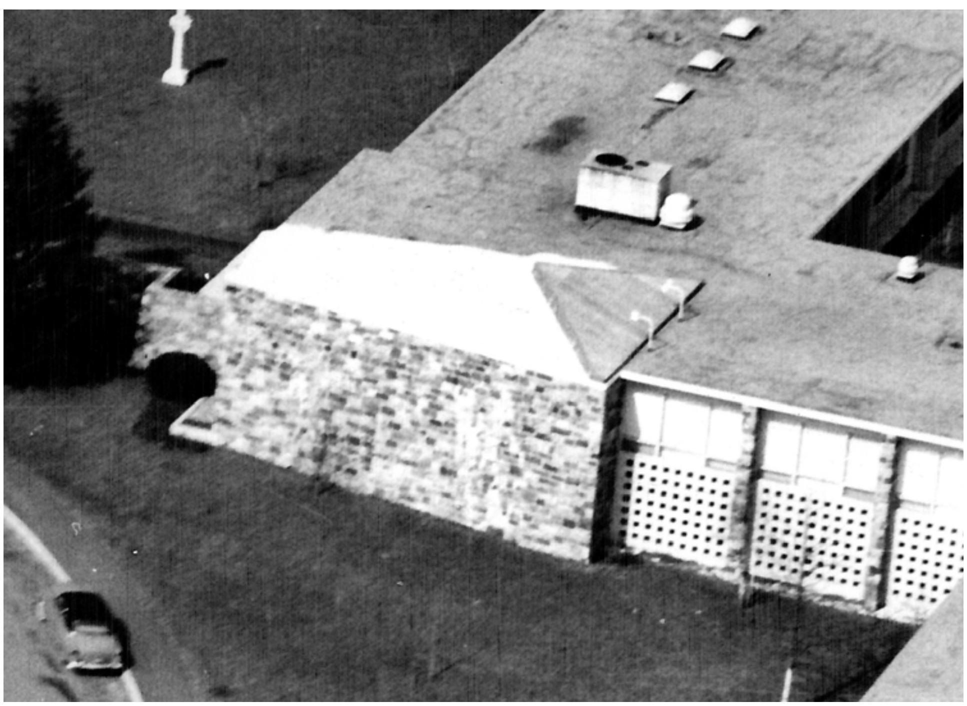


Figure A16. Detail of archival image showing the Chapel roof in 1966. The enclosure over the dalle de verre appears similar to the existing materials (See Figure A17). Note the two light fixtures to the right of the Chapel roof, which back light the skylight. Courtesy of the DeLuca Construction Company archives.

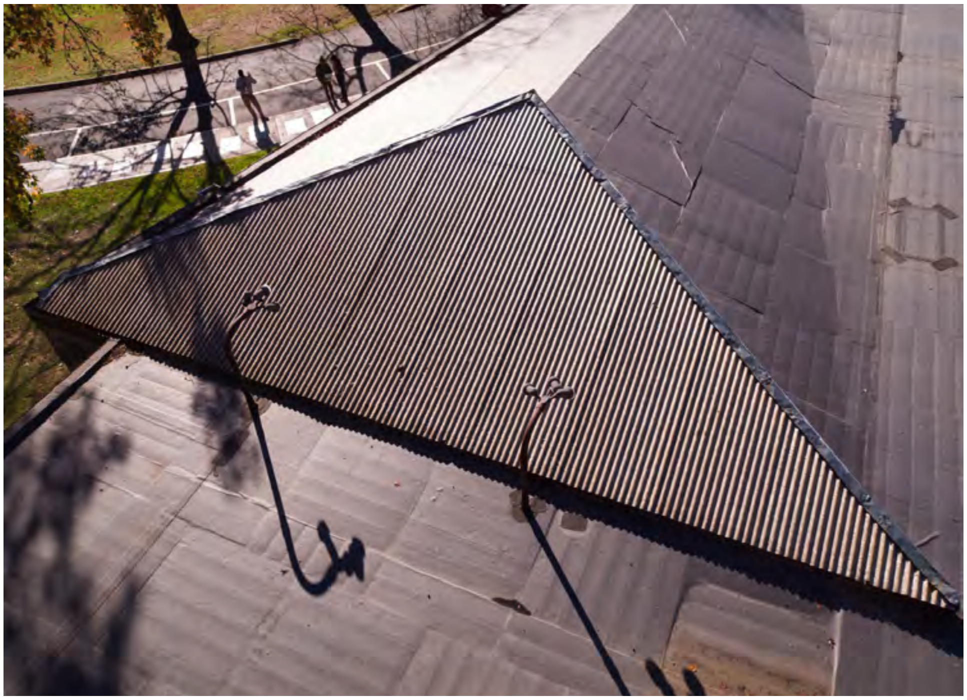


Figure A17. Existing roof protection over dalle de verre in Chapel and two existing light fixtures.

Figure A18 Existing dalle de verre in the Chapel with painted framework.

Figure A19. Archival image of dalle de verre in Chapel. The framework between the dalle de verre panels is identified as wood on archival drawings and is painted a light color to match the walls, in contrast to the current dark finish (See Figure A18). Courtesy of the First Presbyterian Church of Stamford archives.

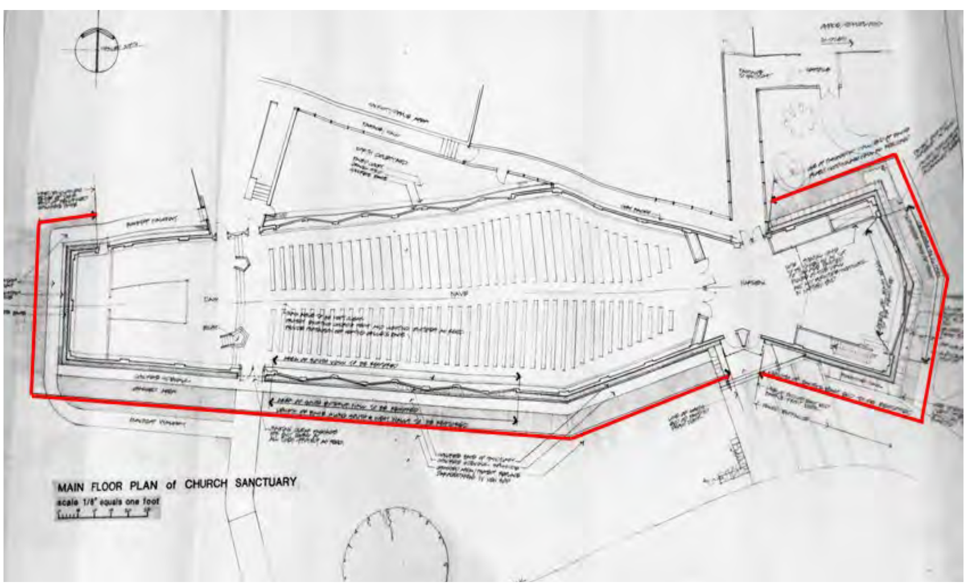


Figure A20. Restoration drawing with area of work outlined in red. No work was called for on the north elevation between the northwest entrance and the north passage. No work was called for at the southeast entrance to the Narthex. Eberson and Toto, architects, P.C. and Viggo Bonnesen & Assoc., "Restoration of the Sanctuary: The First Presbyterian Church, Stamford, Connecticut," July 1986, 1.

Figure A21. Red arrow indicates the reglet cut at the roofline on the south elevation in 1986. See the archival detail for this work in Figure C3. The reglet was also installed on the east elevation. The reglets are currently filled with sealant. The STO product installed in this area in 1986 was identified for replacement with a new coating during the 2003-2007 waterproofing campaign.

Figure A22. Interior work was not performed above the roofline in 1986. The interior painting stops at this level, as shown here.

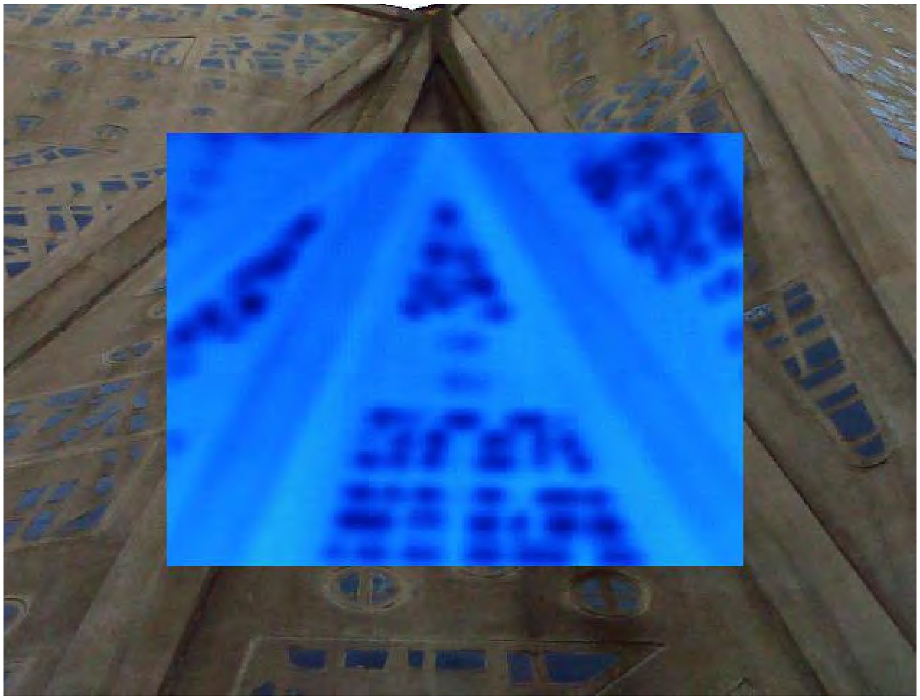


Figure A23. Thermogram of exterior north elevation in January 2017. Thermogram processed to show range of temperatures 45 (Blue) -100 (Red). The temperatures of the materials on this elevation were substantially cooler than those on the south (Figures A24 and A25).

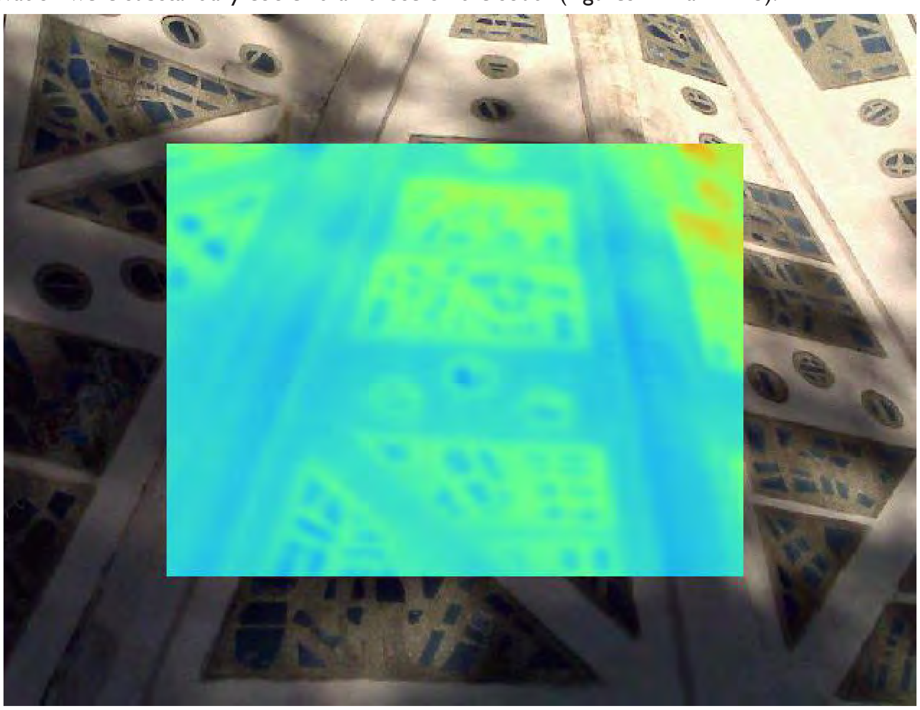


Figure A24. Thermogram of materials in the shade at the west end of the south elevation in January 2017. Thermogram processed to show range of temperatures 45 (Blue) -100 (Red). The temperatures of the materials on this elevation were substantially warmer than those on the north (Figure A23).

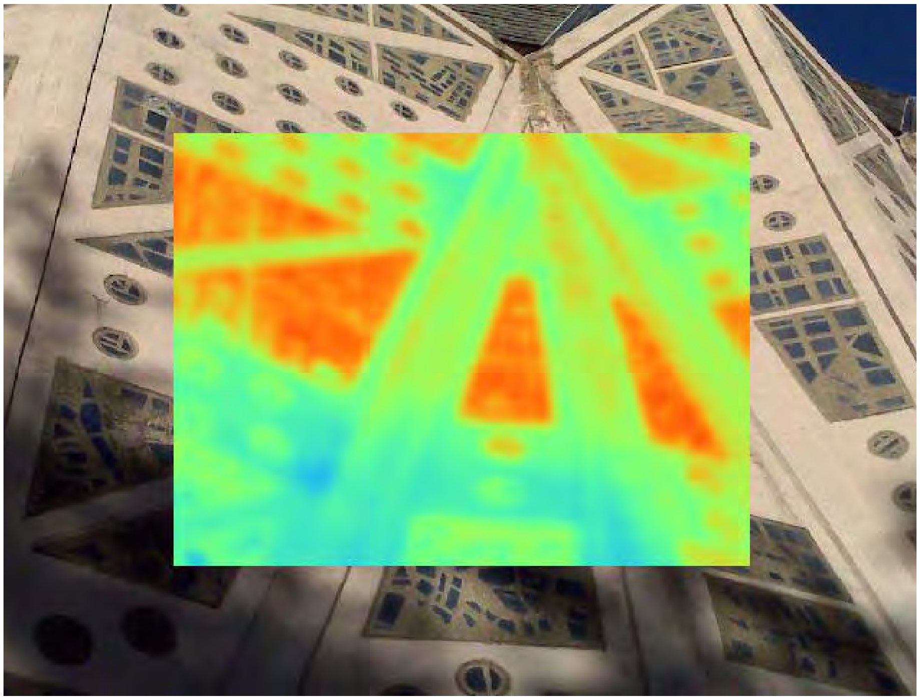


Figure A25. Thermogram of an area in direct sunlight at the east end of the south elevation in January 2017. Thermogram processed to show range of temperatures 45 (Blue) -100 (Red). The temperatures of the materials on this elevation were substantially warmer than those on the north (Figure A23). The dalle de verre exhibits greater heat gain and loss and more stresses.

Figure A26. Thermogram of interior north elevation in January 2017. Thermogram processed to show range of temperatures 55 (Blue) -100 (Red). The temperatures of the materials on this elevation were substantially cooler than those on the interior of the south (Figure A27).

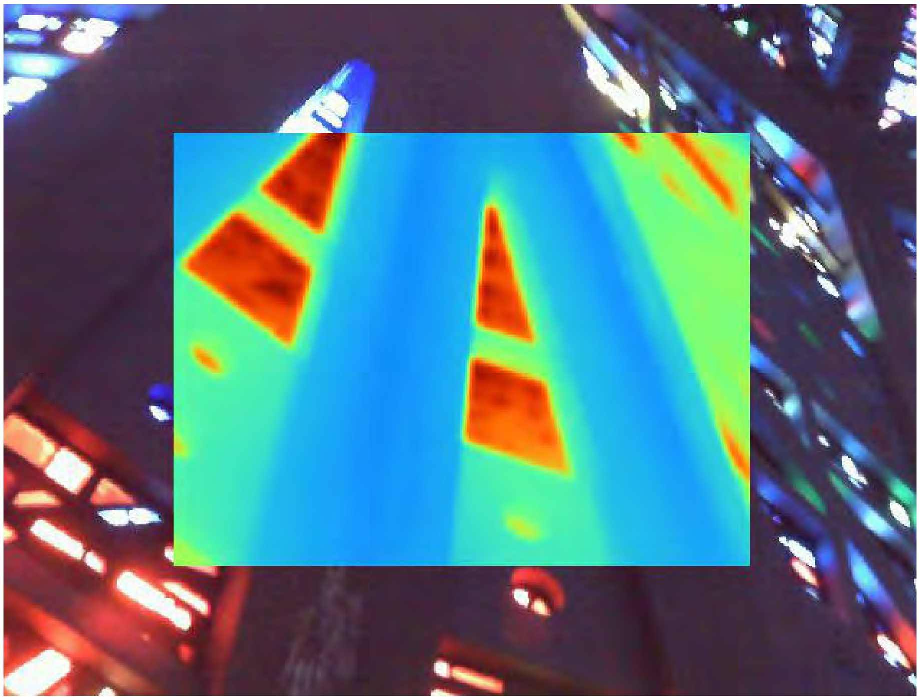


Figure A27. Thermogram of interior south elevation in January 2017. Thermogram processed to show range of temperatures 55 (Blue) -100 (Red). The temperatures of the materials on this elevation were substantially warmer than those on the interior of the north (Figure A26). The dalle de verre exhibits greater heat gain and loss and more stresses.

Figure A28. Typical application of the exterior concrete coating on the north elevation. The 2003 report by Hoffman Architects, Inc. suggests this coating was applied in 1994. Note the coating overlaps the edges of the glass.

Figure A29. Typical darkened interior appearance of deteriorated glass on the south elevation due to biological growth and dirt deposition between layers of delaminating glass. Similar glass deterioration is visible on the north and east elevations.

Figure A30. Water pooling at the base of the south elevation during a heavy rain in October 2016.

Appendix B
Plans and Elevations

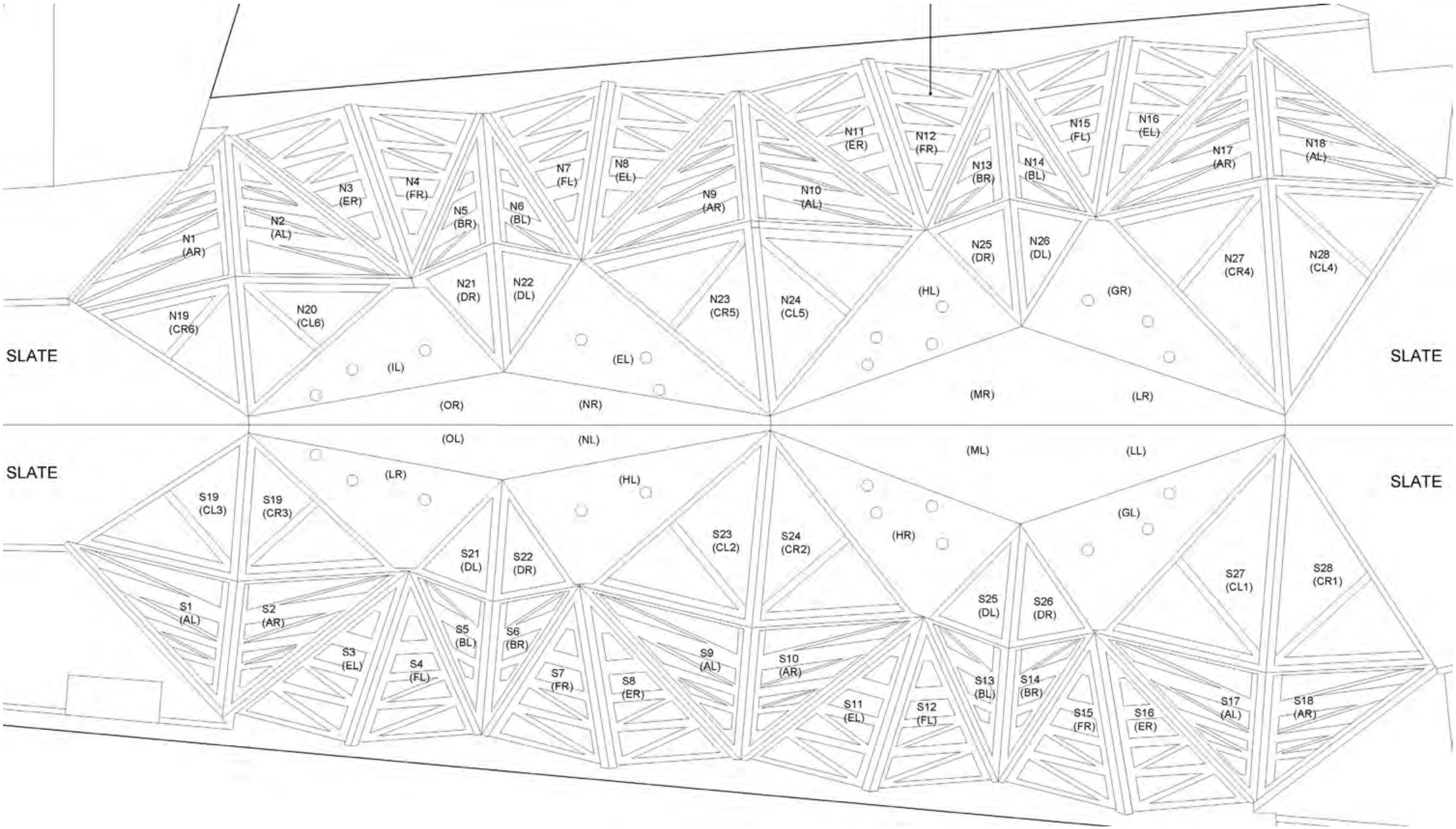


Figure B1. Sanctuary Roof Plan with Pre-cast Panel ID Numbers. Prudon & Partners, LLP., First Presbyterian Church, November 4, 2016, A-200.00.

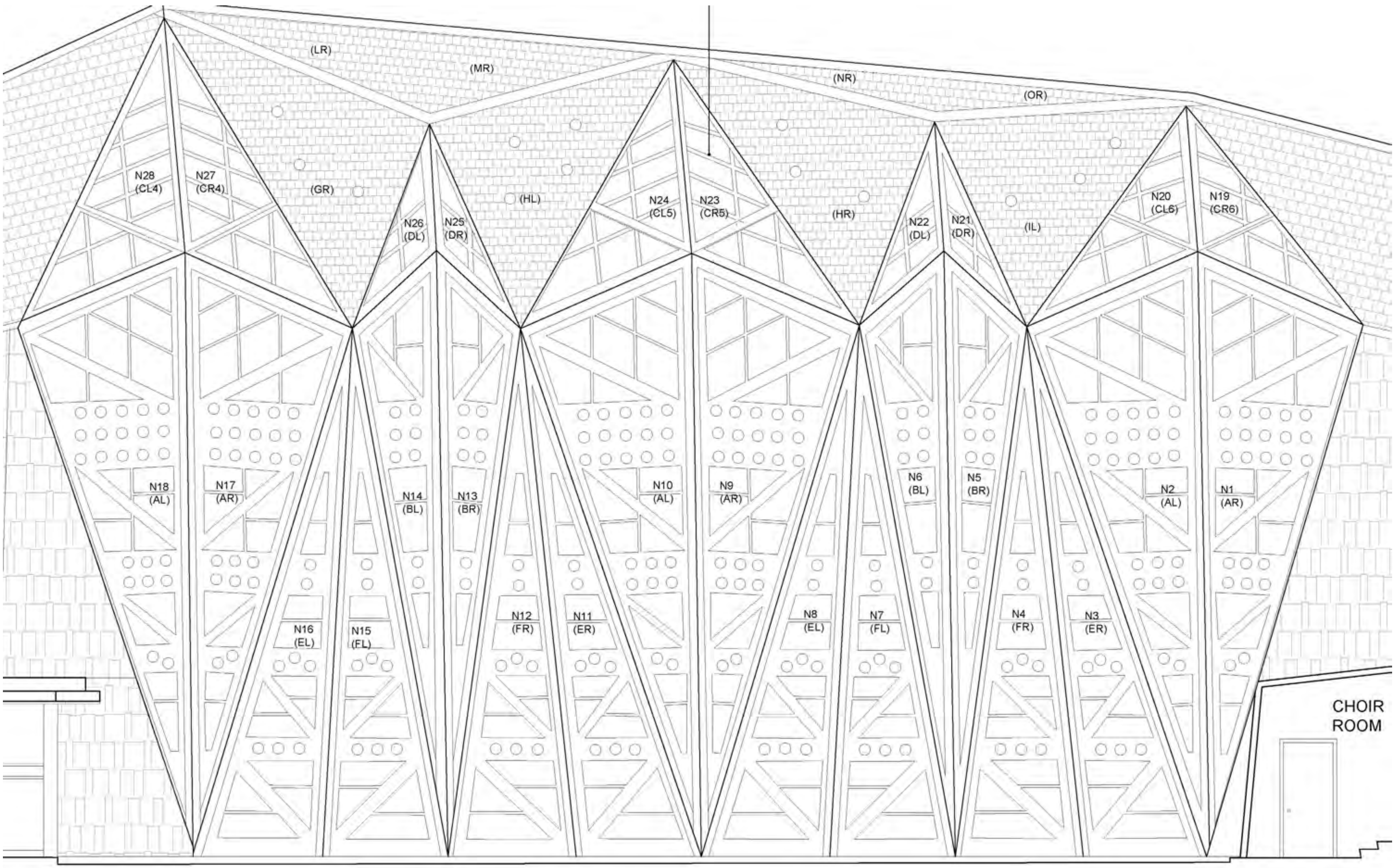


Figure B2. Center of the North Elevation of the Sanctuary with Pre-cast Panel ID Numbers. Prudon & Partners, A-201.00.

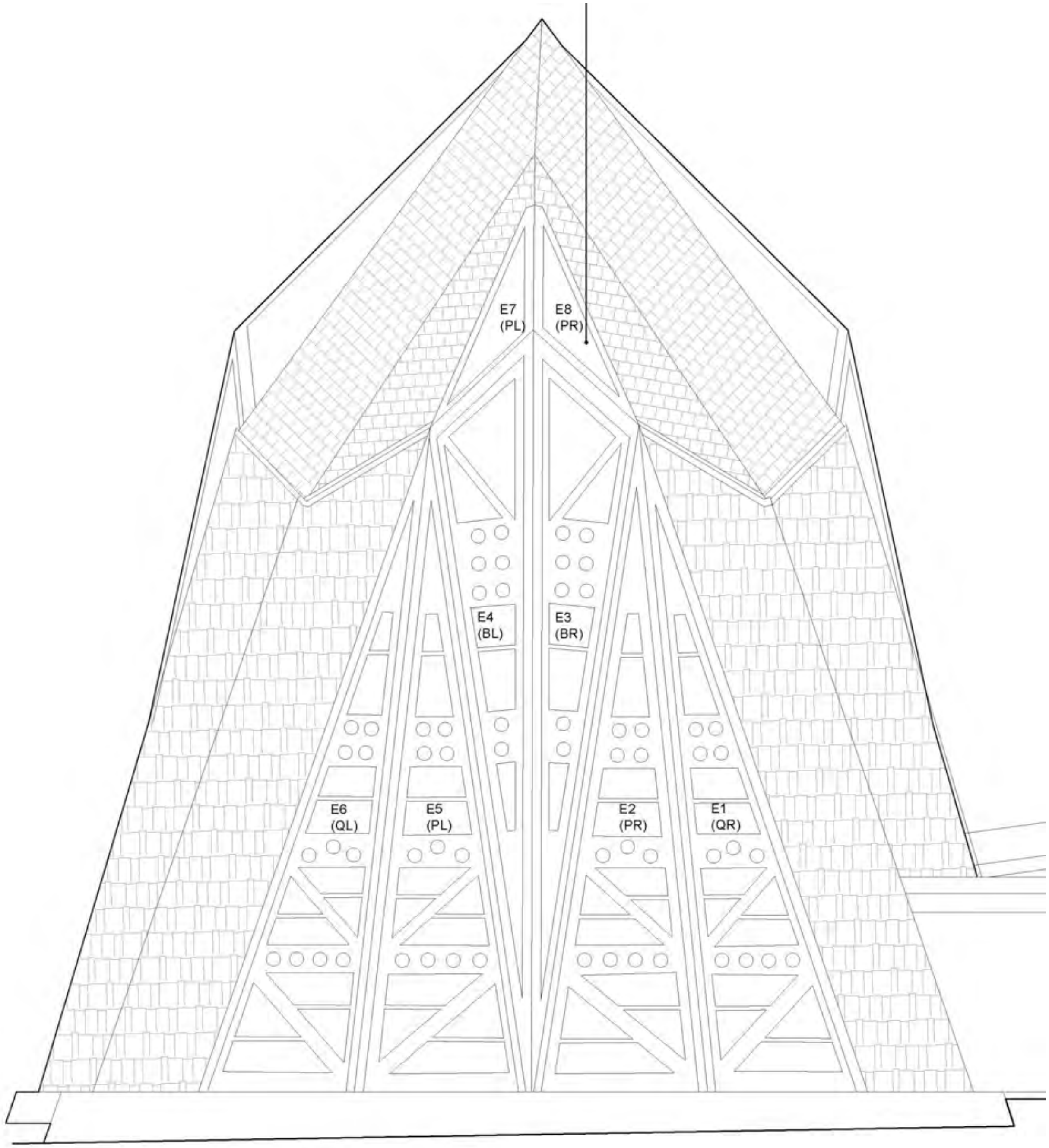


Figure B3. East Elevation of the Sanctuary with Pre-cast Panel ID Numbers. Prudon & Partners, A-107.00.

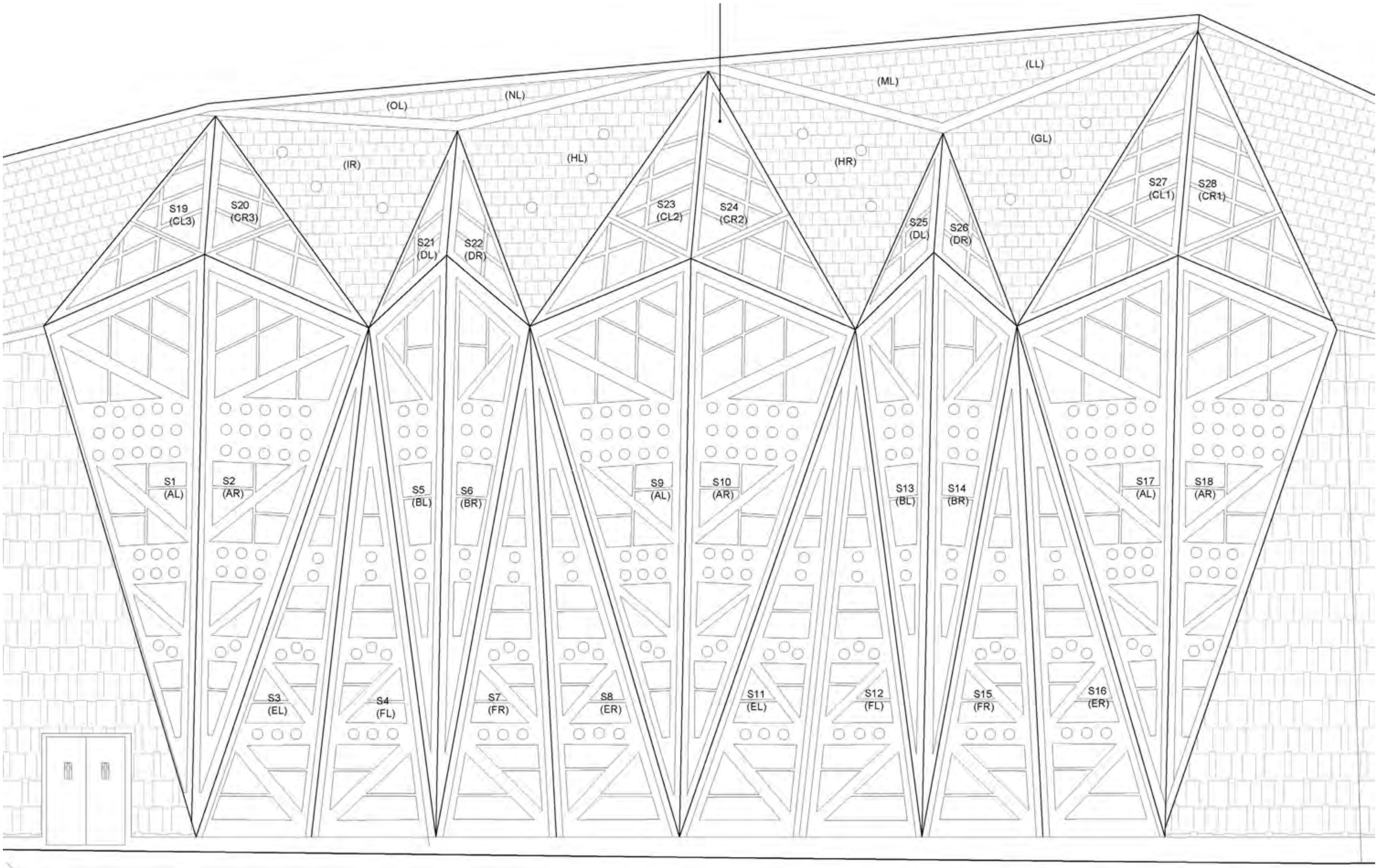


Figure B4. Center of the South Elevation of the Sanctuary with Pre-cast Panel ID Numbers, Prudon & Partners, A-202.00.

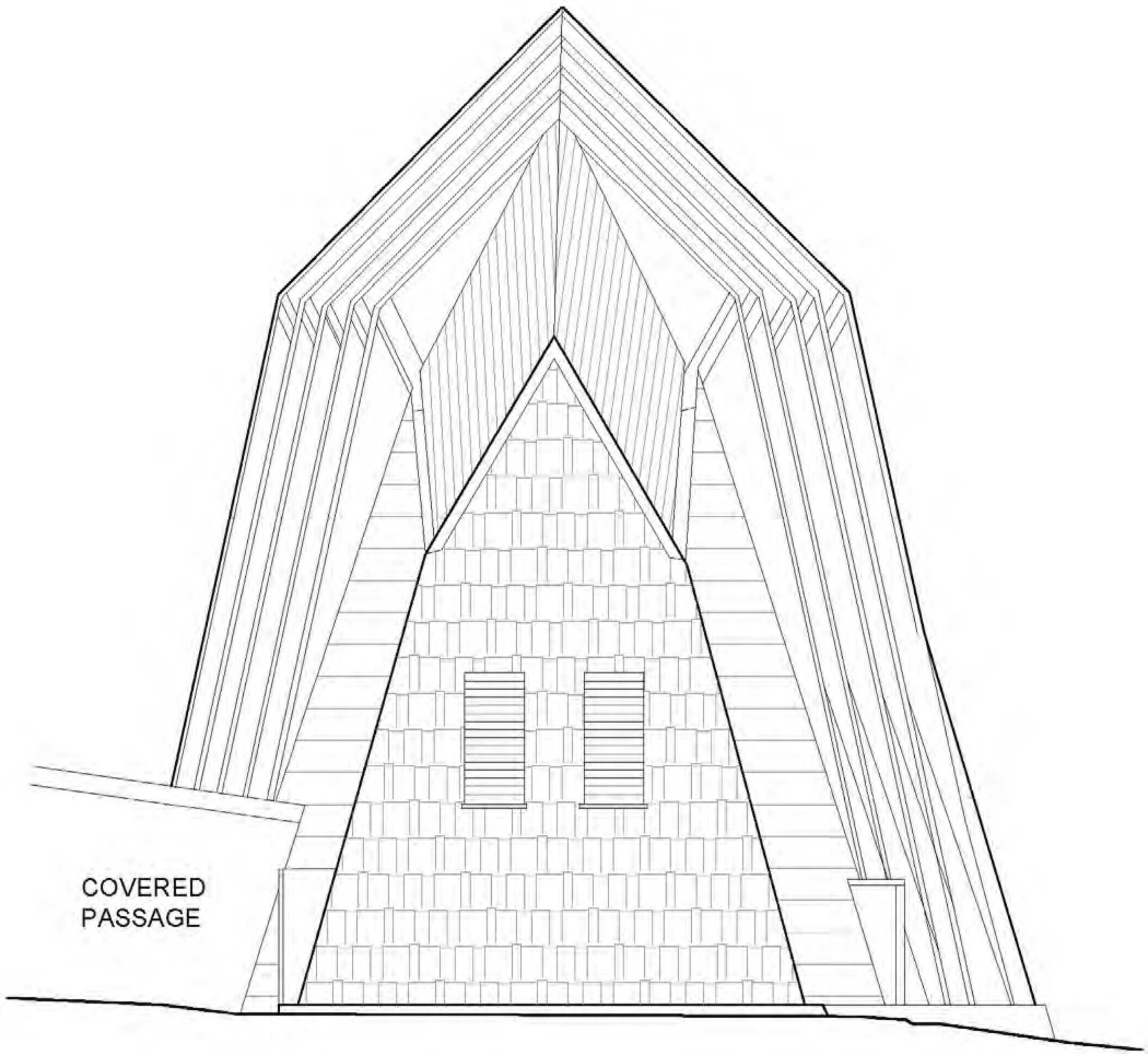


Figure B5. West Elevation of the Sanctuary. Prudon & Partners, A-106.00.

Appendix C
Archival Details

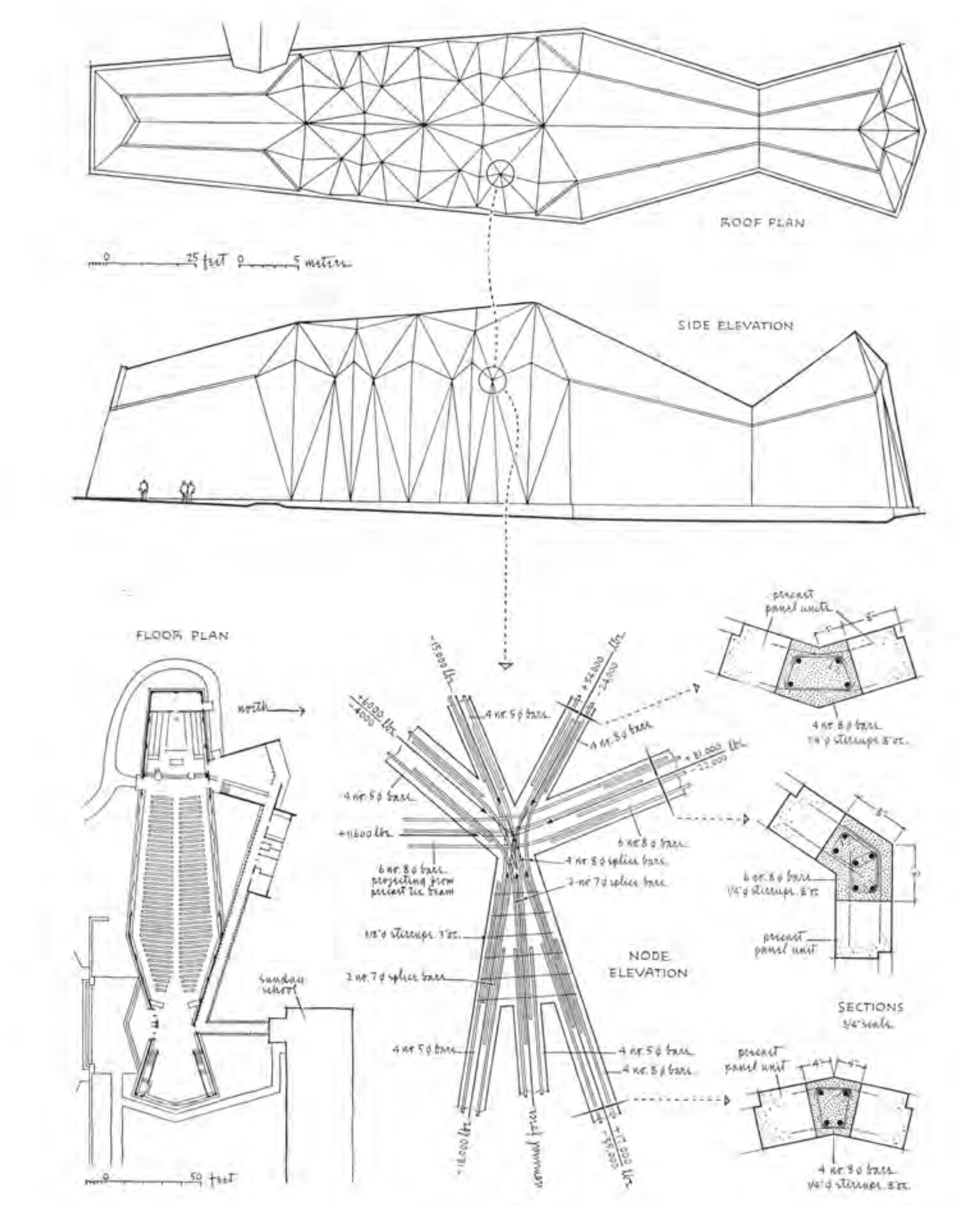


Figure C1. Details of cast-in-place concrete rib construction. "Precast-Concrete Facets Enclose Piscine-Form Sanctuary," p/a news survey, April 1958, 107. These details are also found on the original drawings.

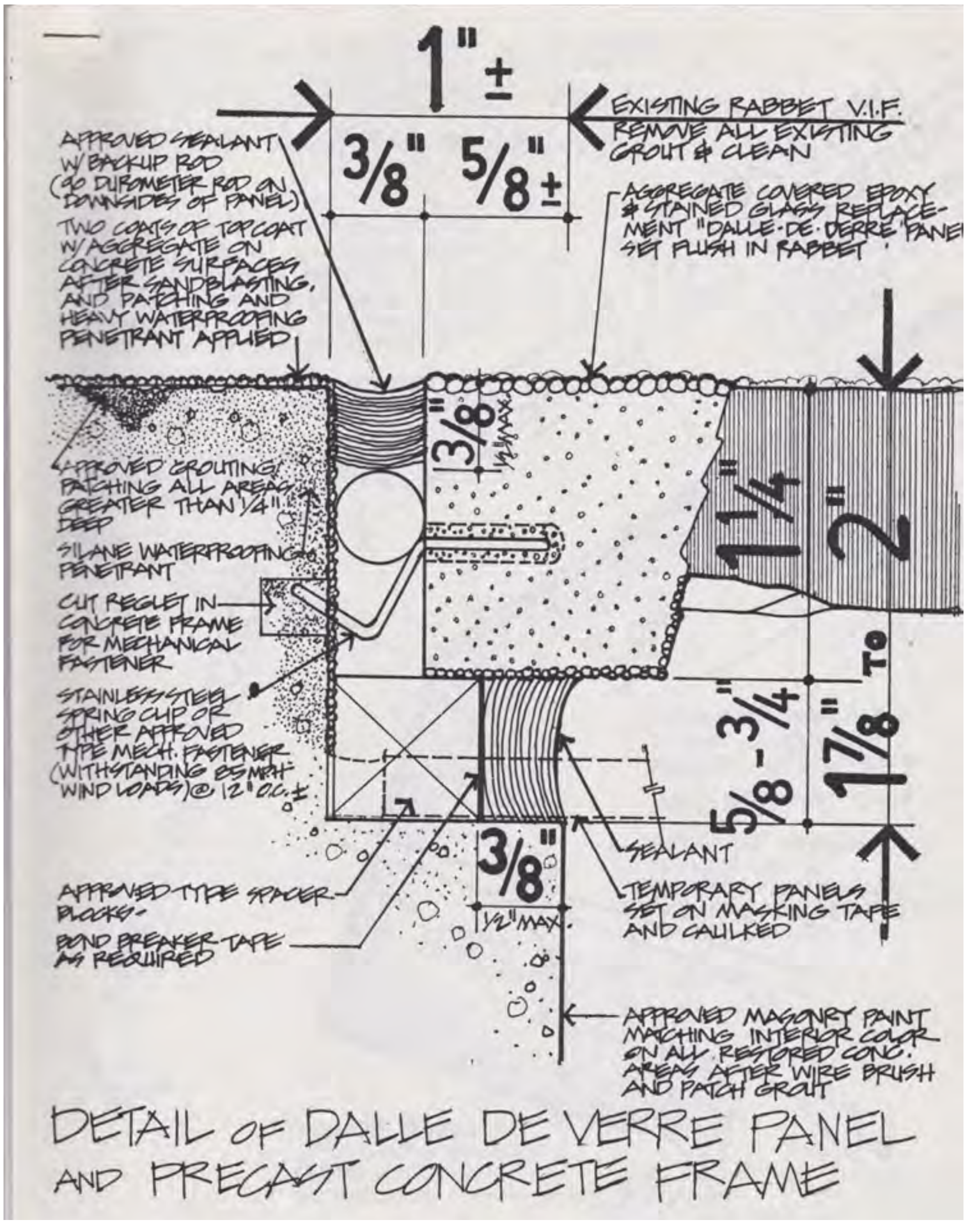


Figure C2. 1986 Construction Detail for Epoxy Dalle de Verre Panel and Precast Concrete Frame. Eberson and Toto, architects, P.C. and Viggo Bonnesen & Assoc. (Consulting Structural Engrs.), "Restoration of the Sanctuary: The First Presbyterian Church, Stamford, Connecticut," July 1986, Detail A/5. No interior sealant is currently installed. Flexible foam expansion joint filler was applied to the interior perimeter of the panels to separate them from the concrete; in some locations this foam filler is loose and protruding. Note that the epoxy matrix and glass directly abut each other. A hairline separation between these materials is common and allows for water infiltration.

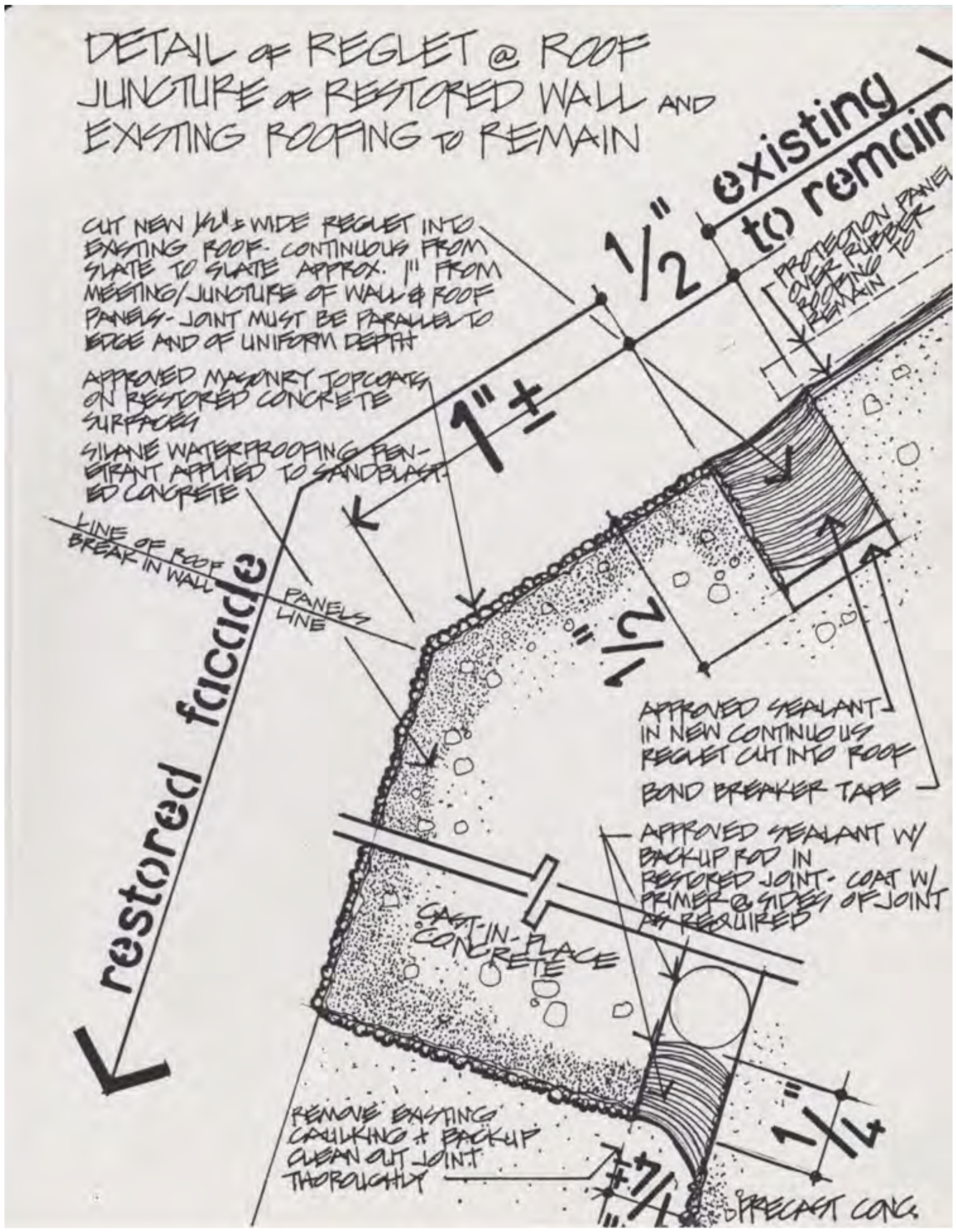


Figure C3. 1986 Construction Detail for New Reglet at Roof Juncture of Restored Wall and Existing Roofing to Remain. Eberson and Toto, Detail B/5. Coating was changed from a silane waterproofing penetrant to a STO product during construction.

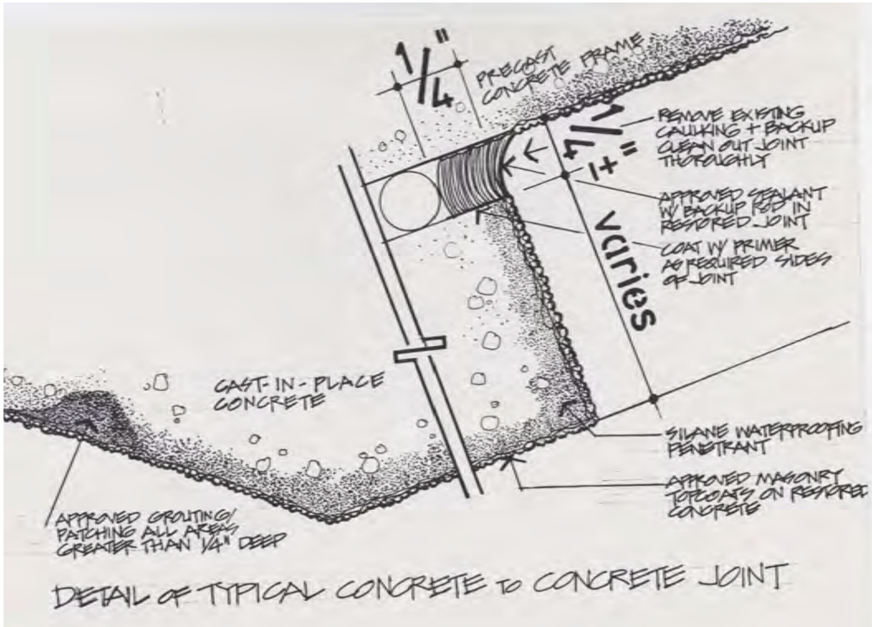


Figure C4. 1986 Construction Detail for Typical Concrete-to-Concrete Joint. Eberson and Toto, Detail C/5.

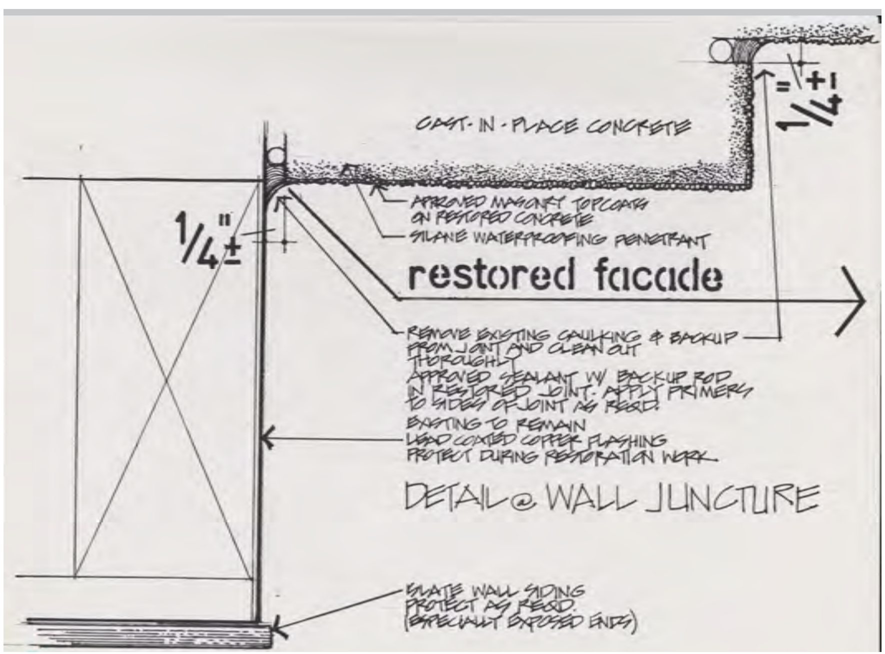


Figure C5. 1986 Construction Detail at Wall Juncture. Shows connection between concrete and slate-clad wall surfaces. Eberson and Toto, Detail D/5.)

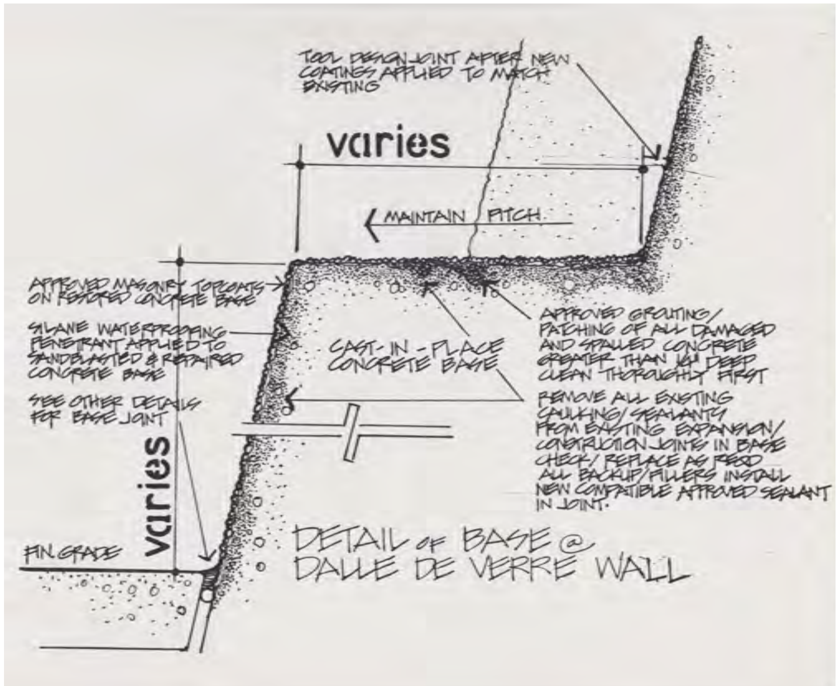


Figure C6. 1986 Construction Detail at Base of Dalle de Verre Wall. Eberson and Toto, Detail E/5.

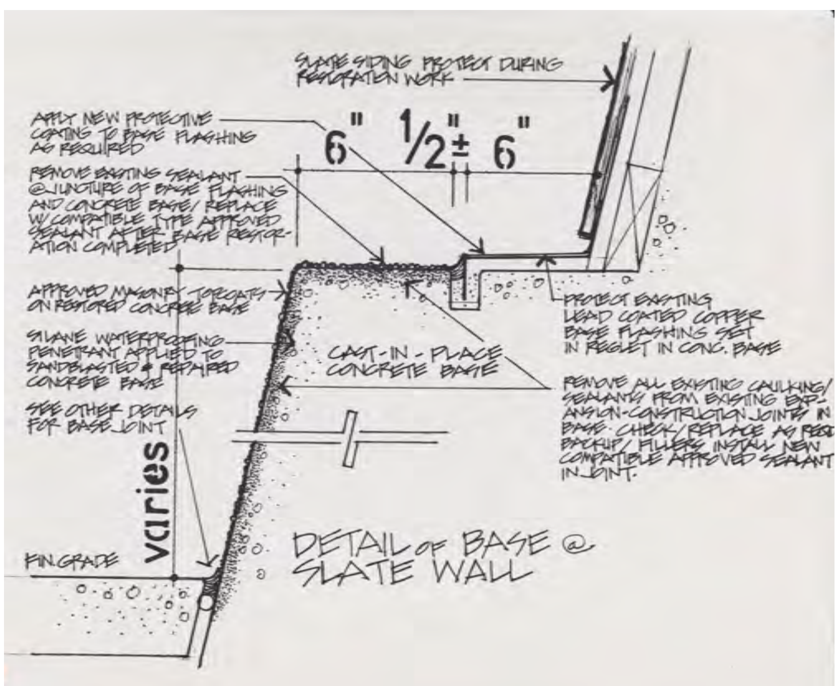


Figure C7. 1986 Construction Detail at Base of Slate Wall. Eberson and Toto, Detail F/5.

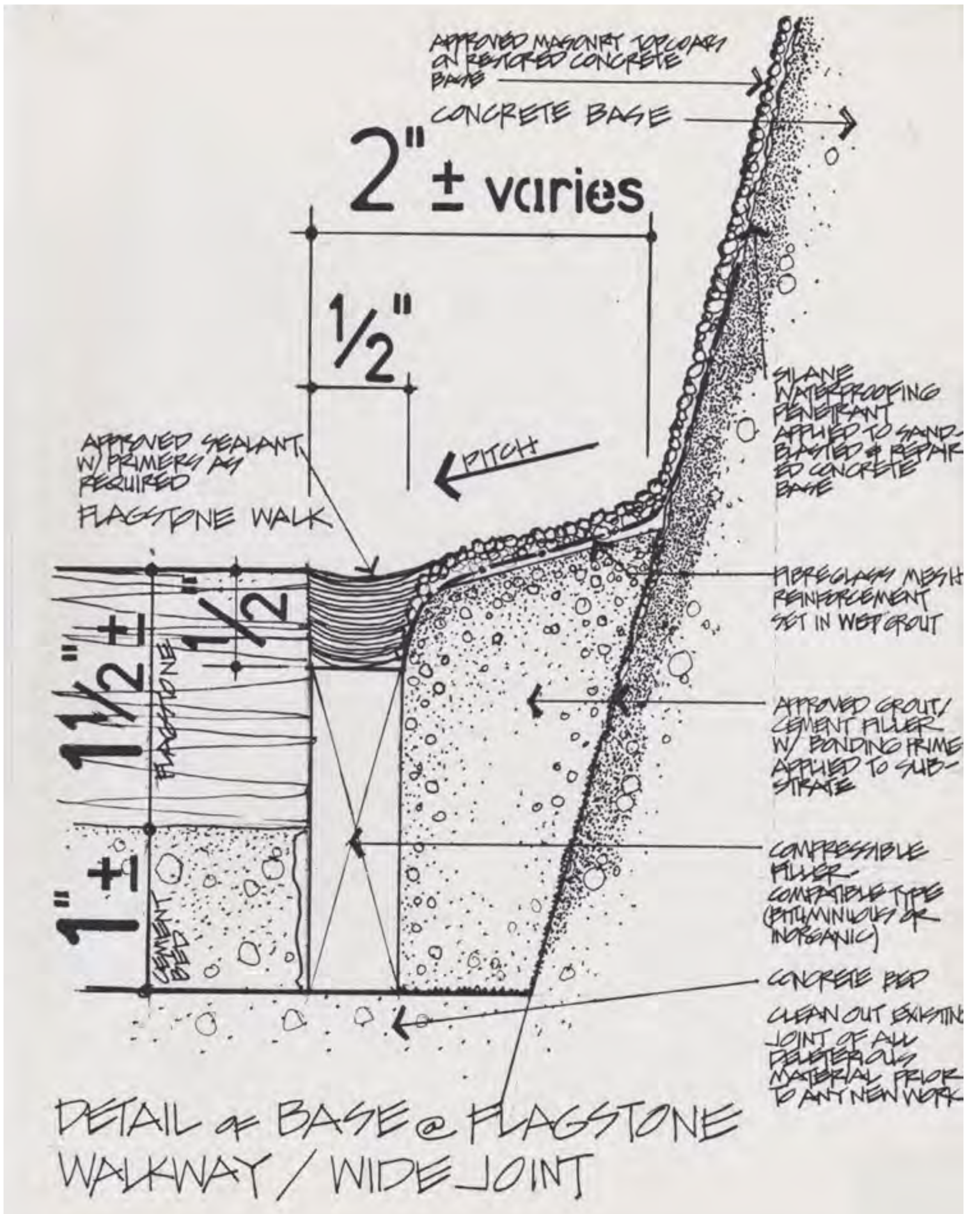


Figure C8. 1986 Construction Detail at Base at Flagstone Walkway. Eberson and Toto, Detail 1/5.

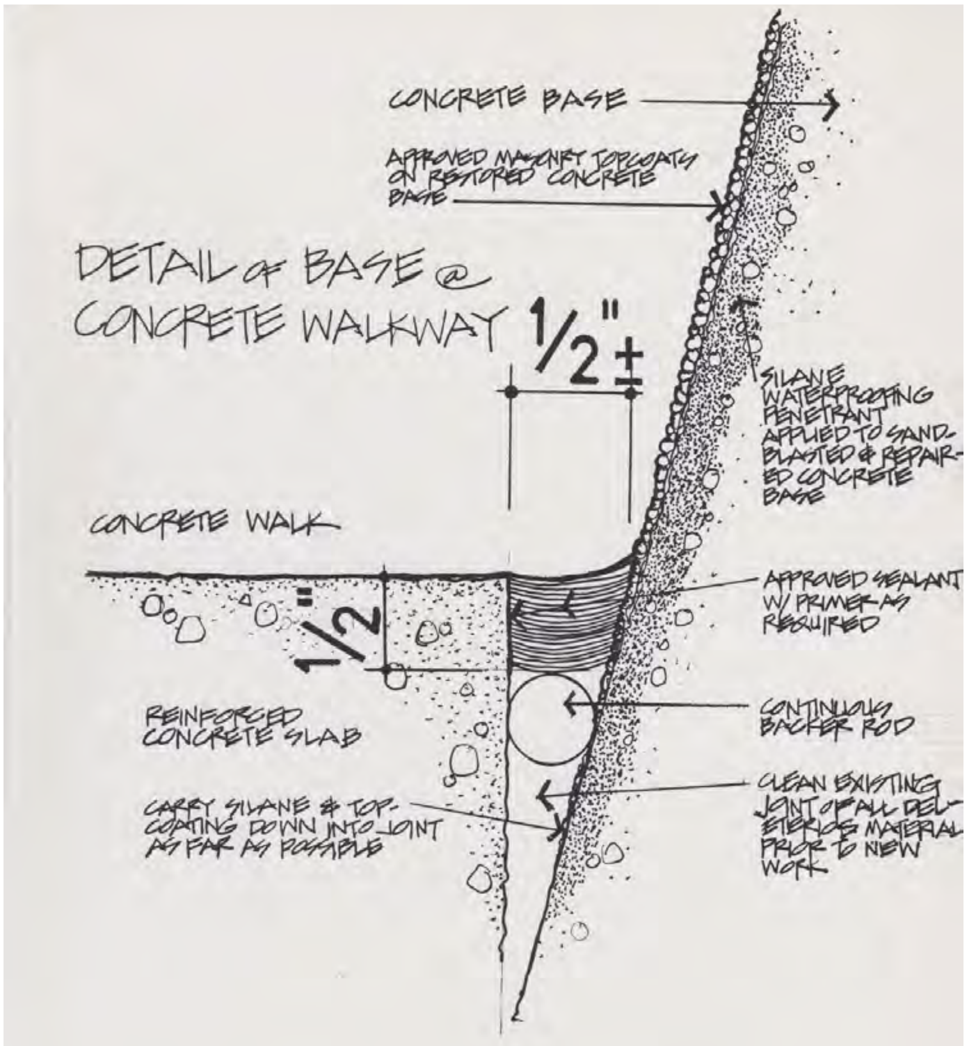


Figure C9. 1986 Construction Detail at Base at Concrete Walkway. Eberson and Toto, Detail 2/5.

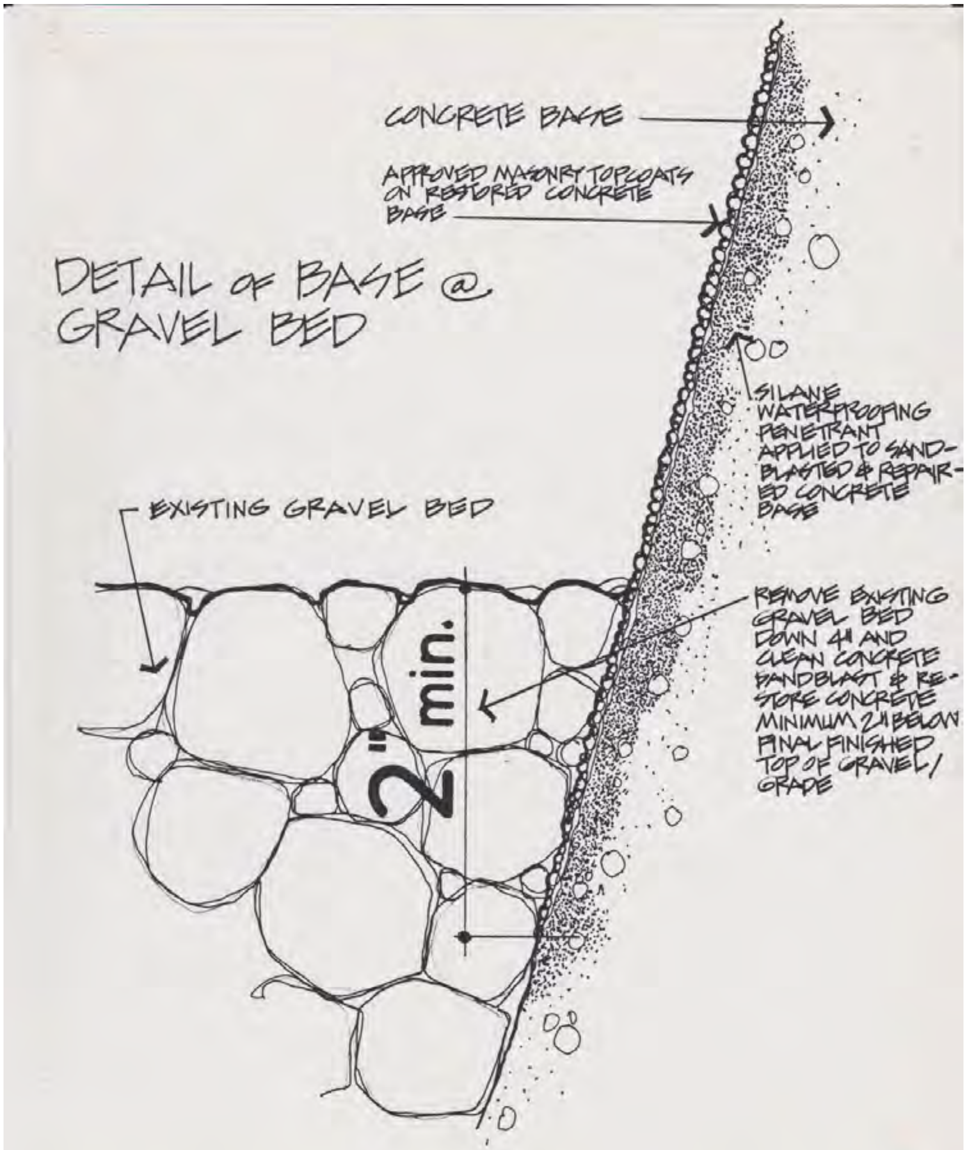


Figure C10. 1986 Construction Detail at Base at Gravel Bed. Eberson and Toto, Detail 3/5. This construction is no longer visible at the perimeter of the Sanctuary.

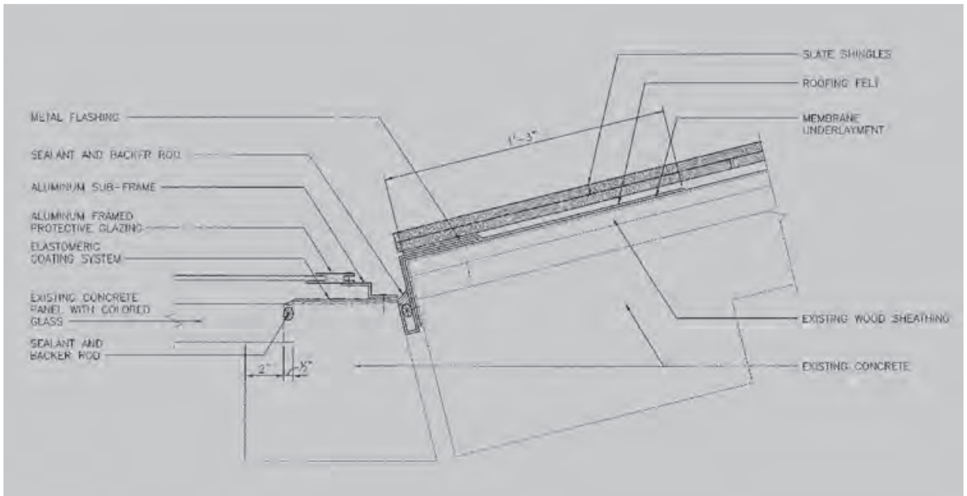


Figure C11. 2005 Aluminum Protective Glazing Construction Detail. Hoffmann Architects, "Building Envelope Rehabilitation: First Presbyterian Church," July 11, 2005, 2/A6. Detail is for typical protective glazing at dalle de verre above roofline. All protective glazing at skyward facing panels was scheduled for replacement. The detail does not show ventilation. Direct access was not available to confirm whether the installed protective glazing was built as shown in this detail.

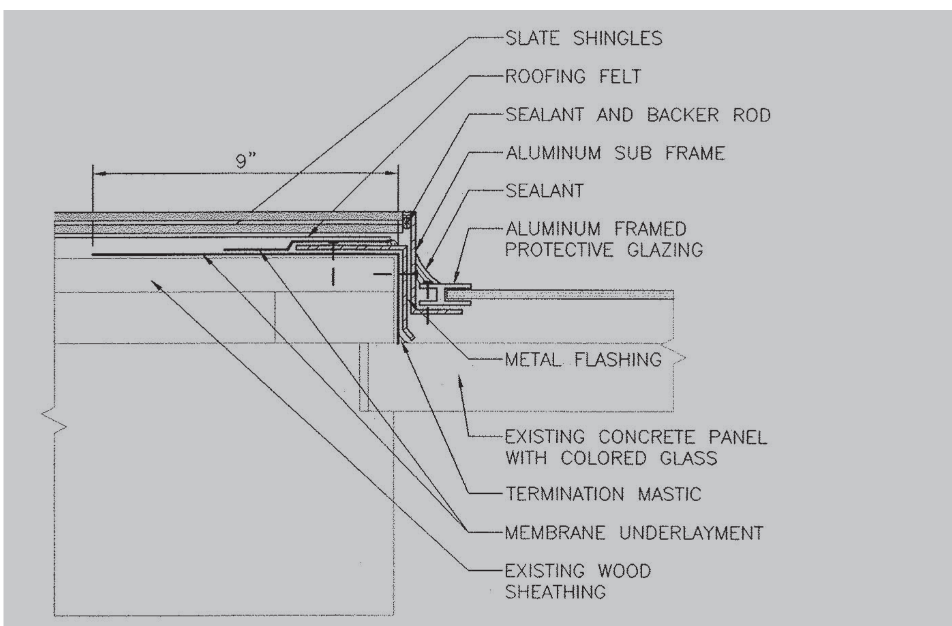


Figure C12. Aluminum Protective Glazing Construction Detail for Portal Windows in Slate. Hoffmann Architects, "Building Envelope Rehabilitation," 7/A6. The detail does not show ventilation. Direct access was not available to confirm whether the installed protective glazing was built as shown in this detail.

Appendix D
Existing Conditions and Recommendations Table

VISUAL GLOSSARY OF CONDITIONS AND RECOMMENDATIONS

Figure 1D below shows a typical entry from the table in Appendix D, with various components identified to assist with its interpretation. Within this table, these conditions have been prioritized as A, B, or C. The priority definitions, described below, reflect the urgency of recommendations.

The recommendations in this report and Appendix D are not project plans and specifications and could easily be misinterpreted if given to a contractor, as such it should be anticipated that a qualified restoration architect or consultant will prepare precise specifications based on the findings of this report.

Priorities

Priority A): Potential Life Safety Issues, Water Proofing, or Loss of Material Integrity

These items relate to deficiencies posing potentially dangerous conditions that if left uncorrected could fail and possibly affect life safety and/or cause rapid deterioration of the materials, adversely affecting the physical integrity. Included in this category are issues related to waterproofing.

Priority B): Diminished Material Performance

These items relate to deficiencies affecting the integrity of the materials. Repairs may be delayed but are necessary to remedy the conditions compromising the performance of the architectural materials, which will eventually lead to further deterioration, damage, or potentially dangerous conditions. It is strongly recommended that these items be addressed within the next five years.

Priority C): Aesthetic (Restoration Treatment)

These items relate to deficiencies that are cosmetic and affect the appearance of the building but not the integrity or performance of a material or the construction system.

CSI DIVISION: 03 Concrete

CSI Division of Element/Material Recommendation

Element Surveyed

ELEMENT(S) Framework, Pre-cast Panel

Primary Material(s) that Comprise Element

MATERIAL(S) Concrete

Location(s) Where Element/Material is Found

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) East, North, South

Elevation or Surface Where Element/Material Found

General Photograph Area

PHOTO LOCATION North Façade

Typical Image of Element/Material and Condition

Exposed steel reinforcement at location of spalled concrete in pre-cast panel N3. The rebar is approximately 3/4" in diameter and located approximately 3/4" below the concrete surface.

Caption Describing Condition(s) Shown in Image

Condition Noted

CONDITION(S)

8 A Spalled Exterior Concrete with Exposed Ferrous Reinforcement

Condition ID: Consists of Number and Priority Level (A, B, or C) and is Unique to Each CSI Division

RECOMMENDATION(S)

Remove unsound concrete. Clean exposed reinforcing bar and coat with corrosion inhibitor. Provide concrete patch(es).

Recommendations Related to the Condition(s) Noted Above

Figure 1D. Typical entry in the conditions and recommendations table with data from the table identified to assist with its interpretation.

CSI DIVISION: 03 Concrete

ELEMENT(S) Dalle de Verre, Framework, Pre-cast Panel, Southwest and Northwest Door Surrounds, Entrance Canopy, Base

MATERIAL(S) Glass Dalle(s), Pre-Cast Concrete, Concrete

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION North Façade

Deteriorated coating on the north elevation, exposing concrete below and allowing for water penetration into the concrete. In some areas, the deteriorated coating traps water, resulting in damage to the underlying masonry and glass.

CONDITION(S)

1 A Deteriorated Elastomeric Coating, General Atmospheric Soil, and Biological Growth on Exterior Concrete

RECOMMENDATION(S)

Strip all coatings from all surfaces. Provide new breathable water repellent coating to all concrete.

ELEMENT(S) Framework, Pre-cast Panel

MATERIAL(S) Concrete

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION South Façade

Extensive cracks in the deteriorated coating on the concrete substrate.

CONDITION(S)

2 A Network Crack(s) in Concrete Coating

RECOMMENDATION(S)

Further investigation required to determine the extent that the cracks propogate from the substrate. Removal all coatings and survey concrete. Provide necessary concrete repairs and new waterproof coating.

CSI DIVISION: 03 Concrete

ELEMENT(S) Framework, Pre-cast Panel

MATERIAL(S) Concrete

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION North Façade

Spalled concrete and exposed steel reinforcement in pre-cast panel N3. The rebar is approximately 3/4" in diameter and located approximately 3/4" below the concrete surface.

CONDITION(S)

3 A Spalled Exterior Concrete with Exposed Ferrous Reinforcement

RECOMMENDATION(S)

Remove unsound concrete. Clean exposed reinforcing bar and coat with corrosion inhibitor. Provide concrete patch(es).

ELEMENT(S) Framework, Pre-cast Panel, Southwest and Northwest Door Surrounds, Entrance Canopy, Base

MATERIAL(S) Concrete

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION East Façade

Horizontal crack visible in concrete coating on the cast-in-place framework. The extent that such cracks in the concrete coating project from the substrate is not known. Some repairs are assumed necessary.

CONDITION(S)

4 A Crack(s) in Exterior Concrete

RECOMMENDATION(S)

Remove all coatings. Review cracks and perform sounding survey. Remove unsound concrete. Clean exposed reinforcing bar and coat with corrosion inhibitor. Provide concrete patch(es)

CSI DIVISION: 03 Concrete

ELEMENT(S) Concrete Base

MATERIAL(S) Concrete

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION East Façade

Delaminating coating and crack in base. Cracks are visible in the concrete base on all elevations. Similar conditions were previously addressed in multiple restoration campaigns.

CONDITION(S)

5 A Crack(s) in Exterior Concrete Base

RECOMMENDATION(S)

Further investigation required. Remove deteriorated coatings and patching materials for further review of concrete substrate. Perform additional testing to determine source of cracking.

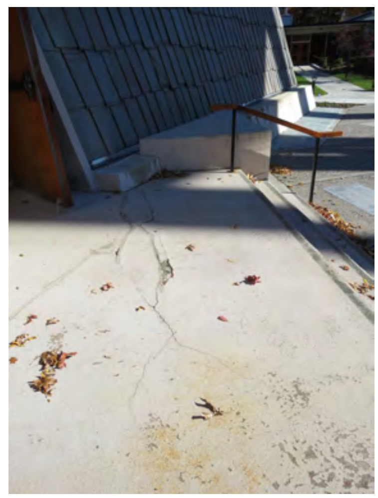
ELEMENT(S) Stairs

MATERIAL(S) Concrete

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) South

PHOTO LOCATION Southwest Entrance



Cracks in stairs at Narthex entrance. Condition requires review by a structural engineer.

CONDITION(S)

6 A Cracks in Concrete Stairs

RECOMMENDATION(S)

Further investigation required. Engineer to review cause of cracking.

CSI DIVISION: 03 Concrete

ELEMENT(S) Plaque, Cast-in-Place Concrete

MATERIAL(S) Granite, Concrete, Sealant

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) South

PHOTO LOCATION Narthex Entrance

Significant cracks and deteriorated sealant at the stairs and granite plaque of the Narthex entrance. These were previously identified for repair during the 2003-2007 Waterproofing Campaign.

CONDITION(S)

7 A Cracks and Deteriorated Sealant Around Granite Plaque

RECOMMENDATION(S)

Further investigation required. Engineer to review cause of cracking.

ELEMENT(S) Framework, Pre-cast Panel

MATERIAL(S) Concrete

LOCATION(S) Nave, Narthex

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION Interior North Wall

Water infiltration is common at the corners of pre-cast panels, along the roof ridge on both the north and south elevations.

CONDITION(S)

8 A Water Infiltration Typical at Corners of Pre-Cast Panels Along the Roof Ridge and at the Valleys Where the Wall Panels Meet

RECOMMENDATION(S)

Determine and eliminate source of water infiltration. Vacuum efflorescence from concrete, strip deteriorated paint from surface of concrete, remove all salts using poultice, and provide concrete repairs as necessary.

CSI DIVISION: 03 Concrete

ELEMENT(S) Concrete Base, Framework, Pre-cast Panel

MATERIAL(S) Concrete

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) East, South

PHOTO LOCATION Interior North Wall

Spalled concrete over steel reinforcement in the concrete base near the door to the Choir room on the north elevation. Small spalls over corroding steel are also visible in the cast-in-place framework of the walls.

CONDITION(S)

9 A Spalled Interior Concrete with Exposed Ferrous Reinforcement

RECOMMENDATION(S)

Remove unsound concrete. Clean exposed reinforcing bar and coat with corrosion inhibitor. Provide concrete patch(es).

ELEMENT(S) Framework

MATERIAL(S) Concrete

LOCATION(S) Nave, Narthex

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION Interior East Wall

Large crack parallel to the face of the cast-in-place concrete framework in the Narthex. The ferrous stains along the crack indicate rusting reinforcement.

CONDITION(S)

10 A Crack(s) and Impending Spall(s) in Concrete

RECOMMENDATION(S)

Remove unsound concrete and patching material from interior surfaces. Clean exposed reinforcing bar and coat with corrosion inhibitor. Provide concrete patch(es).

CSI DIVISION: 03 Concrete

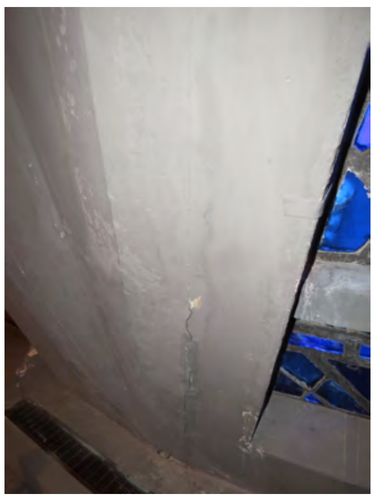
ELEMENT(S) Framework, Pre-cast Panel

MATERIAL(S) Concrete

LOCATION(S) Nave, Narthex

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION Interior North Wall



Typical vertical crack at the interior, where pre-cast panels abut cast-in-place concrete framework.

CONDITION(S)

11 A Vertical Cracks at the Interior Where Pre-cast Panels Intersect the Cast-in-Place Framework

RECOMMENDATION(S)

Further investigation required. Remove deteriorated coatings and patching materials for further review by engineer.

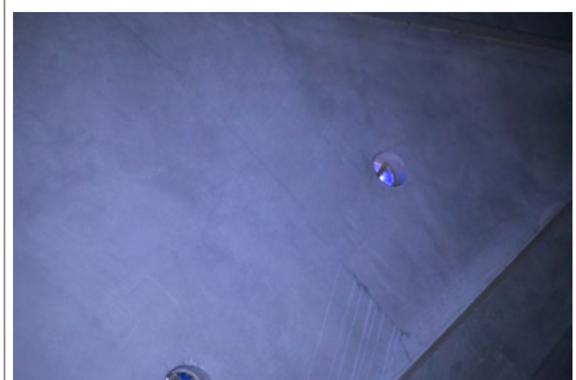
ELEMENT(S) Pre-cast Panel

MATERIAL(S) Concrete

LOCATION(S) Nave, Narthex

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION Interior North Wall



Water infiltration through crack in pre-cast ceiling panel between Panels N26 and N27. The exterior of this panel is covered with slate. It has not been determined if this in an active leak or if it was resolved by the 2005 waterproof campaign.

CONDITION(S)

12 A Crack(s) in Precast Panels

RECOMMENDATION(S)

Determine and eliminate source of water infiltration. Repair crack with grout injection crack repair.

CSI DIVISION: 03 Concrete

ELEMENT(S) Framework, Pre-cast Panel, Southwest and Northwest Door Surrounds, Entrance Canopy, Base

MATERIAL(S) Concrete

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION South Façade

Efflorescence on the exterior concrete. Also note the cracks and ferrous stains visible in this image.

CONDITION(S)

1 B Efflorescence on Exterior Concrete

RECOMMENDATION(S)

Remove all coatings. Remove all salts using poultice and provide concrete repairs as necessary.

ELEMENT(S) Framework, Pre-cast Panel

MATERIAL(S) Pre-Cast Concrete

LOCATION(S) Nave, Narthex

ELEVATION(S)/SURFACE(S) North

PHOTO LOCATION Interior North Wall

Typical thin efflorescence visible on the pre-cast panels comprising the north wall of the nave.

CONDITION(S)

2 B Efflorescence on Interior Concrete

RECOMMENDATION(S)

Determine and eliminate source of water infiltration. Vacuum efflorescence from concrete and remove all salts using poultice.

CSI DIVISION: 03 Concrete

ELEMENT(S) Concrete Base

MATERIAL(S) Concrete

LOCATION(S) Nave
ELEVATION(S)/SURFACE(S) North

PHOTO LOCATION Interior North Wall

Efflorescence visible on the interior concrete base below the acoustical panels on the North elevation. See Condition 4B for view of concrete on the other side of interior wall.

CONDITION(S)

3 B Efflorescence at Interior Concrete Base in Nave

RECOMMENDATION(S)

Determine and eliminate source of water infiltration. Vacuum efflorescence from concrete and remove all salts using poultice.

ELEMENT(S) Concrete Base

MATERIAL(S) Concrete

LOCATION(S) North Passage
ELEVATION(S)/SURFACE(S) South

PHOTO LOCATION North Passage

Efflorescence visible on the interior concrete base in the North Passage. See Condition 3B for view of concrete on the other side of interior wall.

CONDITION(S)

4 B Efflorescence at Interior Concrete Base in North Passageway

RECOMMENDATION(S)

Determine and eliminate source of water infiltration. Vacuum efflorescence from concrete and remove all salts using poultice.

CSI DIVISION: 03 Concrete

ELEMENT(S) Framework, Pre-cast Panel

MATERIAL(S) Concrete

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION North Façade

Previous exterior patch on the north elevation. The shape of the patch suggests a previous core location.

CONDITION(S)

5 B Previous Exterior Patch(es) in Concrete

RECOMMENDATION(S)

Remove previous deteriorated or non-matching repair(s) and provide new concrete patch(es) matching adjacent concrete.

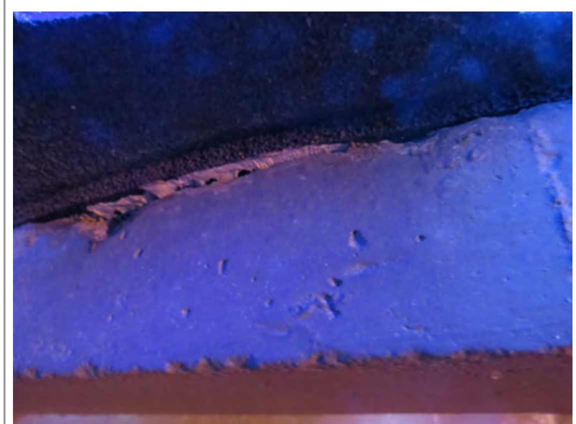
ELEMENT(S) Framework, Pre-cast Panel

MATERIAL(S) Concrete

LOCATION(S) Nave, Narthex

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION Interior South Wall



Edge spalls visible along interior of pre-cast concrete panels. This may have resulted from the removal and replacement of the dalle de verre in the 1980s. Also note the exposed and loose flexible foam expansion joint filler.

CONDITION(S)

6 B Shallow Spall(s) in Interior Concrete (No Exposed Ferrous Reinforcement)

RECOMMENDATION(S)

Remove only unsound concrete and provide concrete patch(es) at deep losses.

CSI DIVISION: 03 Concrete

ELEMENT(S) Dalle de Verre, Framework, Pre-cast Panel

MATERIAL(S) Concrete

LOCATION(S) Nave, Narthex

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION Interior North Wall

Water infiltration stains on the concrete.

CONDITION(S)

1 C Water Stains and General Atmospheric Soil on Interior Concrete. Heavy Soiling at Skyward Facing Surfaces of Concrete.

RECOMMENDATION(S)

Determine and eliminate source of water infiltration. Vacuum heavy dust from skyward facing surfaces, and clean concrete.

ELEMENT(S) Framework, Pre-cast Panel

MATERIAL(S) Concrete

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION South Façade

Typical ferrous stain telegraphing through the existing coating.

CONDITION(S)

2 C Ferrous Stains on Concrete

RECOMMENDATION(S)

Remove all coatings. Remove ferrous stains using a chemical cleaner in a poultice and pressurized water rinsing.

CSI DIVISION: 03 Concrete

ELEMENT(S) Framework, Pre-cast Panel

MATERIAL(S) Concrete

LOCATION(S) Nave

ELEVATION(S)/SURFACE(S) North

PHOTO LOCATION Interior North Wall

Previous patch near the base of pre-cast panel N11. The shape of the patch suggests it was a core sample location during a previous building investigation. Note the efflorescence on the original dalle de verre panels visible in this image.

CONDITION(S)

3 C Previous Nonmatching/Inappropriate Interior Patch(es) in Concrete

RECOMMENDATION(S)

Remove previous repair(s) and provide new concrete patch(es) matching adjacent concrete.

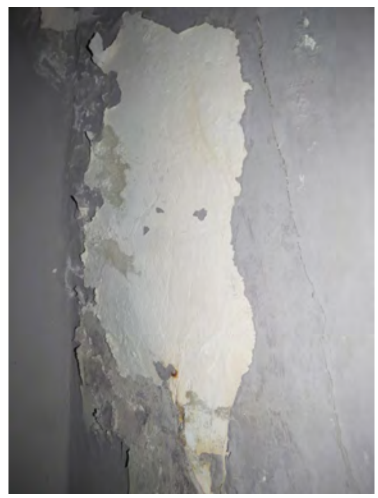
ELEMENT(S) Framework, Pre-cast Panel

MATERIAL(S) Concrete

LOCATION(S) Nave, Narthex

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION Interior East Wall



Deteriorated paint revealing a skim coat finishes applied to the interior concrete. Also note the small area of ferrous stains visible at the bottom center of this image, where embedded reinforcement is rusting.

CONDITION(S)

4 C Previous Plaster Patch Repair(s) in Concrete

RECOMMENDATION(S)

Remove all coatings. Remove existing inappropriate patch material. Clean exposed reinforcing bar and coat with corrosion inhibitor. Provide concrete patch(es).

CSI DIVISION: 03 Concrete

ELEMENT(S) Framework, Pre-cast Panel

MATERIAL(S) Concrete

LOCATION(S) Nave, Narthex

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION Interior North Wall

Isolated abandoned anchors in concrete.

CONDITION(S)

5 C Abandoned Conduit(s)/Wire(s)Anchor(s) in Concrete

RECOMMENDATION(S)

Remove Conduit(s)/Wire(s)/Anchor(s) and provide cementitious patch repair.

ELEMENT(S) Framework, Pre-cast Panel

MATERIAL(S) Concrete

LOCATION(S) Nave, Narthex

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION Interior North Wall

Typical pitting on interior concrete framework surface.

CONDITION(S)

6 C Voids and Pitting at Surface of Concrete

RECOMMENDATION(S)

No Restoration Work is Recommended

CSI DIVISION: 04 Masonry

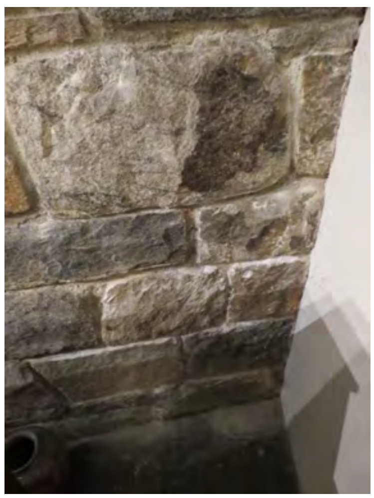
ELEMENT(S) Wall(s)

MATERIAL(S) Masonry (Field Stone)

LOCATION(S) Chapel

ELEVATION(S)/SURFACE(S) East

PHOTO LOCATION Interior East Wall



Efflorescence on the interior field stone at the bottom of exterior wall on east elevation of Chapel.

CONDITION(S)

1 B Efflorescence on Interior Masonry

RECOMMENDATION(S)

Determine and eliminate source of water infiltration. Vacuum efflorescence from stone and remove all salts using poultice.

CSI DIVISION: 05 Metals

ELEMENT(S) Railing

MATERIAL(S) Concrete

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) South

PHOTO LOCATION Narthex Entrance

Corrosion and deteriorated concrete at base of ferrous metal rail post.

CONDITION(S)

1 B Corroding Base of Handrail

RECOMMENDATION(S)

Remove railing, strip paint, and remove corrosion. Prepare, prime, and paint. Reinstall railing with lead around rail bases in lieu of sealant.

ELEMENT(S) Louvers

MATERIAL(S) Sheet Metal

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) North, West

PHOTO LOCATION West Façade

Louvers on west elevation leading to organ loft. Louvers are also located on east end of the north elevation.

CONDITION(S)

2 B Deteriorated Finish on Exterior Louvers

RECOMMENDATION(S)

Prepare surface of louvers and provide new coating.

CSI DIVISION: 05 Metals

ELEMENT(S) Wire

MATERIAL(S) Wire

LOCATION(S) Nave, Narthex

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION Interior North Wall

Typical wire installed under skyward facing dalle de verre panels during the building's original construction. It is assumed that this wire was installed to comply with skylight construction codes.

CONDITION(S)

1 C Metal Wire at Interior of Skyward Facing Panels

RECOMMENDATION(S)

Vacuum all wire and confirm securely attached.

CSI DIVISION: 07 Thermal & Moisture Protection

ELEMENT(S) Waterproofing/Flashing

MATERIAL(S) Waterproofing

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION North Façade

Typical failing sealant between the pre-cast and cast-in-place concrete on the north elevation.

CONDITION(S)

1 A Failing/Deteriorated/Missing Sealant Between Pre-cast Concrete and Cast-in-Place Concrete

RECOMMENDATION(S)

Provide new sealant.

ELEMENT(S) Framework, Pre-cast Panel

MATERIAL(S) Concrete, Sealant

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) East, South

PHOTO LOCATION South Façade

Reglet installed at roof line during 1980s restoration campaign. The sealant and concrete coatings are typically deteriorated at the valley where the roof and wall panels connect. See Condition 8A for typical interior damage in these areas.

CONDITION(S)

2 A Deteriorated Sealant in Reglet at Exterior of South and East Elevations

RECOMMENDATION(S)

Provide new sealant in exterior reglet.

CSI DIVISION: 07 Thermal & Moisture Protection

ELEMENT(S) Dalle de Verre, Pre-Cast Concrete

MATERIAL(S) Glass Dalle(s), Pre-Cast Concrete, Sealant

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) North

PHOTO LOCATION North Façade

The deteriorated coating on the north elevation was also installed over the sealant at the perimeter of the dalle de verre panels and larger pre-cast panels. It additionally laps onto the glass. Archival research suggests it was applied in the 1990s.

CONDITION(S)

3 A Deteriorated Coating Over Sealant at Perimeter of Panels

RECOMMENDATION(S)

Remove all coatings. Provide new sealant around all panels on the north elevation.

ELEMENT(S) Waterproofing/Flashing

MATERIAL(S) Waterproofing

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) Ground

PHOTO LOCATION North Façade

Deteriorated sealant in the joint at the base of the east end of north elevation. Biological growth is present in joint and on concrete base. The existing construction varies slightly from 1980s construction detail included as Figure C8 in Appendix C.

CONDITION(S)

4 A Failing/Deteriorated/Missing Sealant at Base of Building

RECOMMENDATION(S)

Provide new sealant.

CSI DIVISION: 07 Thermal & Moisture Protection

ELEMENT(S) Waterproofing/Flashing

MATERIAL(S) Waterproofing

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION South Façade

Typical deteriorated sealant at the flashing along the base of the building. Also note the typical biological growth visible on the concrete base.

CONDITION(S)

5 A Failing/Deteriorated/Missing Sealant At Flashing of Concrete Base

RECOMMENDATION(S)

Provide new sealant. Review flashing details and performance.

ELEMENT(S) Waterproofing/Flashing

MATERIAL(S) Waterproofing

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) All

PHOTO LOCATION East Façade

Deteriorated sealant at the juncture of flashing and concrete.

CONDITION(S)

6 A Failing/Deteriorated/Missing Sealant at Flashing/Counter Flashing

RECOMMENDATION(S)

Provide new sealant. Review flashing details and performance.

CSI DIVISION: 07 Thermal & Moisture Protection

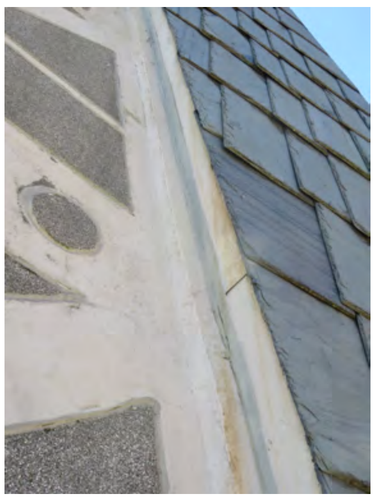
ELEMENT(S) Waterproofing/Flashing

MATERIAL(S) Metal

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) East

PHOTO LOCATION East Façade



The coating found on the concrete was also applied the flashing between the concrete and slate on the east elevation.

CONDITION(S)

7 A Deteriorated Coating on Flashing

RECOMMENDATION(S)

Remove all coatings from existing flashing. Review condition of underlying flashing and repair or replace where necessary.

ELEMENT(S) Waterproofing/Flashing

MATERIAL(S) Lead Coated Copper

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) Roof

PHOTO LOCATION North Façade

Lead coated copper flashing is still visible at isolated areas of the building, such as at this connection of the slate and concrete on the north elevation.

CONDITION(S)

8 A Open Seams

RECOMMENDATION(S)

Confirm proper sheet metal flashing connections and modify if necessary.

CSI DIVISION: 07 Thermal & Moisture Protection

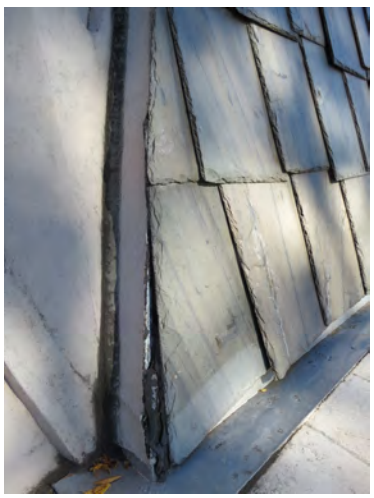
ELEMENT(S) Roofing/Exterior Cladding

MATERIAL(S) Shingle (Slate)

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) All

PHOTO LOCATION South Façade



Deteriorated waterproofing material at the edge of the slate on the south elevation.

CONDITION(S)

9 A Deteriorated Waterproofing at Perimeter of Slate

RECOMMENDATION(S)

Provide new flashing.

ELEMENT(S) Roofing/Exterior Cladding

MATERIAL(S) Shingle (Slate)

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) All

PHOTO LOCATION South Façade

Isolated loose slate shingle on south elevation.

CONDITION(S)

10 A Loose Slate Shingles

RECOMMENDATION(S)

Remove, salvage, and reinstall loose slate shingles. Provide new to matching existing where shingles are damaged.

CSI DIVISION: 07 Thermal & Moisture Protection

ELEMENT(S) Roofing/Exterior Cladding

MATERIAL(S) Shingle (Slate)

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) All

PHOTO LOCATION North Façade

Typical isolated missing slate shingle.

CONDITION(S)

11 A Missing Slate Shingles

RECOMMENDATION(S)

Provide new slate shingles to replace missing slate shingles.

ELEMENT(S) Roofing/Exterior Cladding

MATERIAL(S) Shingle (Slate)

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) All

PHOTO LOCATION South Façade

Typical isolated cracked slate.

CONDITION(S)

12 A Cracked Slate

RECOMMENDATION(S)

Provide new slate shingles to replace broken slate shingles.

CSI DIVISION: 07 Thermal & Moisture Protection

ELEMENT(S) Roofing/Exterior Cladding

MATERIAL(S) Shingle (Slate)

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) All

PHOTO LOCATION South Façade

Missing anchor in slate at the center of the image. Also note the previously repaired slate visible directly above the missing anchor.

CONDITION(S)

13 A Missing Anchors/Corroding Ferrous Nails in Slate Roof

RECOMMENDATION(S)

Replace fasteners with new stainless steel or copper fasteners.

ELEMENT(S) Entrance Canopy

MATERIAL(S) Concrete, Waterproofing

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) South

PHOTO LOCATION Narthex Entrance

Archival research suggests the existing coating on this canopy was applied during the 1990s. Repairs to the flashing were reportedly performed in 2005 to address water infiltration and damage to the interior concrete. The red arrow identifies the drain.

CONDITION(S)

14 A Deteriorated Coating and Debris in Drain

RECOMMENDATION(S)

Clean and inspect drain. Remove existing coating and examine condition of underlying concrete. Provide concrete patching and crack repairs as necessary. Provide new waterproofing coating.

CSI DIVISION: 07 Thermal & Moisture Protection

ELEMENT(S) Northwest Door Surround Roof, Southwest Door Surround Roof

MATERIAL(S) Concrete, Waterproofing

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) South

PHOTO LOCATION Southwest Entrance

Weathered roof coating over the southwest entrance. This metal roof was scheduled for replacement as part of the work in 2005, but it appears to have been coated instead. The interior concrete at the soffit of the entrance exhibits impending spalls.

CONDITION(S)

15 A Deteriorated Roofing Coating

RECOMMENDATION(S)

Further investigation required. Remove existing coating and examine condition of underlying metal roof.

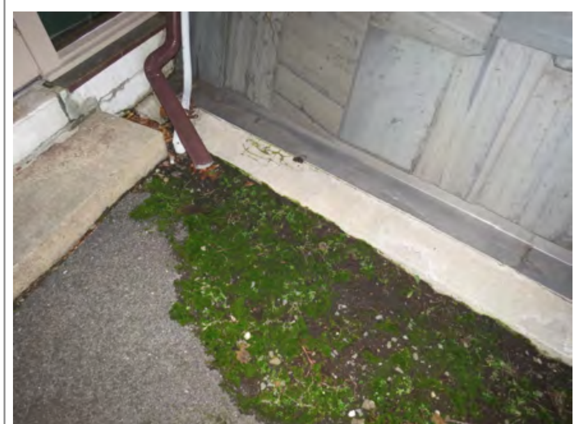
ELEMENT(S) Waterproofing/Flashing

MATERIAL(S) Concrete, Waterproofing

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) North

PHOTO LOCATION North Façade



Drainage from Choir Room roof is directed to the base of Sanctuary, promoting moisture penetration into the concrete.

CONDITION(S)

1 B Drainage from Adjacent Roof Directed to Base of Sanctuary

RECOMMENDATION(S)

Redirect drainage away from base of Sanctuary. Install proper drainage system to separate landscaping from façade.

CSI DIVISION: 07 Thermal & Moisture Protection

ELEMENT(S) Waterproofing/Flashing

MATERIAL(S) Concrete

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) North

PHOTO LOCATION North Façade

Plantings adjacent to the base of the Sanctuary in the north courtyard.

CONDITION(S)

2 B Plantings Adjacent to Base of Sanctuary

RECOMMENDATION(S)

Remove plantings from the base of the building in the north courtyard. Install proper drainage system to separate landscaping from façade.

ELEMENT(S) Waterproofing/Flashing

MATERIAL(S) Concrete

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) North, West

PHOTO LOCATION North Façade, West Façade

Grass adjacent to concrete base at the northwest corner of the Sanctuary.

CONDITION(S)

3 B Grass Adjacent Concrete

RECOMMENDATION(S)

Install proper drainage system to separate landscaping from façade.

CSI DIVISION: 07 Thermal & Moisture Protection

ELEMENT(S) Roofing/Exterior Cladding

MATERIAL(S) Shingle (Slate)

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) All

PHOTO LOCATION West Façade

Typical soil and biological growth on slate.

CONDITION(S)

4 B General Atmospheric Soil and Biological Growth on Slate Roof

RECOMMENDATION(S)

Clean slate surfaces using chemical cleaner designed to remove biological growth. Further investigation required to determine the type of staining below the metal louvers.

ELEMENT(S) Roofing/Exterior Cladding

MATERIAL(S) Shingle (Slate)

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) All

PHOTO LOCATION Roof

Typical efflorescence visible on isolated slate.

CONDITION(S)

5 B Efflorescence on Slate

RECOMMENDATION(S)

Remove efflorescence using poultices.

CSI DIVISION: 07 Thermal & Moisture Protection

ELEMENT(S) Roofing/Exterior Cladding

MATERIAL(S) Shingle (Slate)

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) All

PHOTO LOCATION South Façade

Isolated slate appear to have been repaired with various materials.

CONDITION(S)

6 B Previously Repaired Slate

RECOMMENDATION(S)

Provide new slate shingles to replace broken slate shingles.

ELEMENT(S) Dalle de Verre, Epoxy

MATERIAL(S) Glass Dalle(s), Pre-Cast Concrete, Sealant

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) East, South

PHOTO LOCATION South Façade

Sealant smears around panels installed on the south elevation. Also note the cracks in the concrete and coating in this area.

CONDITION(S)

1 C Sealant Smears on Adjacent Concrete and Dalle de Verre

RECOMMENDATION(S)

Overall recommendation for dalle de panels with an epoxy matrix includes fabrication and installation of new dalle de verre panels.

CSI DIVISION: 07 Thermal & Moisture Protection

ELEMENT(S) Roofing/Exterior Cladding

MATERIAL(S) Shingle (Slate)

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) All

PHOTO LOCATION South Façade

Typical ferrous stains from inclusions in the slate.

CONDITION(S)

2 C Ferrous Stains on Slate Roof

RECOMMENDATION(S)

Remove ferrous stains using a chemical cleaner in a poultice and pressurized water rinsing.

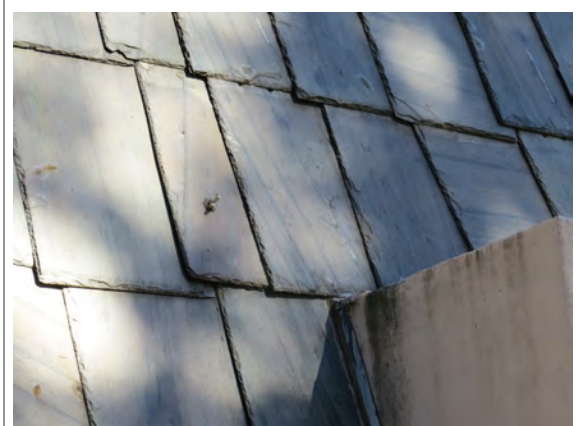
ELEMENT(S) Roofing/Exterior Cladding

MATERIAL(S) Shingle (Slate)

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) South

PHOTO LOCATION Southwest Entrance



The 2005 water infiltration report noted that the fixtures in this location were water logged. They appear to have been subsequently removed.

CONDITION(S)

3 C Abandoned Wires From Removed Light Fixtures

RECOMMENDATION(S)

Remove wires and seal holes.

CSI DIVISION: 07 Thermal & Moisture Protection

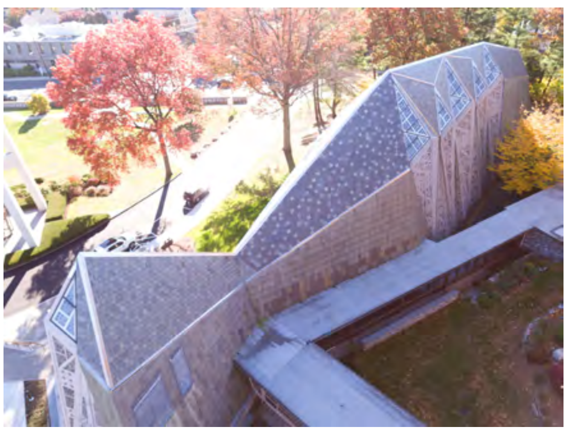
ELEMENT(S) Roofing/Exterior Cladding

MATERIAL(S) Shingle (Slate)

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) All

PHOTO LOCATION North Façade



Non-matching replacement slate is visible in this image above the roofline of the north passage and at the roof portions above the Nave (although not above the concrete panels).

CONDITION(S)

4 C Previous Non-Matching Replacement Slate

RECOMMENDATION(S)

No Restoration Work is Recommended

ELEMENT(S) Roofing/Exterior Cladding

MATERIAL(S) Shingle (Slate)

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) All

PHOTO LOCATION South Façade

Isolated slate are supported by visible clips.

CONDITION(S)

5 C Previously Reinstalled Slate with Exposed Anchors

RECOMMENDATION(S)

No Restoration Work is Recommended

CSI DIVISION: 07 Thermal & Moisture Protection

ELEMENT(S) Framework, Pre-cast Panel

MATERIAL(S) Concrete

LOCATION(S) Nave

ELEVATION(S)/SURFACE(S) North, South

PHOTO LOCATION Interior North Wall

Existing control joint, running north to south in the framework, just west of the Choir Loft.

CONDITION(S)

6 C Existing Control Joint

RECOMMENDATION(S)

No Restoration Work is Recommended

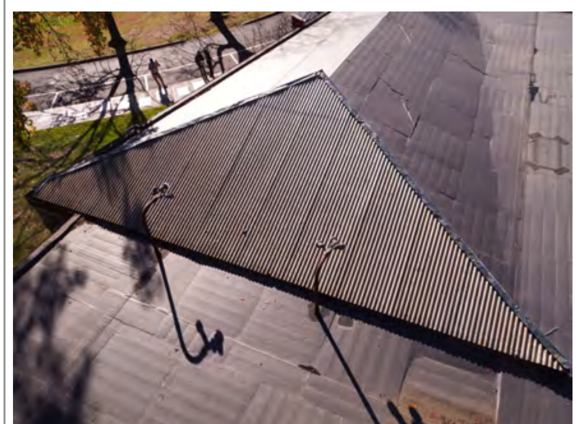
ELEMENT(S) Dalle de Verre Exterior Protection

MATERIAL(S) Corrugated Plastic Panels

LOCATION(S) Chapel Façade

ELEVATION(S)/SURFACE(S) Roof

PHOTO LOCATION Chapel Roof



Roofing protection over chapel dalle de verre. Archival drawings identify it as Corrulux, which was a corrugated, translucent plastic panel with fiber glass reinforcement.

CONDITION(S)

7 C Existing Stained Glass Protection Panel

RECOMMENDATION(S)

No Restoration Work is Recommended

CSI DIVISION: 08 Doors & Windows

ELEMENT(S) Dalle de Verre

MATERIAL(S) Glass Dalle(s), Pre-Cast Concrete

LOCATION(S) Nave, Narthex

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION Interior North Wall

Typical stains resulting from water infiltration through hairline separation between the dalles and concrete matrix.

CONDITION(S)

1 A Water Infiltration at Perimeter of Dalle(s) in Concrete Matrix

RECOMMENDATION(S)

Provide protective glazing on the north elevation over all original dalle de verre. Recommendation also intended to address glass deterioration on this elevation.

ELEMENT(S) Protective Glazing

MATERIAL(S) Aluminum Framed Protective Glazing System

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION North Façade

Typical protective glazing units on the north. Similar units are installed above the roofline on the south and east elevations. They do not appear to be vented, resulting in condensation on the glass and potential water infiltration through panels below.

CONDITION(S)

2 A Condensation Visible Within Protective Glazing. Signs of water infiltration visible on interior concrete.

RECOMMENDATION(S)

Provide new vented protective glazing.

CSI DIVISION: 08 Doors & Windows

ELEMENT(S) Protective Glazing

MATERIAL(S) Protective Glazing System

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION Roof

Typical deteriorated and inconsistent sealant application around the protective glazing over the roof portal windows. The 2005 details of the protective glazing show no venting.

CONDITION(S)

3 A Deteriorated Sealant at Protective Glazing Over Portholes. Glazing is Not Vented.

RECOMMENDATION(S)

Provide new vented protective glazing.

ELEMENT(S) Narthex Doors

MATERIAL(S) Wood

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) North

PHOTO LOCATION Narthex Entrance

Typical deterioration at Narthex door. The finish is abraded and exhibits water stains. Abandoned anchors are visible and holes are visible from previously removed hardware.

CONDITION(S)

1 B Deteriorated Finish and Abandoned Anchor Holes

RECOMMENDATION(S)

Strip existing finish. Provide dutchmen and patch repairs as necessary. Provide new clear finish.

CSI DIVISION: 08 Doors & Windows

ELEMENT(S) Southwest Doors

MATERIAL(S) Wood

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) South

PHOTO LOCATION Southwest Entrance

Deteriorated finish and wood veneer at southwest entrance door.

CONDITION(S)

2 B Deteriorated Wood Finish and Delaminating Veneer Door and Wood Frame

RECOMMENDATION(S)

Strip existing finish. Restore delaminating veneer and replace missing section of veneer. Provide dutchmen and patch repairs as necessary. Provide new clear finish. Alternate: replace door with new matching historic design.

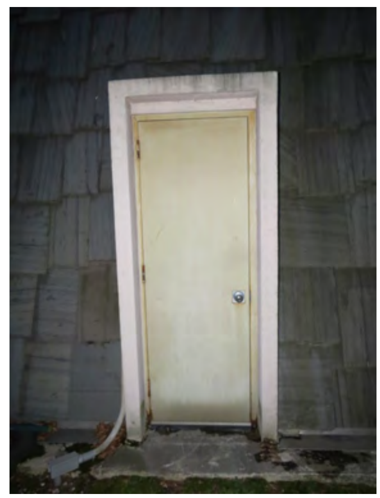
ELEMENT(S) Northwest Door

MATERIAL(S) Hollow Metal Door

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) North

PHOTO LOCATION North Façade



Exterior of door at west end of north elevation. The door leads to the pit under the original organ loft.

CONDITION(S)

3 B Deteriorated Finish and Corrosion

RECOMMENDATION(S)

Strip, prepare, prime, and paint metal door and frame.

CSI DIVISION: 08 Doors & Windows

ELEMENT(S) Main Doors, Northwest Doors, Southwest Doors

MATERIAL(S) Hardware

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) South

PHOTO LOCATION Southwest Entrance

Typical corroding hinge and deteriorated veneer on the southwest entrance door.

CONDITION(S)

4 B Missing, Inappropriate, Damaged Door Hardware, and/or Deteriorated Finishes on Hardware

RECOMMENDATION(S)

Return hardware to first class operating condition and refinishing to match original appearance at each door. Replace missing components.

CSI DIVISION: 09 Finishes

ELEMENT(S) Framework, Pre-cast Panel

MATERIAL(S) Concrete

LOCATION(S) Nave, Narthex

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION Interior East Wall

Significant water damage on the east elevation and small areas of exposed corroding steel reinforcement.

CONDITION(S)

1 B Flaking/Peeling Paint, Water Stains, and General Atmospheric Soil on Interior Concrete. Heavy Soiling at Skyward Facing Surfaces of Concrete.

RECOMMENDATION(S)

Vacuum heavy dust from skyward facing surfaces. Strip all coatings from all surfaces to sound finish. Repaint with breathable mineral coating.

ELEMENT(S) Carpet

MATERIAL(S) Carpet

LOCATION(S) Nave, Narthex

ELEVATION(S)/SURFACE(S) Floor

PHOTO LOCATION Southwest Entrance

Water damaged carpet near southwest entrance. Water damage is visible on the concrete door surround. It is undetermined if the damage here is from water ingress around or underneath the door.

CONDITION(S)

2 B Water Stained Carpet

RECOMMENDATION(S)

Determine and eliminate source of water infiltration. Further recommendations not in building envelope restoration scope.

CSI DIVISION: 09 Finishes

ELEMENT(S) Framework, Pre-cast Panel

MATERIAL(S) Concrete

LOCATION(S) Nave, Narthex

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION Interior North Wall

The concrete framework at the center of the Nave was previously repainted up to the roofline on both the north and south elevations. The pre-cast concrete panels on the south were also painted; the pre-cast panels on the north were not painted.

CONDITION(S)

1 C Inconsistently Painted Concrete

RECOMMENDATION(S)

Strip all coatings from all surfaces to sound finish. Repaint with breathable mineral coating.

ELEMENT(S) Acoustical Panels

MATERIAL(S) Non-Original Acoustical Panels

LOCATION(S) Nave

ELEVATION(S)/SURFACE(S) North, South

PHOTO LOCATION Interior South Wall

Acoustical panels on north and south elevations of Nave, near the Choir Loft exhibit isolated areas of water damage. The stains appear similar to photos in a 2005 conditions assessment, suggesting damage has not progressed since the roof repairs.

CONDITION(S)

2 C Water Damaged Acoustical Panels

RECOMMENDATION(S)

Determine and eliminate source of water infiltration. Further recommendations not in building envelope restoration scope.

CSI DIVISION: 09 Finishes

ELEMENT(S) Acoustical Panels

MATERIAL(S) Acoustical Panels

LOCATION(S) Nave

ELEVATION(S)/SURFACE(S) North, South

PHOTO LOCATION Interior North Wall

Panels installed at the base of north and south elevations, over previously installed acoustical panels that stretch the full height of the Nave. Conditions behind the surface of these more recently installed panels were not accessible for review.

CONDITION(S)

3 C Panels Installed to Height of Approximately 12 Feet

RECOMMENDATION(S)

Further investigation required. Remove more recently installed panels to allow for review of underlying conditions requiring treatment. Evaluate appropriateness of existing materials and design and consider potential replacement materials.

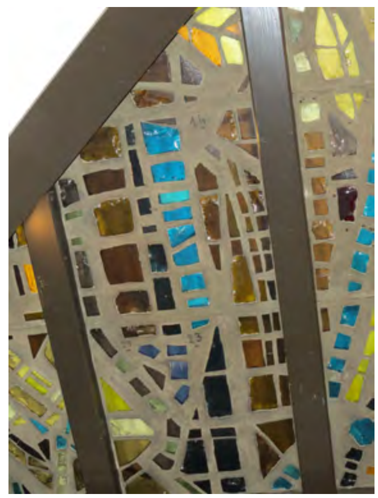
ELEMENT(S) Framework

MATERIAL(S) Wood

LOCATION(S) Chapel

ELEVATION(S)/SURFACE(S) East

PHOTO LOCATION Interior East Wall



The frame for the dalle de verre in the chapel is identified as wood on the archival drawings. It is painted brown, which contrasts with the original light color finish visible in archival images.

CONDITION(S)

4 C Sound Painted Wood

RECOMMENDATION(S)

Perform finishes analysis to determine original finish on wood.

CSI DIVISION: 12 Furnishings & Built-In Artwork

ELEMENT(S) Dalle de Verre

MATERIAL(S) Glass Dalle(s), Pre-Cast Concrete

LOCATION(S) Nave, Sanctuary Façade

ELEVATION(S)/SURFACE(S) North

PHOTO LOCATION North Façade

Typical delaminating glass. Heavy soiling and biological growth is visible in the foliations. Some of the foliations appear to have been filled with mortar. These materials result in discoloration of the glass from the interior.

CONDITION(S)

1 A Delaminating Dalle(s) in Concrete Dalle de Verre

RECOMMENDATION(S)

Carefully clean soil and biological growth from glass. Following installation of protective glazing stabilize interior surfaces of dalles. Work to be performed by an experienced conservator.

ELEMENT(S) Dalle de Verre

MATERIAL(S) Glass Dalle(s), Pre-Cast Concrete

LOCATION(S) Nave

ELEVATION(S)/SURFACE(S) North

PHOTO LOCATION Interior North Wall

Efflorescence visible on delaminated glass and on the concrete matrix on the north elevation.

CONDITION(S)

2 A Efflorescence on Glass and Concrete in Dalle de Verre

RECOMMENDATION(S)

Carefully vacuum efflorescence from concrete and glass. Carefully rinse salts from glass and remove all salts from adjacent concrete using a poultice. Work to be performed by an experienced conservator.

CSI DIVISION: 12 Furnishings & Built-In Artwork

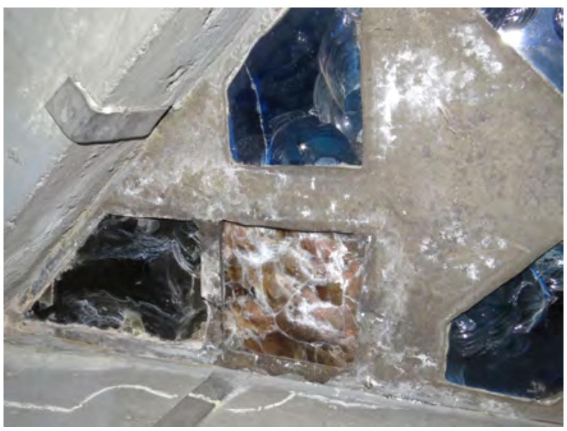
ELEMENT(S) Dalle de Verre

MATERIAL(S) Glass Dalle(s), Pre-Cast Concrete

LOCATION(S) Nave, Narthex, Sanctuary Façade

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION Interior North Wall



Isolated crack in glass dalle at the top of image. This condition occurs less frequently than the delamination of the glass seen in the dalle at the bottom center of the image.

CONDITION(S)

3 A Cracked Dalle(s) in Concrete Dalle de Verre

RECOMMENDATION(S)

Provide adhesive injection repairs at cracks that threaten to destabilize glass.

ELEMENT(S) Dalle de Verre

MATERIAL(S) Glass Dalle(s), Pre-Cast Concrete

LOCATION(S) Nave, Narthex

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION Interior North Wall

Typical cracks in the concrete matrix. Some cracks are apparent on the exterior, but most are too fine to telegraph through the existing coating.

CONDITION(S)

4 A Crack(s) in Concrete at Dalle de Verre

RECOMMENDATION(S)

Remove all coatings. Review cracks and provide crack repairs on the north elevation that threaten to destablize glass or allow light penetration.

CSI DIVISION: 12 Furnishings & Built-In Artwork

ELEMENT(S) Dalle de Verre

MATERIAL(S) Pre-Cast Concrete

LOCATION(S) Nave
ELEVATION(S)/SURFACE(S) North

PHOTO LOCATION North Façade

Network surface cracks, typical at interior of dalle de verre concrete matrix exhibiting efflorescence.

CONDITION(S)

5 A Network Crack(s) in Concrete Matrix

RECOMMENDATION(S)

Further investigation required. Remove all coatings from concrete to determine extent of cracking in substrate. Repair concrete as necessary and provide new coating.

ELEMENT(S) Dalle de Verre

MATERIAL(S) Epoxy, Glass Dalle(s)

LOCATION(S) Nave, Narthex, Sanctuary Façade
ELEVATION(S)/SURFACE(S) East, South

PHOTO LOCATION South Façade

Typical delaminating glass. Heavy soiling and biological growth is visible in the foliations, resulting in discoloration of the glass from the interior.

CONDITION(S)

6 A Delaminating Dalle(s) in Epoxy Dalle de Verre

RECOMMENDATION(S)

Overall recommendation for dalle de panels with an epoxy matrix includes fabrication and installation of new dalle de verre panels.

CSI DIVISION: 12 Furnishings & Built-In Artwork

ELEMENT(S) Dalle de Verre

MATERIAL(S) Epoxy, Glass Dalle(s)

LOCATION(S) Nave, Narthex

ELEVATION(S)/SURFACE(S) East, South

PHOTO LOCATION Interior South Wall

Heavy efflorescence on the glass and epoxy dalle de verre at the base of pre-cast panel S15.

CONDITION(S)

7 A Efflorescence on Epoxy and Glass in Dalle de Verre

RECOMMENDATION(S)

Overall recommendation for dalle de panels with an epoxy matrix includes fabrication and installation of new dalle de verre panels.

ELEMENT(S) Dalle de Verre

MATERIAL(S) Epoxy, Glass Dalle(s)

LOCATION(S) Nave, Sanctuary Façade

ELEVATION(S)/SURFACE(S) South

PHOTO LOCATION Interior South Wall

Hole in glass dalle in epoxy dalle de verre panel.

CONDITION(S)

8 A Hole in Glass Dalle

RECOMMENDATION(S)

Overall recommendation for dalle de panels with an epoxy matrix includes fabrication and installation of new dalle de verre panels.

CSI DIVISION: 12 Furnishings & Built-In Artwork

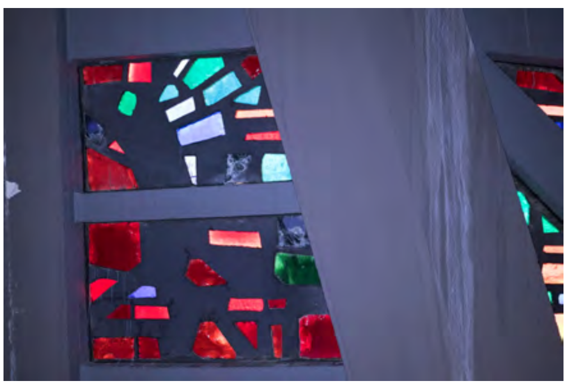
ELEMENT(S) Dalle de Verre

MATERIAL(S) Epoxy, Glass Dalle(s)

LOCATION(S) Nave, Narthex

ELEVATION(S)/SURFACE(S) East, South

PHOTO LOCATION Interior South Wall



Cracks radiating from dalles in the epoxy matrix are generally to fine to perceive, except when water infiltration makes them more visible.

CONDITION(S)

9 A Crack(s) in Epoxy at Dalle de Verre

RECOMMENDATION(S)

Overall recommendation for dalle de panels with an epoxy matrix includes fabrication and installation of new dalle de verre panels.

ELEMENT(S) Dalle de Verre

MATERIAL(S) Epoxy, Glass Dalle(s)

LOCATION(S) Nave, Narthex

ELEVATION(S)/SURFACE(S) East, South

PHOTO LOCATION East Façade

Sealant was specified in the construction documents from the 1980s, but is not installed. The perimeter of panels is therefore a common source of water infiltration on the east and south facades.

CONDITION(S)

10 A No Interior Sealant at Perimeter of Dalle de Verre

RECOMMENDATION(S)

Overall recommendation for dalle de panels with an epoxy matrix includes fabrication and installation of new dalle de verre panels.

CSI DIVISION: 12 Furnishings & Built-In Artwork

ELEMENT(S) Dalle de Verre

MATERIAL(S) Epoxy, Glass Dalle(s)

LOCATION(S) Nave, Narthex

ELEVATION(S)/SURFACE(S) East, South

PHOTO LOCATION Interior East Wall

Typical water stains as a result of moisture infiltration through hairline separation between dalle and matrix. Note that no loose dalles were detected at the accessible areas.

CONDITION(S)

11 A Water Infiltration at Perimeter of Dalle(s) in Epoxy Matrix

RECOMMENDATION(S)

Overall recommendation for dalle de panels with an epoxy matrix includes fabrication and installation of new dalle de verre panels.

ELEMENT(S) Dalle de Verre

MATERIAL(S) Glass Dalle(s), Pre-Cast Concrete

LOCATION(S) Nave

ELEVATION(S)/SURFACE(S) North

PHOTO LOCATION Interior North Wall

Previous repair to the interior of glass and concrete at a dalle-de-verre panel near the base of pre-cast panel N4. The repair material is brittle and disfiguring to the glass. In other locations, cementitious mortar was used to patch glass.

CONDITION(S)

1 B Previous Inappropriate Dalle/Matrix Repair in Concrete Panel

RECOMMENDATION(S)

Remove patching material and review underlying condition. Where a glass dalle is destablized or there is a significant hole in the dalle, replace with a new dalle matching the original.

CSI DIVISION: 12 Furnishings & Built-In Artwork

ELEMENT(S) Dalle de Verre

MATERIAL(S) Concrete, Glass Dalle(s), Pre-Cast Concrete

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION South Façade

Residue is visible on the skyward facing dalle de verre; this appears to be from adhesives previously used to attach plexiglass protection. The pre-cast concrete within the protective glazing also exhibits a white waterproofing coating.

CONDITION(S)

2 B Residue on Dalle de Verre and Unidentified Coating on Skyward Facing Surfaces Within Protective Glazing

RECOMMENDATION(S)

Remove all residue and coatings from dalle de verre and pre-cast panels in advance of installing new recommended protective glazing.

ELEMENT(S) Dalle de Verre

MATERIAL(S) Epoxy, Glass Dalle(s)

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) East, South

PHOTO LOCATION South Façade

Biological growth visible on the uncoated epoxy dalle de verre on the south and east elevations. Differential growth is visible on patching material in the pre-cast concrete and

CONDITION(S)

3 B General Atmospheric Soil and Biological Growth on Epoxy Dalle de Verre

RECOMMENDATION(S)

Overall recommendation for dalle de panels with an epoxy matrix includes fabrication and installation of new dalle de verre panels.

CSI DIVISION: 12 Furnishings & Built-In Artwork

ELEMENT(S) Dalle de Verre

MATERIAL(S) Epoxy

LOCATION(S) Sanctuary Façade
ELEVATION(S)/SURFACE(S) East

PHOTO LOCATION East Façade

Disaggregation of the panel surface was noted on the panels on the east elevation. The deterioration was notably worse at the south end of this short elevation.

CONDITION(S)

4 B Friable Epoxy Matrix

RECOMMENDATION(S)

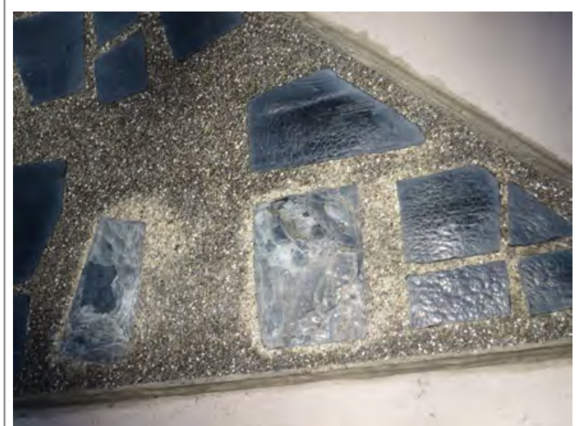
Overall recommendation for dalle de panels with an epoxy matrix includes fabrication and installation of new dalle de verre panels.

ELEMENT(S) Dalle de Verre

MATERIAL(S) Epoxy, Glass Dalle(s)

LOCATION(S) Sanctuary Façade
ELEVATION(S)/SURFACE(S) East, South

PHOTO LOCATION South Façade



Typical discoloration of the exterior epoxy matrix adjacent to delaminating glass.

CONDITION(S)

5 B Discolored Epoxy at Perimeter of Deteriorated Glass

RECOMMENDATION(S)

Overall recommendation for dalle de panels with an epoxy matrix includes fabrication and installation of new dalle de verre panels.

CSI DIVISION: 12 Furnishings & Built-In Artwork

ELEMENT(S) Dalle de Verre

MATERIAL(S) Epoxy, Glass Dalle(s)

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) South

PHOTO LOCATION South Façade

Rough mortar material appears to have been used to repair multiple locations in this triangular dalle de verre panel in pre-cast panel S9.

CONDITION(S)

6 B Previous Inappropriate Dalle/Matrix Repair in Epoxy Panel

RECOMMENDATION(S)

Overall recommendation for dalle de panels with an epoxy matrix includes fabrication and installation of new dalle de verre panels.

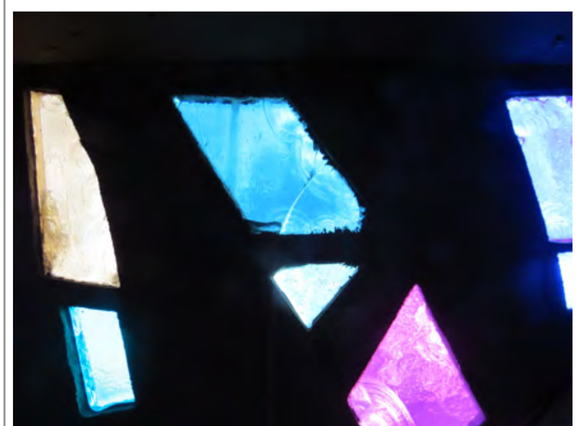
ELEMENT(S) Dalle de Verre

MATERIAL(S) Epoxy, Glass Dalle(s), Pre-Cast Concrete

LOCATION(S) Nave, Narthex

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION Interior South Wall



Isolate crack in glass dalle.

CONDITION(S)

7 B Cracked Dalle(s) in Epoxy Dalle de Verre

RECOMMENDATION(S)

Overall recommendation for dalle de panels with an epoxy matrix includes fabrication and installation of new dalle de verre panels.

CSI DIVISION: 12 Furnishings & Built-In Artwork

ELEMENT(S) Dalle de Verre

MATERIAL(S) Glass Dalle(s), Pre-Cast Concrete

LOCATION(S) Chapel

ELEVATION(S)/SURFACE(S) East

PHOTO LOCATION Interior East Wall

Heavy soiling on the top side of dalles in the Chapel.

CONDITION(S)

1 C Heavy Soiling on Exterior Surface of Glass

RECOMMENDATION(S)

Clean glass on north elevation with chemical cleaner designed specifically for glass in advance of installing recommended protective glazing.

ELEMENT(S) Dalle de Verre

MATERIAL(S) Glass Dalle(s), Pre-Cast Concrete

LOCATION(S) Nave, Narthex

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION Interior North Wall

Displaced interior panel anchors visible throughout Nave and Narthex at original panels. There is no record of these panels having been previously removed.

CONDITION(S)

2 C Loose/Displaced Panel Anchor at Concrete Dalle de Verre

RECOMMENDATION(S)

Reposition existing interior anchors to original configuration.

CSI DIVISION: 12 Furnishings & Built-In Artwork

ELEMENT(S) Dalle de Verre

MATERIAL(S) Epoxy, Glass Dalle(s), Pre-Cast Concrete

LOCATION(S) Nave, Narthex

ELEVATION(S)/SURFACE(S) East, North, South

PHOTO LOCATION Interior North Wall

Typical heavy dust accumulation at perimeter of dalles and in deep facets.

CONDITION(S)

3 C Heavy Soiling in Facets

RECOMMENDATION(S)

Vacuum all interior glass on north elevation. Clean all stable glass with glass cleaner after general cleaning performed at adjacent materials.

ELEMENT(S) Dalle de Verre

MATERIAL(S) Glass Dalle(s), Pre-Cast Concrete

LOCATION(S) Nave

ELEVATION(S)/SURFACE(S) North

PHOTO LOCATION North Façade

Possible previous cementitious patch repair at missing dalle. Two such patches were noted at the base of the north elevation. Other similar patches may be covered with the existing concrete coating.

CONDITION(S)

4 C Missing Glass

RECOMMENDATION(S)

Remove existing patch in concrete matrix and replace with new dalle matching the original where the original color of the glass can be determined through archival research.

CSI DIVISION: 12 Furnishings & Built-In Artwork

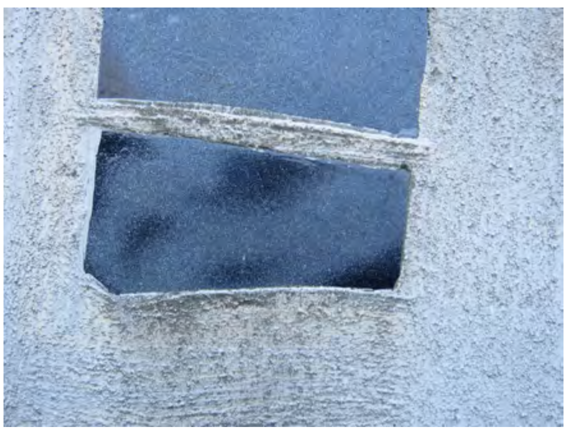
ELEMENT(S) Dalle de Verre

MATERIAL(S) Glass Dalle(s), Pre-Cast Concrete

LOCATION(S) Sanctuary Façade

ELEVATION(S)/SURFACE(S) North

PHOTO LOCATION North Façade



Abraded glass in two dalle de verre panels at base of the pre-cast panel N12. This darkens the interior appearance of the glass. This may have resulted from a previous cleaning test using an abrasive material.

CONDITION(S)

5 C Abraded Glass in Panel

RECOMMENDATION(S)

No Restoration Work is Recommended

ELEMENT(S) Dalle de Verre

MATERIAL(S) Epoxy, Glass Dalle(s)

LOCATION(S) Nave, Narthex

ELEVATION(S)/SURFACE(S) East, South

PHOTO LOCATION Interior South Wall

Water infiltration and damage at the perimeter of epoxy dalle-de-verre panels, where no sealant is installed.

CONDITION(S)

6 C Water Stains and General Atmospheric Soil on Epoxy Dalle de Verre

RECOMMENDATION(S)

Overall recommendation for dalle de panels with an epoxy matrix includes fabrication and installation of new dalle de verre panels.

Appendix E
Laboratory Report:
Glass Characterization

LABORATORY REPORT: GLASS CHARACTERIZATION

Commissioned By:	Prudon and Partners, LLP.
Building/Project:	First Presbyterian Church - Sanctuary
Building Address:	Stamford, CT
Construction Date:	1958/1986
No. of Samples:	6
Samples Removed by:	BCA
Analysis Performed by:	George Wheeler, Ph. D.

OBJECTIVE

Building Conservation Associates, Inc. (BCA) conducted an analysis of sound and deteriorated glass removed from Nave dalle de verre panels at the First Presbyterian Church. Samples of the deteriorated glass were removed by BCA during our site visit in January 2017. Samples of sound glass were taken from a panel that was removed from the south elevation during the 1980s. Rohlf's Stained & Leaded Glass gave the salvaged panel to The Highland Green Foundation, who provided it to BCA for testing.

SAMPLE LOCATIONS

BCA gently removed shards of delaminating glass from the ground level of the north and south elevations using a tweezers. The removed samples were representative of the typical deterioration on each elevation. The salvaged panel was cut apart in BCA laboratory to remove the sound glass. See Figures 1 and 2 for the sample locations identified by the letters below.

Concrete Dalle de Verre

A. Deteriorated purple glass dalle near the base of pre-cast concrete panel N15 (Figure 3).
B. Deteriorated blue glass dalle near the base of pre-cast concrete panel N3 (Figure 4).
C. Sound blue glass dalle from the salvaged panel previously installed in pre-cast panel S12 (Figure 5).
D. Sound red glass dalle from the salvaged panel previously installed in pre-cast panel S12 (Figure 5).

Epoxy Dalle de Verre

E. Deteriorated purple glass dalle near the base of pre-cast concrete panel S12 (Figure 6).
F. Deteriorated orange glass dalle near the base of pre-cast concrete panel S4 (Figure 7).

TEST METHOD

Scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS) were performed using at Bruker TM3000 tabletop SEM and the Quantax 70 EDS system and the associated software. Samples were adhered to graphite stubs using graphite infused tape. Once introduced into the SEM chamber, the chamber was evacuated to a low vacuum and the viewing and analyzes performed. For EDS, collection of elemental data was carried out at 15 keV and for approximately 100 seconds.

X-ray Diffraction (XRD) was also performed on efflorescence removed from the surface of the original and replacement glass. See Appendix F for the XRD testing method and the results of the efflorescence characterization.

DISCUSSION OF FINDINGS

The glass at the Fish Church is soda-lime-silica glass. Typically, such glass is comprised of 70% SiO_2, 10% CaO, and 20% Na_2O.[1] The main component of glass is silica (SiO_2). Alkali materials such as "soda" (sodium carbonate) or potash (potassium carbonate) lower the melting point of the silica. However, the addition of alkali materials results in the production of sodium oxide (Na_2O) or potassium oxide (K_2O), both of which are soluble in water. As the proportion of alkali to silica increases, the production of these oxides increases and the susceptibility of the glass to degradation increases. Lime is added to glass to act as a stabilizer. A higher percentage of CaO forms a more stable glass composition.[2]

SEM/EDS confirmed that the composition of the glass at the Fish Church varies from the recommended formulation for soda-lime-silica glass, regardless of the period of the dalle de verre panel installation. These variations result in unstable glass.[3] See the Table 1 for the calculated composition of the glass samples.[4] See Figures 11-16 for the images and spectrum produced by the analysis.

Table 1: Calculated composition of glass

Sample	SiO_2 (%wt)	CaO (%wt)	Na_2O (%wt)	K_2O (%wt)	SB_2O_3 (%wt)	BaO (%wt)
A1. Deteriorated Original Purple Glass	67.24	10.02	12.11	0.27	10.34	0
B. Deteriorated Original Blue Glass	78.64	12.74	6.87	1.26	0	0
C. Sound Original Blue Glass	62.25	25.18	8.47	4.09	0	0
D. Sound Original Red Glass	58.10	13.70	16.50	10.40	0	0
E. Deteriorated Replacement Purple Glass	80.24	5.94	8.30	0.74	0	4.73
F1. Deteriorated Replacement Orange Glass	75.20	6.48	7.41	0.59	0	5.66

[1] Stephen P. Koob, *Conservation and Care of Glass Objects*, (London: Archetype Publications Ltd., 2006), 11. In her dissertation, "The Consolidation of Architectural Glass and Dalle de Verre; Assessment of Selected Adhesives," Kristel De Vis described the common composition of soda-lime-glass as being comprised of the following ranges of material: 70-75% SiO2, 5-10% CaO, and 13-17% alkali material. Kristel De Vis, "The Consolidation of Architectural Glass and Dalle de Verre; Assessment of Selected Adhesives," PhD diss., Universiteit Antwerpen, 2014, 184.
[2] Koob, *Conservation and Care of Glass Objects*, 11-14.
[3] In addition to the crizzling process described in this report, the high silica content in some of the glass corresponds to a low alkali content, which may have resulted in initial devitrification of the glass during manufacturing. Stephen P. Koob, e-mail correspondence with Laura Buchner (BCA), March 22, 2017.
[4] Calculations were also performed for samples A, E, and F, theoretically eliminating the SB_2O_3 and BaO to determine the affect on the other percentages. This did not change the overall observations.

Efflorescence was removed from the surface of the glass at sample locations A and E. SEM/EDS and XRD identified this as sodium carbonate originating from the glass (Figures 8-10). See Appendix F for further information regarding the XRD analysis.

The significant fracturing of the glass and formation of sodium carbonate is consistent with a type of deterioration known as "glass disease" or "crizzling," which results from an unstable glass composition. Because sodium and potassium oxides in glass are soluble in water, moisture combined with exposure to carbon dioxide causes the Na_2O and K_2O to convert to sodium or potassium carbonate, both of which are very hygroscopic, meaning they absorb or attract moisture in the air. As the sodium or potassium oxides form carbonates and leach out of the glass, a fragile and porous hydrated silica network is left behind.[5] During this process, the pH of the glass surface may rise greater than 10, which is high enough to dissolve the silca.[6] As a result of these reactions, the glass deteroration continues, resulting in crazing, cracks, flakes, pits, and as is the case at the Fish Church, a separation of the glass into layers.

Although crizzling has been identified in modern studio art glass, it is reportedly most common in 16th-19th-century glasses. It is considered fairly rare: only about 4-5% of the glass fabricated during the 16th-19th-century exhibits this reaction.[7] Similar deterioration was documented at the dalle de verre installed at St. Theodore Church in Beringen (Belgium), which was manufactured 1939-1943.[8]

This type of deterioration has also been found to affect relatively stable glass if it is in an aggressive environment, with very high humidity in a closed environment or microclimate.[9]

Dirt is hygroscopic. As biologcial growth and soiling settle into the fractures of the glass, they exacerbate the deterioration by attracting more water and because of expansive forces.[10] The deterioraton is considered an ongoing process, which is activated by climate conditions and may affect glass that currently exhibits no damage.[11]

Currently, no method is known to replace the lost alkali or put CaO back into the glass network. Some research has been performed to consolidate or coat crizzled glass with synthetic polymers. Problems remain with such treatments though due to difficulties associated with adhesive fully penetrating the flaws in the glass, moisture being trapped under the treatments, and ongoing moisture absorption through imperfections in the coating.[12]

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[5] Hamilton, Donny L. "Methods of Conserving Archaeological Material from Underwater Sites: Conservation of Glass," Nautical Archaeology at Texas A&M University, http://nautarch.tamu.edu/CRL/conservationmanual/File5.htm#SUMMARY (accessed March 1, 2017).

[6] Koob, *Conservation and Care of Glass Objects*, 118.

[7] Koob, *Conservation and Care of Glass Objects*, 127.

[8] Kristel De Vis, "The Consolidation of Architectural Glass and Dalle de Verre."

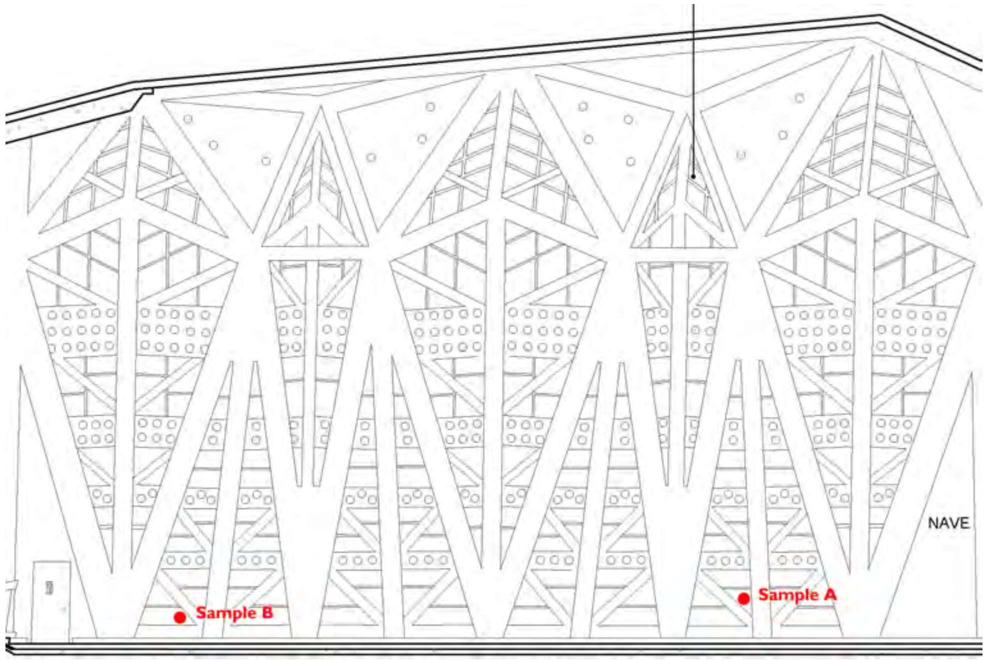
[9] Koob, *Conservation and Care of Glass Objects*, 127.

[10] Ibid., 128.

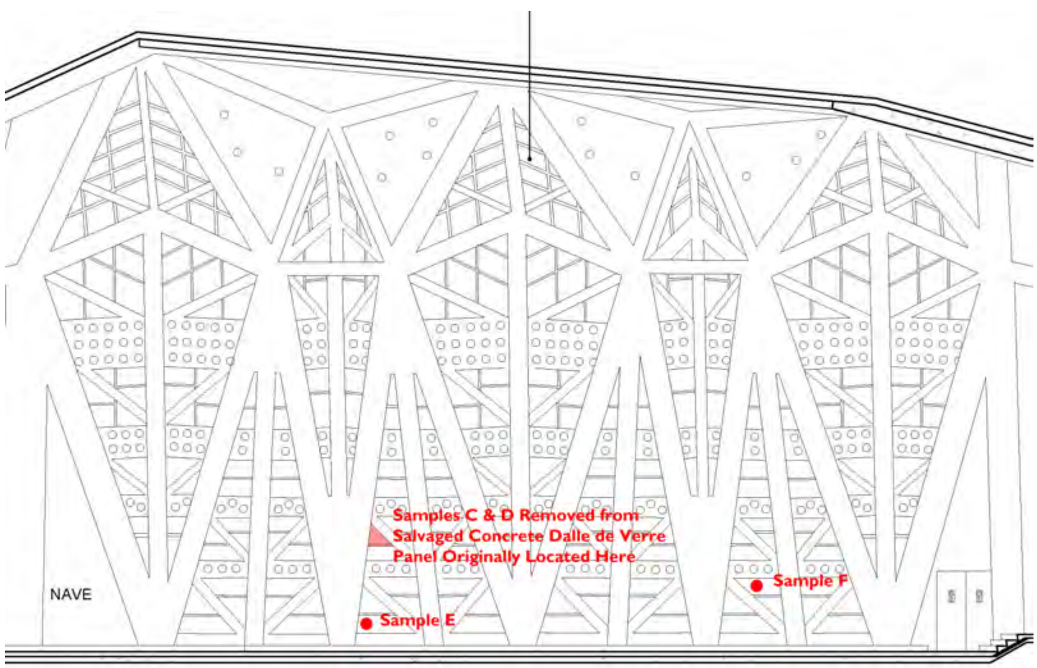
[11] Kristel De Vis, 212.

[12] Koob, *Conservation and Care of Glass Objects*,128-129.

Figures:



1 Sample locations on the interior of the north elevation.



2 Sample locations on the interior of the south elevation.

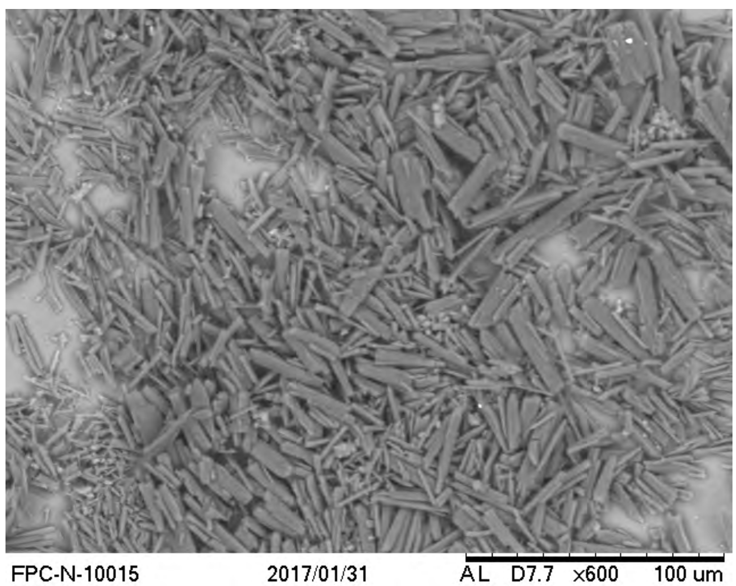
3 Sample location A in Figure 1. Sampled deteriorated purple glass dalle near the base of pre-cast concrete panel N15.

4 Sample location B in Figure 1. Sampled deteriorated blue glass dalle near the base of pre-cast concrete panel N3 (Figure 4).

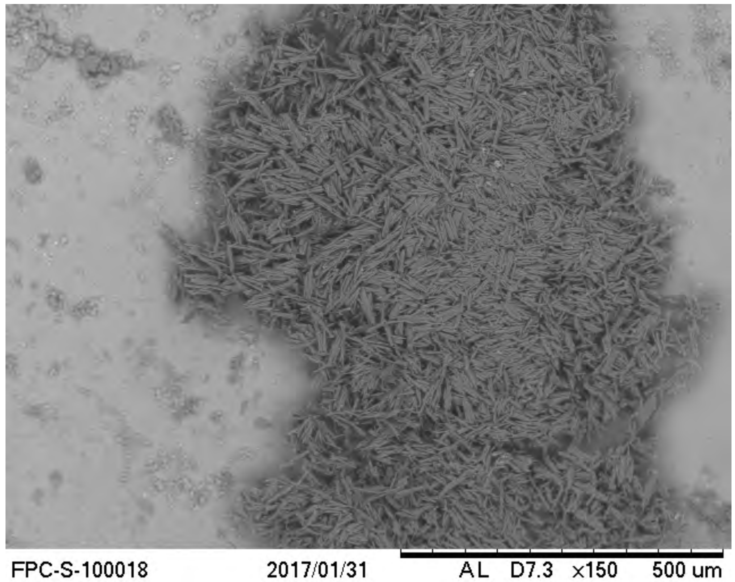
5 Salvaged panel where blue and red dalles were removed for testing (arrows indicated dalles tested; the color of the arrows corresponds to the glass colors). Panel was originally located in pre-cast panel S12, identified as sample locations C/D in Figure 2.

6 Sample location E in Figure 2. Sampled deteriorated purple glass dalle near the base of pre-cast concrete panel S12.

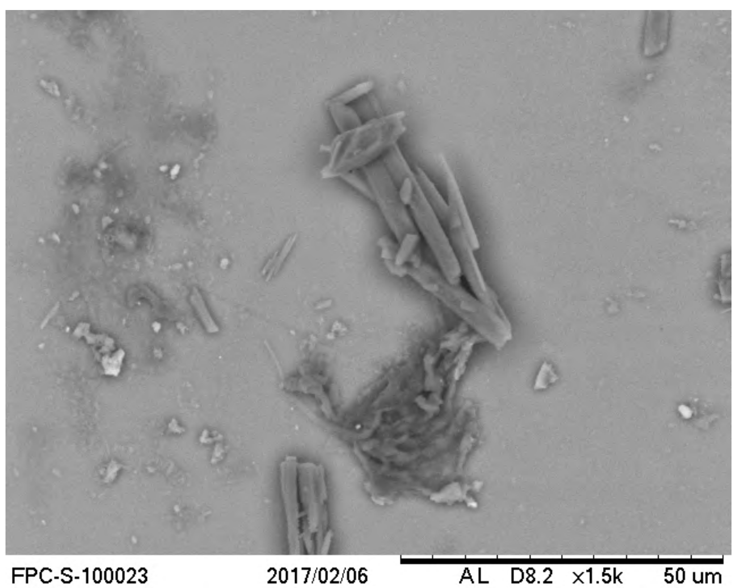
7 Sample location F in Figure 2. Sampled deteriorated orange glass dalle near the base of pre-cast concrete panel S4.



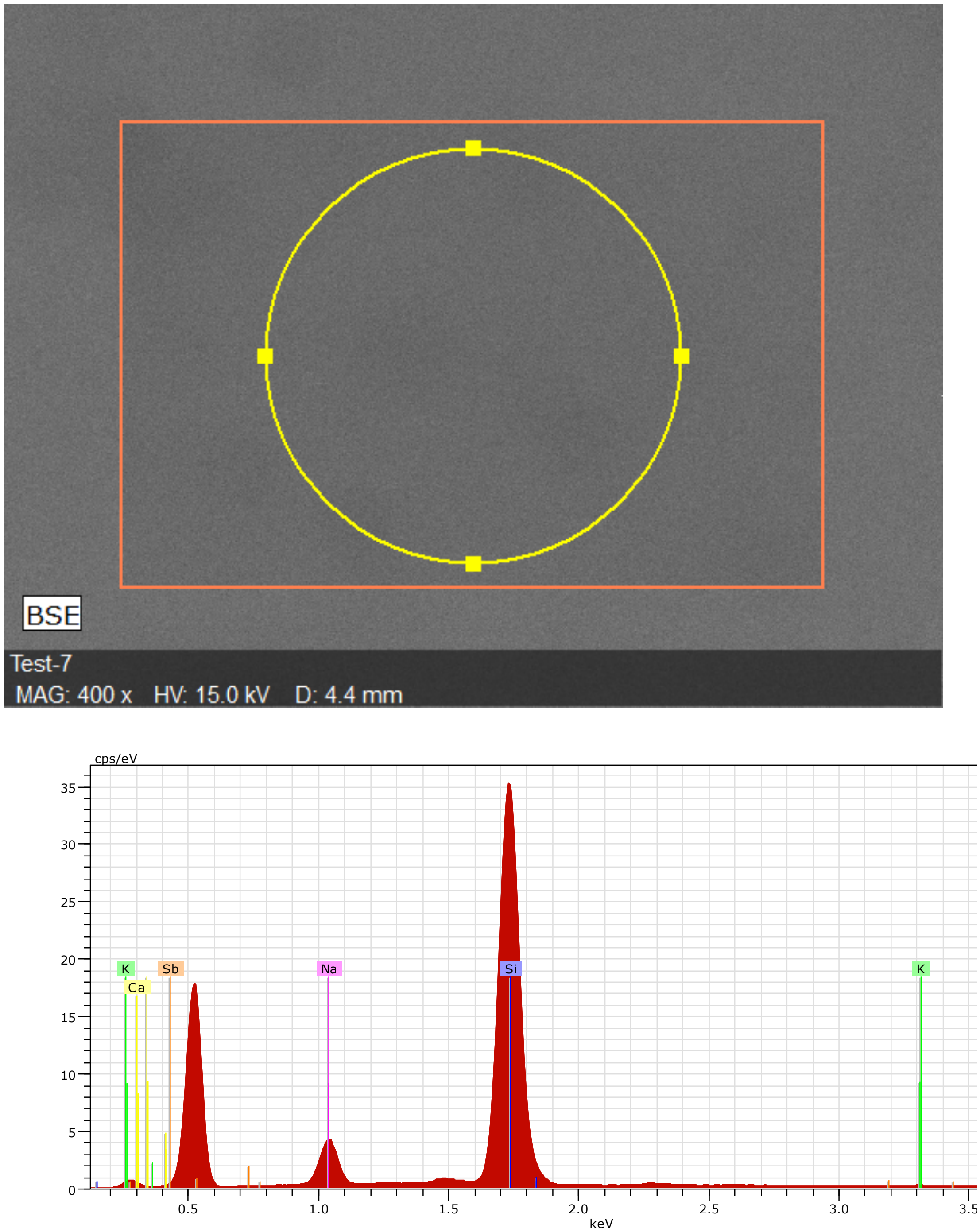
8 Image showing the growth of sodium carbonate from the glass matrix at on Sample Sample A (deteriorated original glass).



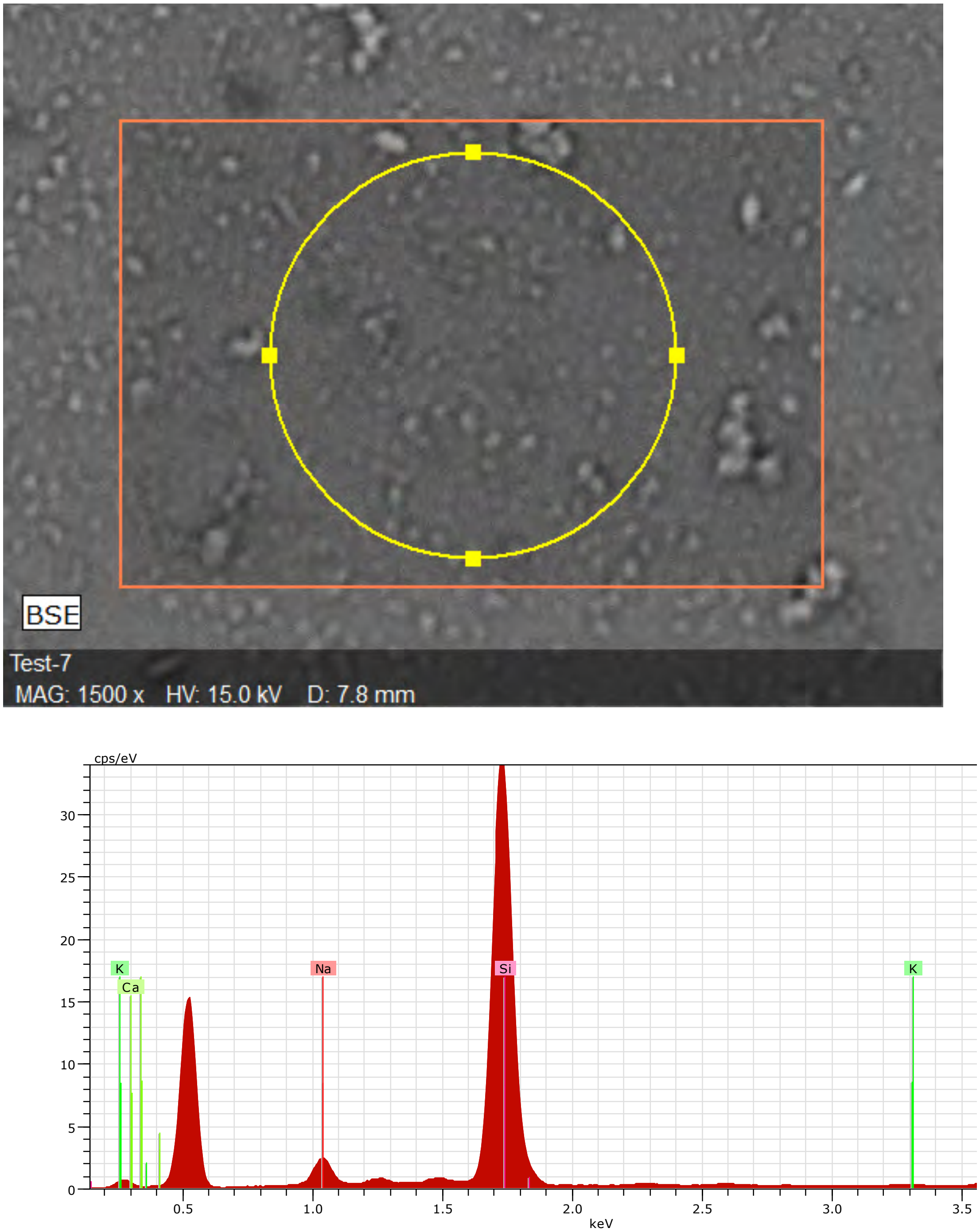
9 Image showing the growth of sodium carbonate from the glass matrix on E (deteriorated replacement glass).



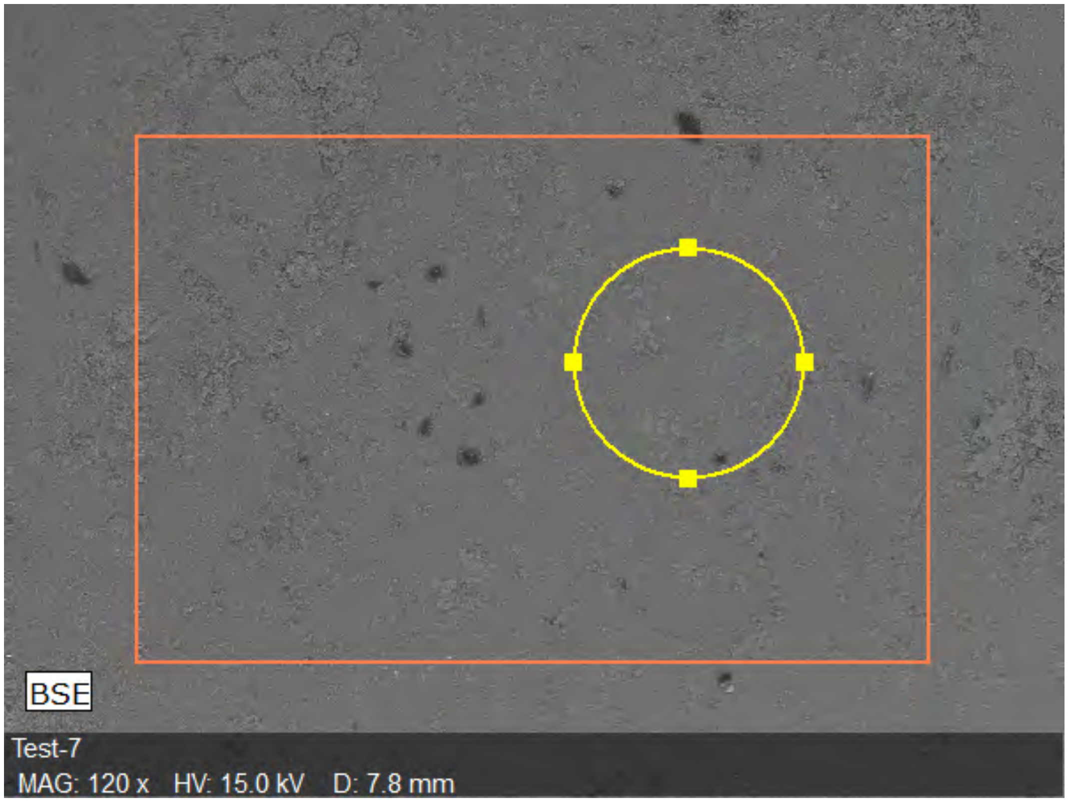
10 Image showing the growth of sodium carbonate from the glass matrix on Sample E (deteriorated replacement glass).

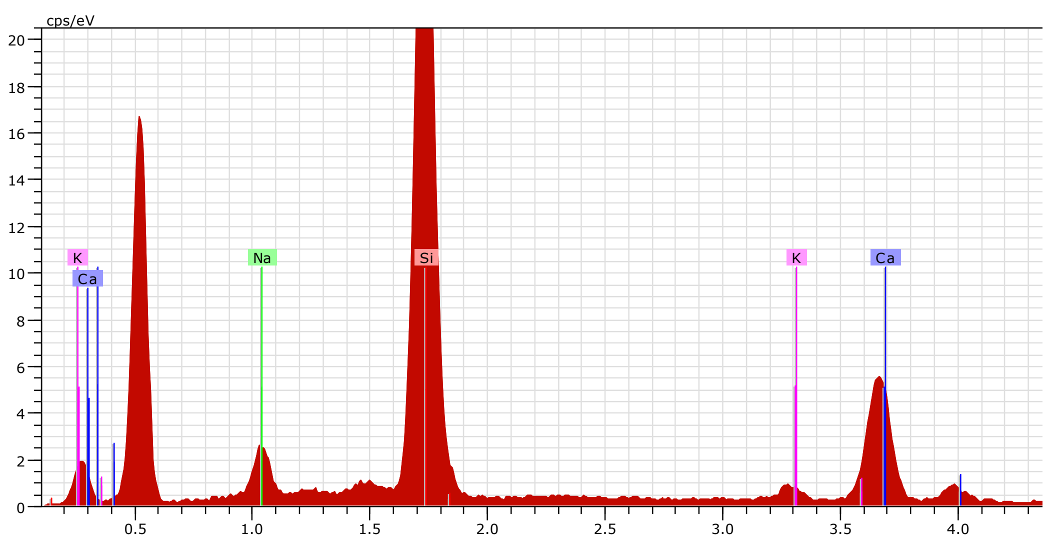


11 Results from analysis of Sample A: Deterioated original purple glass.

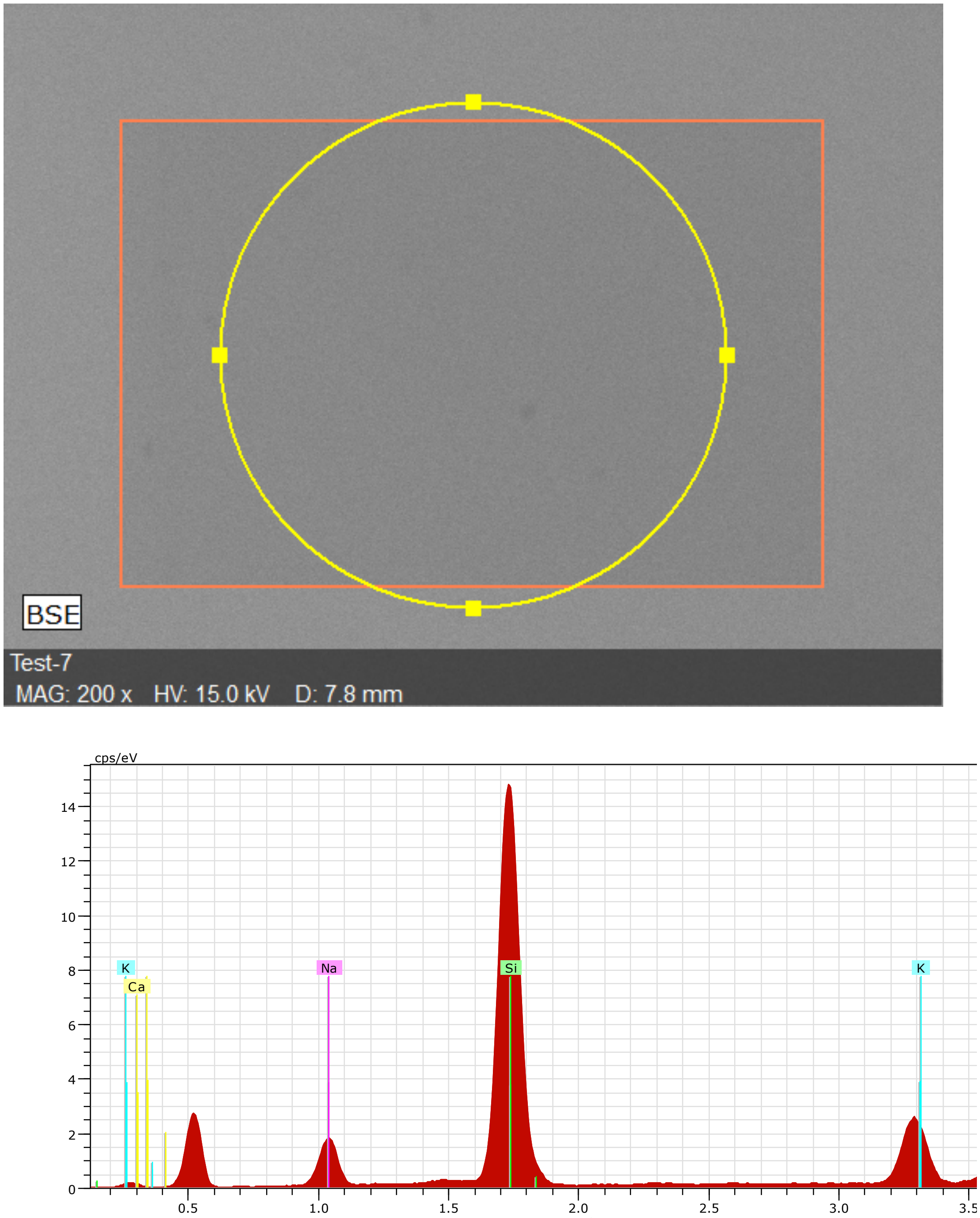


12 Results from analysis of Sample B: Deterioated original blue glass

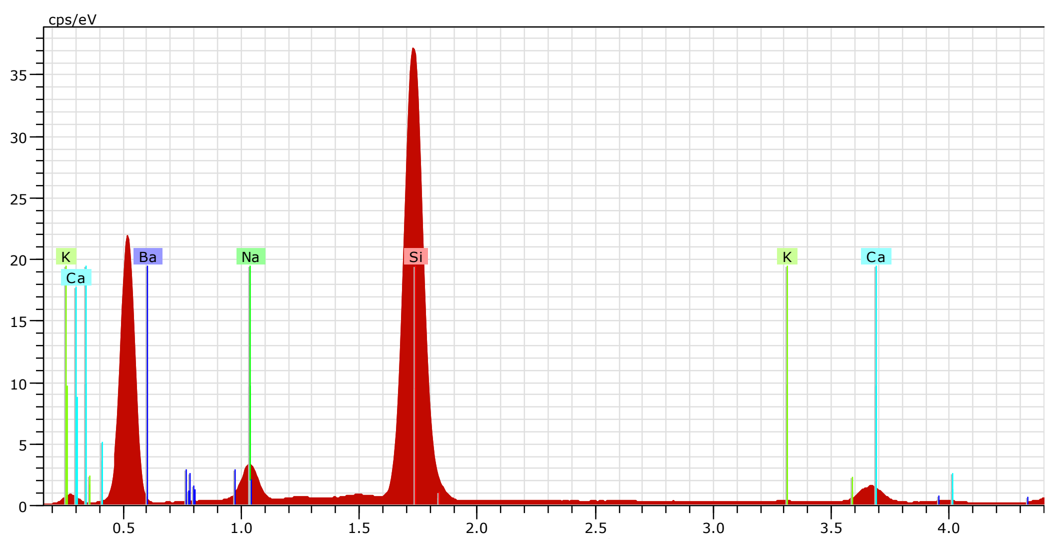




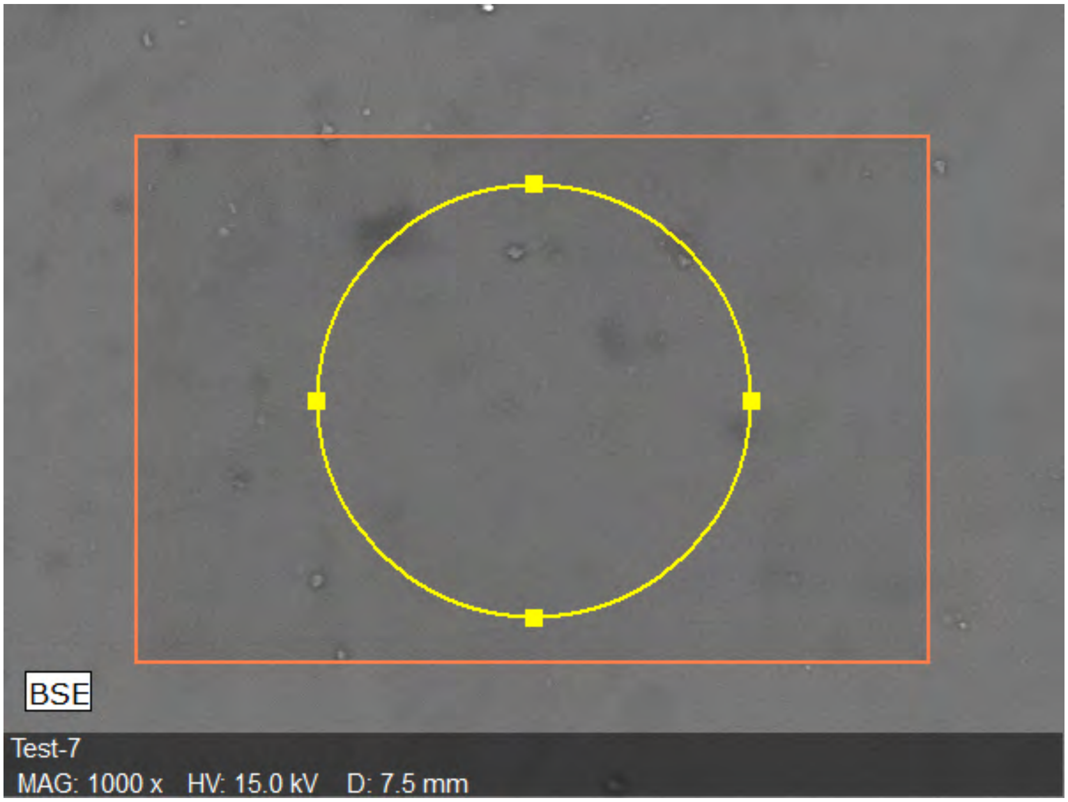
13 Results from analysis of Sample C: Sound original blue glass

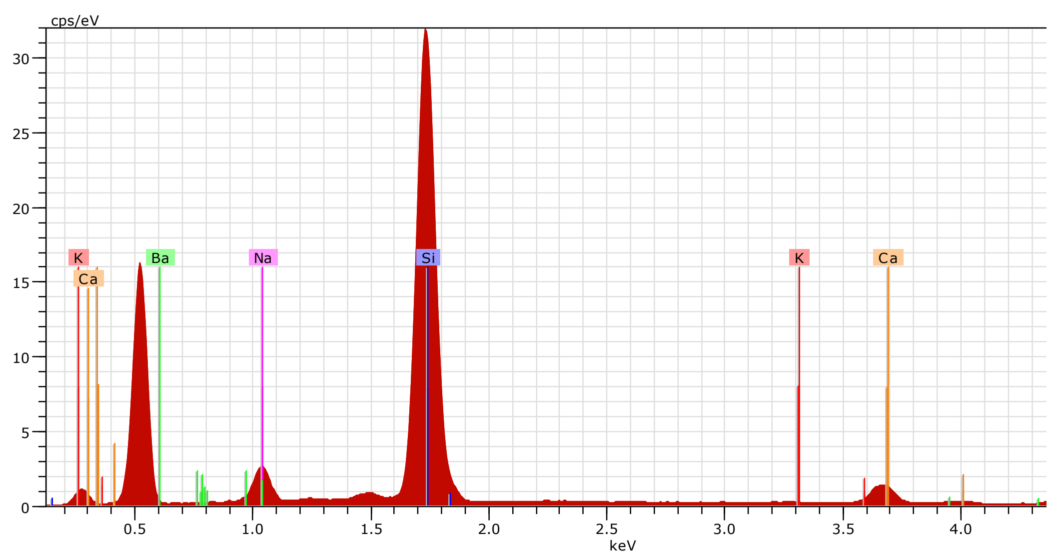


14 Results from analysis of Sample D: Sound original red glass



15 Results from analysis of Sample E: Deterioated replacement purple glass





16 Results from analysis of Sample F: Deterioated replacement orange glass

Appendix F
Laboratory Report:
Efflorescence Characterization

LABORATORY REPORT: EFFLORESCENCE CHARACTERIZATION

Commissioned By:	Prudon and Partners, LLP.
Building/Project:	First Presbyterian Church - Sanctuary
Building Address:	Stamford, CT
Construction Date:	1958
No. of Samples:	5
Samples Removed by:	BCA
Analysis Performed by:	George Wheeler, Ph. D.

OBJECTIVE

Building Conservation Associates, Inc. (BCA) conducted an analysis of the efflorescence visible on glass, concrete, and epoxy on the interior Nave elevations of the First Presbyterian Church. Bulk samples were removed by BCA during our site visit in January 2017.

SAMPLE LOCATIONS

Samples were gently scraped from the substrate using a metal blade. Materials were removed from the following locations. See Figures 1 and 2 for the locations identified by the letters below.

North Elevation:

A. Deteriorated glass in a dalle-de-verre panel near the base of pre-cast concrete panel N15 (Figure 3).
B. Concrete matrix in a dalle-de-verre panel containing no deteriorated glass, near the base of pre-cast concrete panel N12 (Figure 4).
C. Interior cast-in-place concrete base below the acoustical panels by the Choir Loft (Figure 5).

South Elevation:

D. Deteriorated glass in a dalle-de-verre panel near the base of pre-cast concrete panel S15 (Figure 6).
E. Cast-in-place concrete exhibiting flaking and peeling paint, near the base of the building, between pre-cast concrete panels S3 and S4 (Figure 7).

Efflorescence on the accessible pre-cast concrete panels on the north elevation could not be sampled because the deposits were too thin (Figure 9). Efflorescence on the pre-cast panels on the south elevation where materials had clearly dripped from the dalle de verre or cast-in-place framework was not analyzed.

TEST METHOD

Each sample was ground in an agate mortar and pestle and transferred to a zero background quartz plate. After treating with a drop of acetone the sample was secured to the quartz plate. The sample and plate were placed in the sample holder of a Philips 1710 Open Architecture Diffractometer. Copper x-ray radiation was supplied by a Philips 1835 Generator. The diffractometer is driven by MDI DataScan Version 5 and analyses performed with JADE 9.0 software. Data were collected between 5° and 65° 2θ at a scan rate of 0.02°/sec.

Glass shards removed from sample locations A and E and were subjected to scanning electron microscope with energy-dispersive X-ray spectroscopy (SEM/EDS). The salts on the surface of the glass were examined during that analysis. See Appendix E for the SEM/EDS testing method and the results of the glass characterization.

DISCUSSION OF FINDINGS

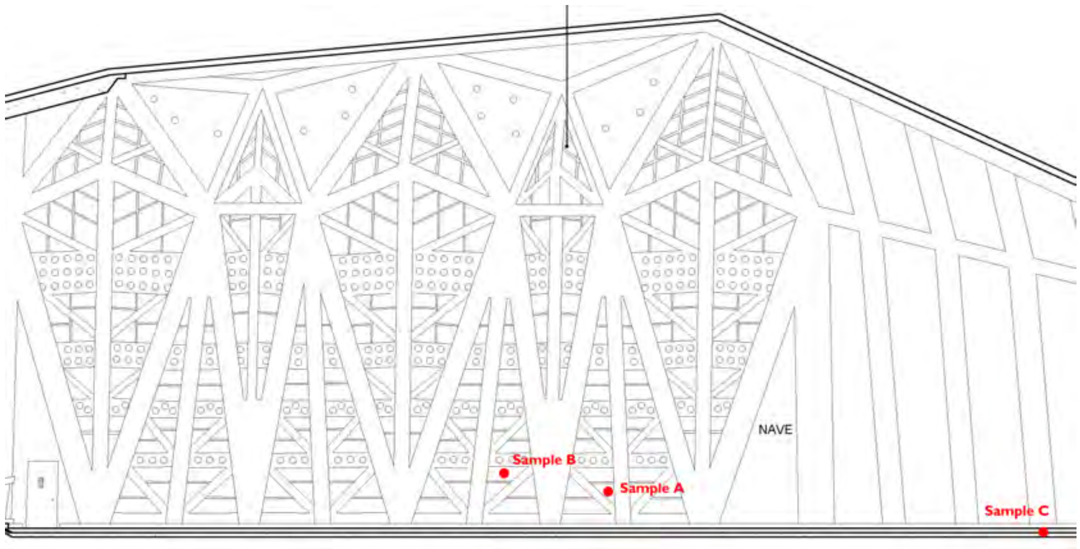
The resulting diffractograms are shown in Figures 9-13. The primary phases present for each sample are listed below:

Sample Location	Primary Phase
A. Glass in Concrete Dalle de Verre Panel	Trona (Sodium Carbonate)
B. Concrete Dalle de Verre Matrix	Gypsum (Calcium Sulfate)
C. Cast-in-Place Concrete Base	Thenardite (Sodium Sulfate)
D. Glass in Epoxy Dalle de Verre Panel	Trona & Thermonatrite (Sodium Carbonate)
E. Cast-in-Place Concrete Framework	Thenardite (Sodium Sulfate)

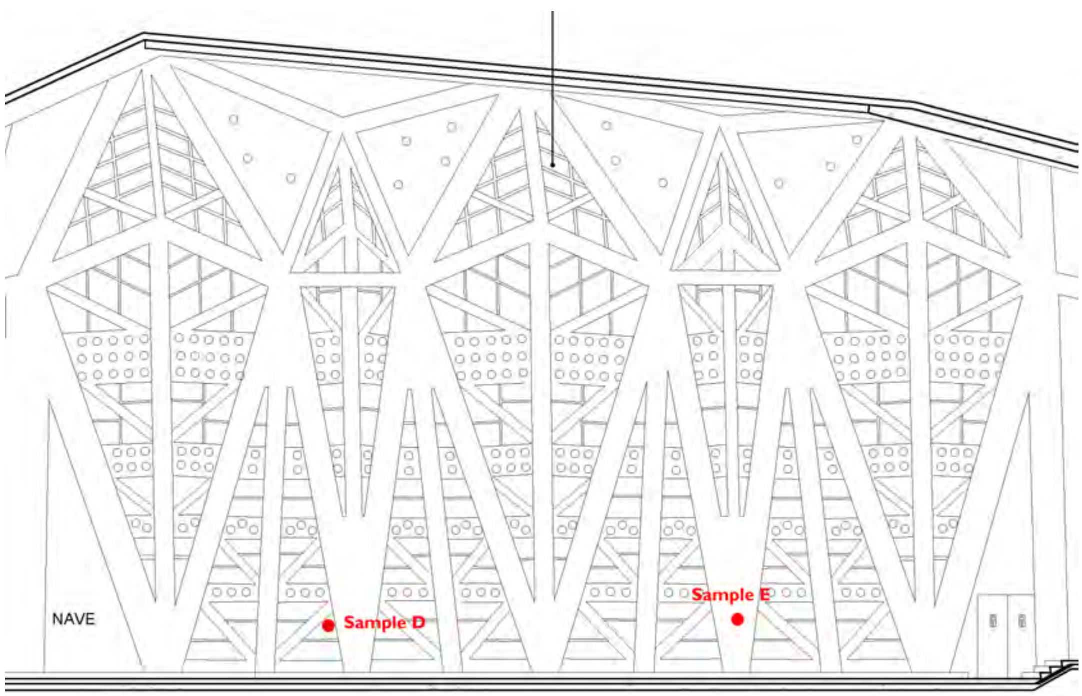
The salt present on the glass in the both the original dalle de verre panels and the replacement panels is sodium carbonate. This salt is assumed to be forming from the interaction of the alkali material in the glass and the carbon dioxide and moisture in the air (See Appendix E for details).

The efflorescence removed from the concrete matrix that comprises the dalle de verre is gypsum (calcium sulfate). The efflorescence removed from the interior of the cast-in-place concrete framework and base is thenardite (sodium sulfate). Both salts are common on concrete structures exposed to long term water infiltration.

FIGURES



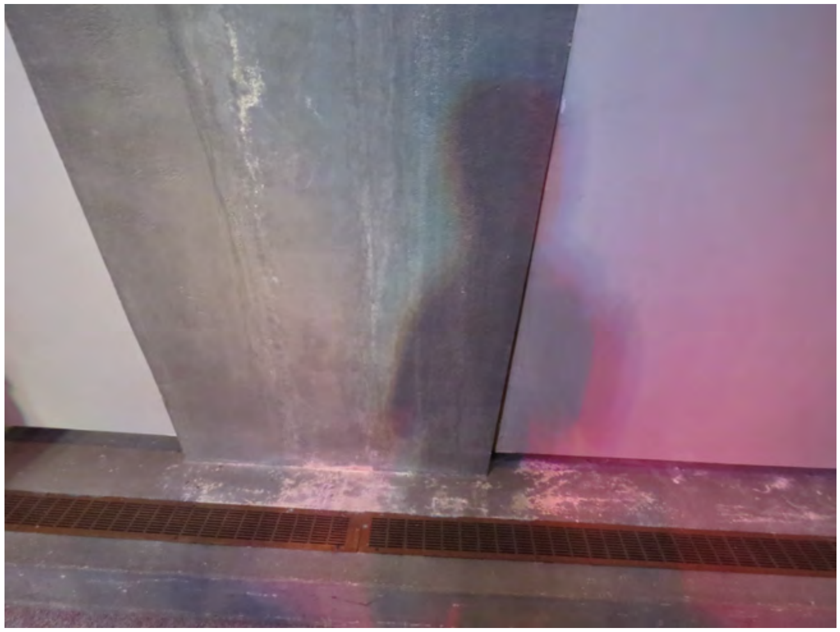
1 Sample locations on the interior of the north elevation.



2 Sample locations on the interior of the south elevation.

3 Sample location A in Figure 1. Efflorescence removed from deteriorated glass in a dalle-de-verre panel near the base of pre-cast concrete panel N15.

4 Sample location B in Figure 1. Efflorescence removed from the concrete matrix in a dalle-de-verre panel near the base of pre-cast concrete panel N12. All glass in the panel appeared sound, free of cracks or delamination.

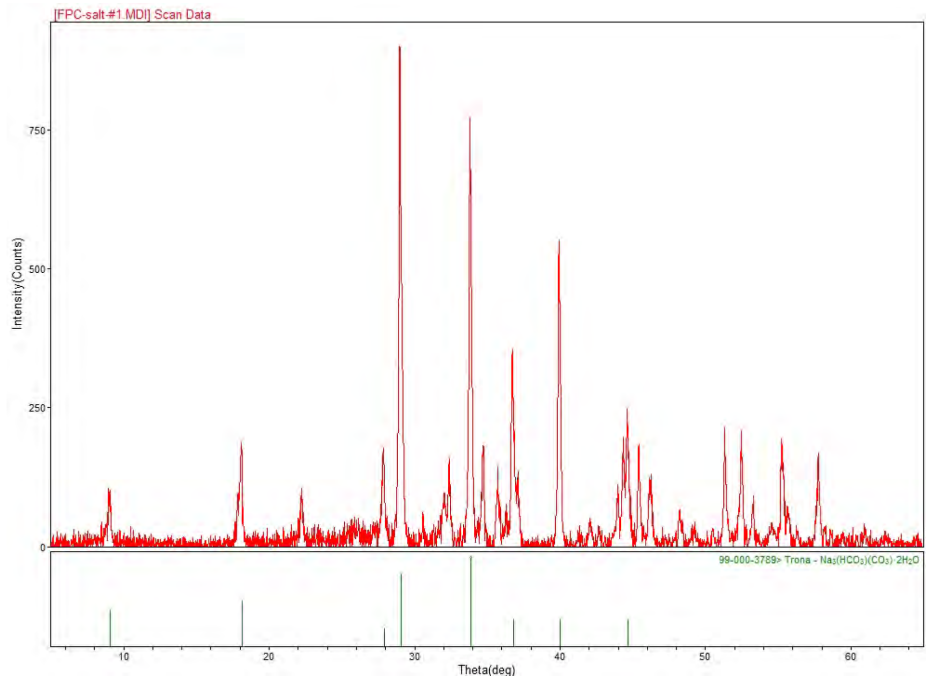


5 Sample location C in Figure 1. Efflorescence removed interior cast-in-place concrete base below the acoustical panels by the Choir Loft. Similar efflorescence was also visible on the portion of the base visible in the north passage.

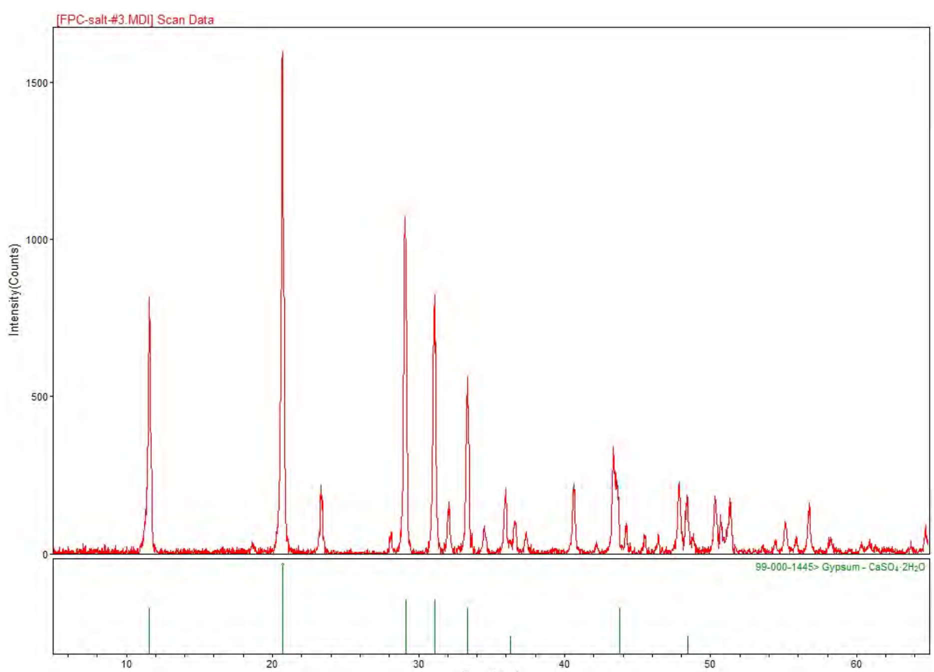
6 Sample location D in Figure 2. Efflorescence removed from deteriorated glass and adjacent epoxy matrix material in a dalle-de-verre panel near the base of pre-cast concrete panel S15.

7 Sample location E in Figure 2. Efflorescence removed from cast-in-place concrete exhibiting flaking and peeling paint, near the base of the building, between pre-cast concrete panels S3 and S4

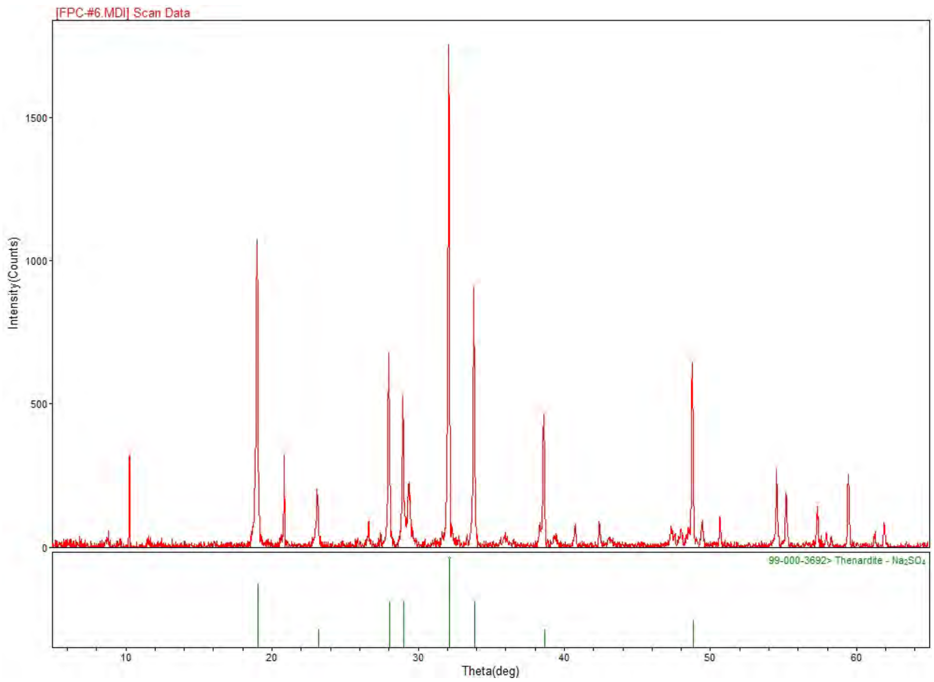
8 Typical efflorescence on pre-cast concrete panel on the north elevation. The surface deposition was too thin for bulk sampling of the material.



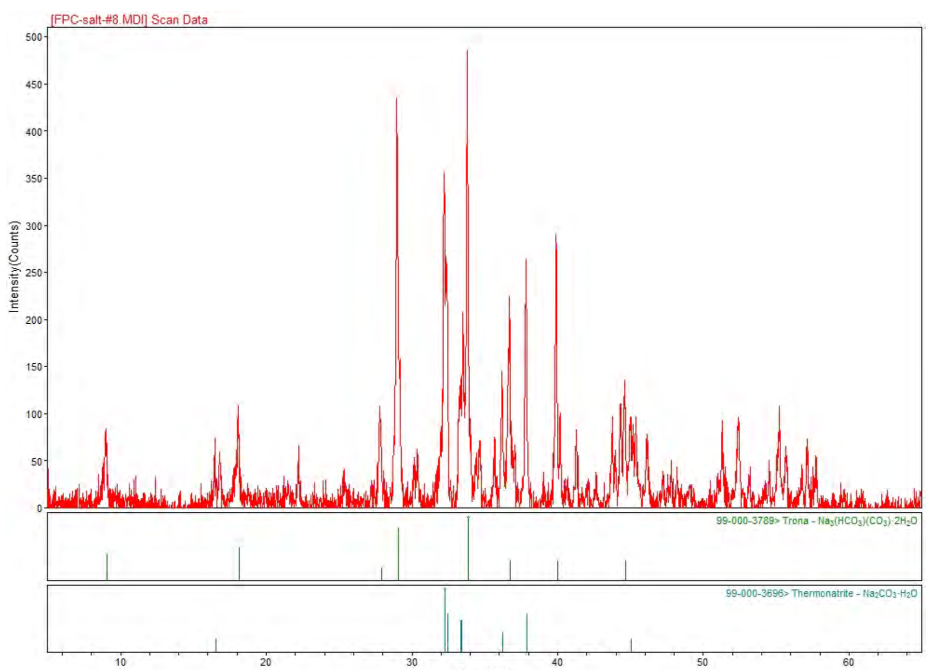
9 Diffractogram for Sample A – Salt on Glass in Concrete Dalle de Verre Panel. The primary phase identified is trona, which is sodium carbonate.



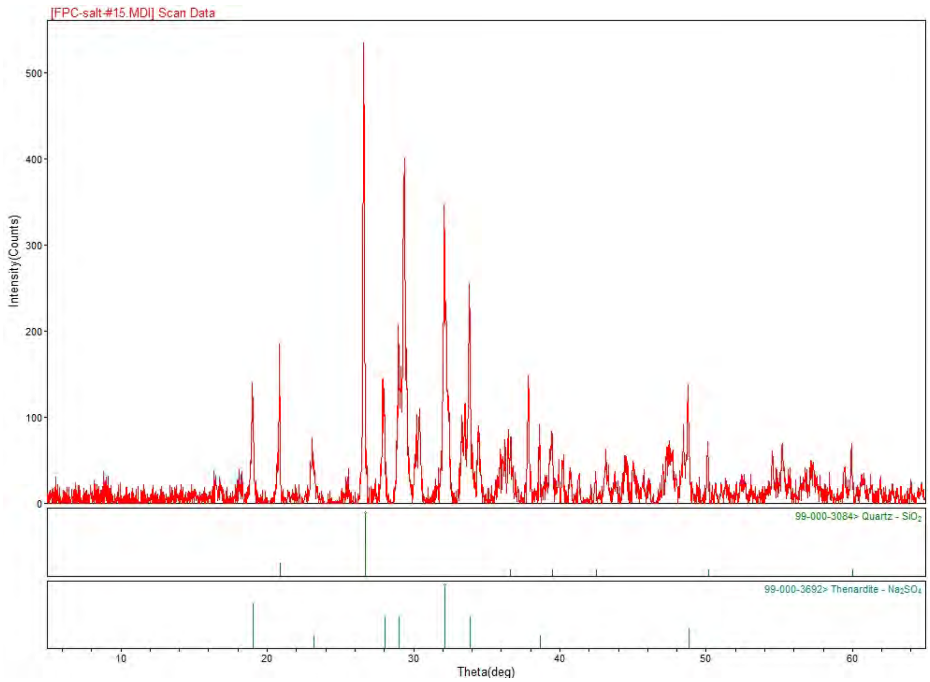
10 Diffractogram for Sample B – Salt on Concrete Dalle de Verre Matrix. The primary phase identified is gypsum, which is calcium sulfate.



11 Diffractogram for Sample C – Salt on Cast-in-Place Concrete Base. The primary phase identified is thenardite, which is sodium sulfate.



12 Diffractogram for Sample D – Salt on Glass in Epoxy Dalle de Verre Panel. The primary phases identified is trona (like Sample A) and thermonatrite, both of which are forms of sodium carbonate.



13 Diffractogram for Sample E – Salt on Cast-in-Place Concrete Framework. The primary phase identified is thenardite, which is sodium sulfate (like Sample C). The quartz identified during the analysis is not a component of the efflorescence; it was inadvertently sampled with the removal of the existing salt.

Appendix G
Laboratory Report:
Concrete Sampling for Petrographic Analysis

LABORATORY REPORT: CONCRETE SAMPLING FOR PETROGRAPHIC ANALYSIS

Commissioned By:	Prudon and Partners, LLP.
Building/Project:	First Presbyterian Church - Sanctuary
Building Address:	Stamford, CT
Construction Date:	1958
No. of Samples:	4
Samples Removed by:	BCA
Analysis Performed by:	Highbridge Materials Consulting, Inc.

OBJECTIVE

Four concrete core samples were removed from original concrete at the First Presbyterian Church during BCA's site visit in January 2017. BCA sent the samples to Highbridge Materials Consulting, Inc. for chemical and petrographic analysis.

SAMPLE LOCATIONS

Prudon and Partners, LLP. contracted Affordable Concrete Sawing and Drilling, based out of West Southfield, CT., to remove the samples. BCA selected three core locations near the bottom of the exterior north façade; this area was selected for testing because there is less archival documentation of repairs and interventions to the original concrete on this elevation.

BCA surveyed the concrete using a Protovale Rebar Locator. This equipment can detect rebar within 6" of the surface. The rebar locator indicated that steel reinforcement near the base of the north elevation generally has cover 0.75"-3" deep in pre-cast concrete ribs and 1.5"-3" deep in the pre-cast panels. Sample locations were selected based on where the greatest concrete cover was anticipated in each element.

The core samples were removed with a wet core drill (Figure 1). Samples were removed from the following locations. See Figures 2 and 3 for the sample locations identified below.

#1 Concrete core removed from the cast-in-place concrete on the north elevation, between pre-cast panels 13/14 (Figures 2 & 4).

#2 Concrete core removed from the pre-cast concrete panel #2 on the north elevation (Figures 1 & 2).

#3 Concrete core removed from the concrete base on the north elevation, below pre-cast panels 13/14 (Figures 2 & 4).

#4 Concrete sample removed from a salvaged concrete dalle de verre panel previously installed in the pre-cast panel S12 in the south elevation. The panel was removed from the façade during the 1980s. Rohlf's Stained & Leaded Glass gave the salvaged panel to The Highland Green Foundation, who provided it to BCA for materials testing (Figure 3).

All sample areas appeared to have sound, original concrete. Sample #3 was taken approximately 5 inches below the horizontal shelf of the base and about 2 inches above an existing continuous crack in the vertical face of the base (Figure 4). No deterioration was noted adjacent to the other sample locations; however, all sample locations on the north elevation are coated with an elastomeric material, which may obscure nearby conditions.

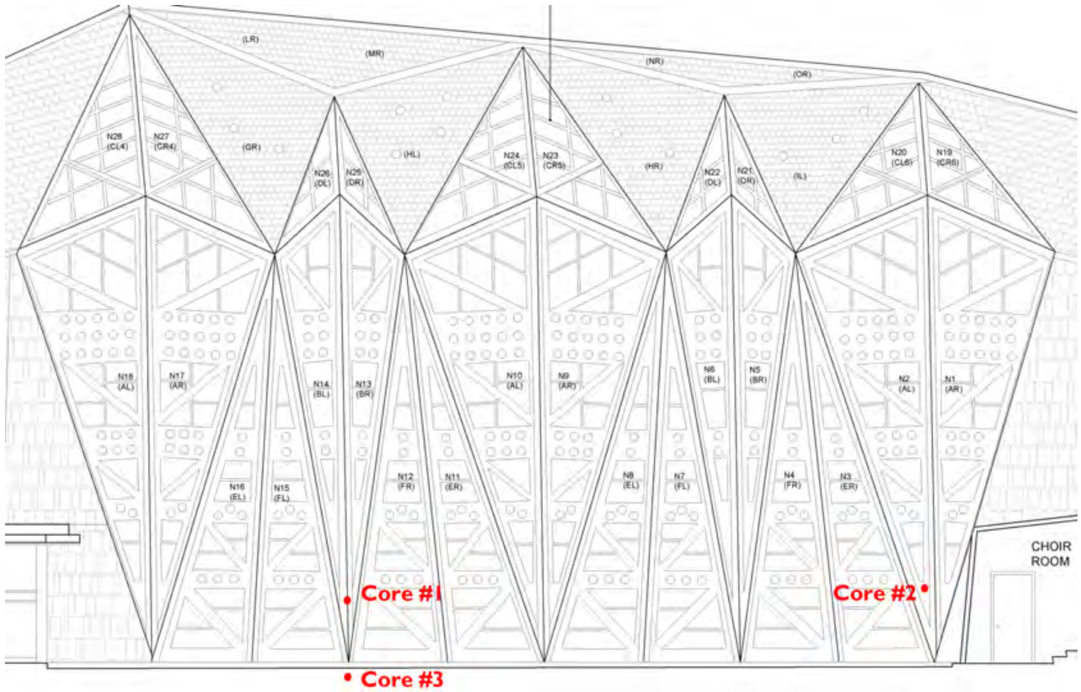
Embedded steel reinforcement was not exposed in any of the sample areas. Following removal of the cores, the Contractor filled the resultant voids with Quikrete Hydraulic Water-Stop Cement.

DISCUSSION OF TEST METHOD AND FINDINGS

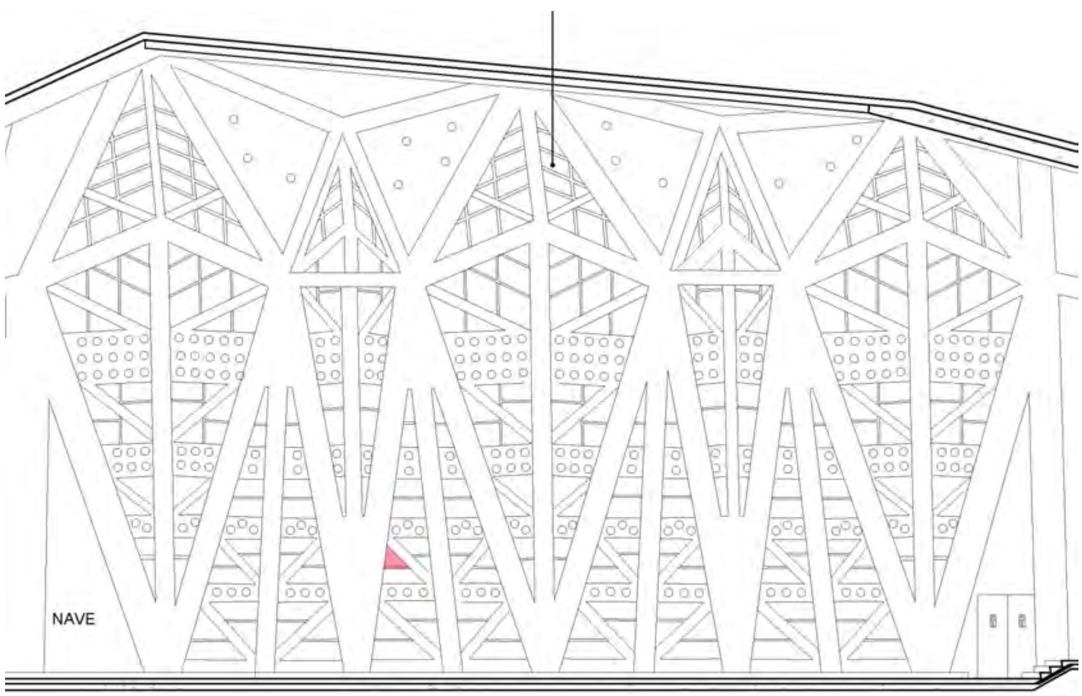
See the attached report from Highbridge Materials Consulting, Inc. for details.

FIGURES

1 Removal of core at sample location #2.



2 Approximate sample locations on the exterior of the north elevation.



3 Highlighted red area indicates original installation location of the salvaged panel cored for sample #4.

4 Location of removed cores #1 and #3. Note that core #3 was taken approximately 2 inches above a continuous crack in the concrete base.

Appendix H
Laboratory Report:
Petrographic Examination of
Cast-in-Place Concrete Framework

By Highbridge Materials Consulting, Inc.

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PETROGRAPHIC EXAMINATION REPORT

Client:	Building Conservation Associates, Inc.	**Client ID:**	BUIL002
Project:	First Presbyterian Church	**Report #:**	SL1113-01
Location:	Stamford, CT	**Date Received:**	01/19/17
Sample Type:	Concrete cores	**Report Date:**	02/16/17
Delivered by:	Client (L. Buchner)	**Petrographer:**	J. Walsh
		Page 1 of 14	

Report Summary

- Four core samples taken from various components along the exterior of the First Presbyterian Church in Stamford, CT are provided for analysis. This report presents the results of a petrographic examination on Core #1, a sample of cast-in-place concrete.
- The material is identified as a normal weight, air-entrained, portland cement concrete with no supplementary cementitious materials. The total air content is estimated at 4-6% though it is suspected that the spacing factor and specific surface might be marginal with respect to adequate freeze-thaw resistance. The original water-cement ratio (w/c) is estimated to have been moderate and likely within the high 0.4's. Though not excessive, it is higher than usually desired for exterior concrete and has resulted in a cementitious matrix with a modest permeability. The coarse aggregate is a carbonate crushed stone consisting of a relatively pure dolostone. The gradation may be near a No. 67 profile. The fine aggregate is a well graded natural quartz sand.
- Though the sample is rather small, there are no obvious deficiencies in the mixing, placement, or hydration of the concrete.
- The concrete is in sound condition and exhibits no evidence for physical or chemical distress. Based on the evidence obtained in this examination, there is no immediate concern over compromised integrity or durability due to existing or potential distress mechanisms. The client has expressed concern over the possibility of alkali-silica reactivity. The probability of this reaction is rather low based on the quality of the aggregate.

1. Introduction

On January 19, 2017, Highbridge received four core samples from Ms. Laura Buchner of Building Conservation Associates. These are reported to represent various components taken from the exterior of the First Presbyterian Church in Stamford, CT, a building constructed in 1958. It is understood from discussions with the client that the exterior includes dalle de verre panels that are themselves set in larger panels of pre-cast concrete. In turn, the pre-cast units are assembled in a structure of cast-in-place concrete. The cores represent each of these components as well as the concrete base below the decorative assembly. Ms. Buchner identifies the samples as follows:

Core #1: Concrete core removed from the cast-in-place concrete on the north elevation, between pre-cast panels 13/14.
Core #2: Concrete core removed from the pre-cast concrete panel #2 on the north elevation.
Core #3: Concrete core removed from the concrete base on the north elevation, below pre-cast panels 13/14.
Core #4: Concrete sample from a dalle de verre panel previously removed from the south elevation.

At the client's request, a petrographic examination is performed on each of the samples. For the concrete materials (Cores #1 through #3), the client has asked for an emphasis on any features related to the existence or potential for alkali-silica reaction. Additionally, the petrography is used to identify constituents, assess overall quality, and investigate the potential cause of any observed distress. At the laboratory's recommendation, the dalle de verre sample is treated as a mortar rather than a concrete and a full compositional analysis is performed on Core #4. Additional goals of this level of analysis are to characterize the types of binders present, understand their performance characteristics, and estimate component proportions where possible.

Given the differences in materials, the laboratory has chosen to issue separate, stand-alone reports for each sample. This report presents the results for Core #1, the cast-in-place concrete.

2. Methods of Examination

The petrographic examination is conducted in accordance with the standard practices contained in ASTM C856. Data collection is performed or supervised by a degreed geologist who by nature of his/her education is qualified to operate the analytical equipment employed. Analysis and interpretation is performed or directed by a supervising petrographer who satisfies the qualifications as specified in Section 4 of ASTM C856.

3. Standard of Care

Highbridge has performed its services in conformance with the care and skill ordinarily exercised by reputable members of the profession practicing under similar conditions at the same time. No other warranty of any kind, expressed or implied, in fact or by law, is made or intended. Interpretations and results are based strictly on samples provided and/or examined.

4. Confidentiality

This report presents the results of laboratory testing requested by the client to satisfy specific project requirements. As such, the client has the right to use this report as necessary in any commercial matters related to the referenced project. Any reproduction of this report must be done in full. In offering a more thorough analysis, it may have been necessary for Highbridge to describe proprietary laboratory methodologies or present opinions, concepts, or original research that represent the intellectual property of Highbridge Materials Consulting and its successors. These intellectual property rights are not transferred in part or in full to any other party. Presentation of any or all of the data or interpretations for purposes other than those necessary to satisfy the goals of the investigation are not permitted without the express written consent of the author. The findings may not be used for purposes outside those originally intended. Unauthorized uses include but are not limited to internet or electronic presentation for marketing purposes, presentation of findings at professional venues, or submission of scholarly articles.

5. Petrographic Findings and Discussion

5.1 - General Summary

A core sample from the cast-in-place concrete along the exterior of the First Presbyterian Church is examined petrographically for this report. The material is identified as a normal weight, air-entrained, portland cement concrete with no supplementary cementitious materials. The total air content is estimated at 4-6% though it is suspected that the spacing factor and specific surface might be marginal with respect to adequate freeze-thaw resistance. The original water-cement ratio (w/c) is estimated to have been moderate and likely within the high 0.4's. Though not excessive, it is higher than usually desired for exterior concrete and has resulted in a cementitious matrix with a modest permeability. The coarse aggregate is a carbonate crushed stone consisting of a relatively pure dolostone. The gradation may be near a No. 67 profile. The fine aggregate is a well graded natural quartz sand. Though the sample is rather small, there are no obvious deficiencies in the mixing, placement, or hydration of the concrete.

The concrete is in sound condition and exhibits no evidence for physical or chemical distress. Based on the evidence obtained in this examination, there is no immediate concern over compromised integrity or durability due to existing or potential distress mechanisms. The client has expressed concern over the possibility of alkali-silica reactivity. The probability of this reaction is rather low based on the quality of the aggregate.

5.2 - Materials

The coarse aggregate is carbonate crushed stone. The core is not large enough to evaluate the aggregate content but the distribution of stone in the area observed is within a range normally considered adequate for a conventional concrete mixture. The aggregate consists predominantly of an equigranular dolostone. In thin section, one argillaceous grain is identified with an even distribution of clays in the interstitial space between dolomite crystals. Another grain in thin section is a slatey dolomitic argillite. Minor to trace sulfide minerals are detected in a moderate proportion of grains. No chert or chalcedony is detected petrographically. From a physical perspective, the aggregate is estimated to be hard, relatively inelastic, and non-porous. There are no obvious chemical concerns based on the specific particles identified, though this type of dolostone can sometimes contain bands of chert and chalcedony that increase the risk for alkali-silica reaction. Sulfide phases can sometimes be subject to staining and/or expansion. However, the quantity observed is within the range usually encountered in stable dolostones.

The coarse aggregate particles are subangular in shape on average. Aspect ratios are mostly equant to subequant with a few plate-like grains having aspect ratios as high as 4 : 1. Overall, the particle shapes are appropriate for aggregate to be used in portland cement concrete. The gradation cannot be quantified petrographically and the sample size is insufficient to make a reasonable estimate. Nonetheless, the nominal top size is at least as coarse as the 1/2" sieve and the aggregate is likely graded down to the No. 8 sieve. The particle size distribution could be compliant with a No. 67 gradation profile as specified by ASTM C33 though there are too few grains observed to make this distinction.

The fine aggregate is a siliceous natural sand estimated at 40-45% by hardened mortar fraction. The sand consists primarily of monocrystalline and polycrystalline quartz with strained varieties more common above the No. 8 sieve. Feldspar is a minor component and there is also a minor assemblage of metamorphic rock grains and minerals. These mostly include pelitic varieties and amphibolites. Trace diabase is also noted. No clay coatings or friable materials are identified and the sand is considered hard, non-porous, and durable for use in cementitious mixtures. Fine aggregate grains are equidimensional and subangular in shape on average. Based on the qualitative petrographic observations, the particle size distribution is estimated to comply with the gradation requirements of ASTM C33. The nominal top size is estimated at the No. 8 sieve. The curve appears to be a bit skewed toward the coarser sizes. The peak abundance is likely between the No. 30 and No. 50 sieves though this is difficult to discern due to the overall broadness of the gradation.

Ordinary gray portland cement is the sole binder and no supplementary cementitious materials are identified. Liquid admixtures cannot be identified petrographically though their influence on paste microstructure can often be detected. The abundance of fine air-voids indicates the use of an air-entraining agent. The cement paste is rather even-textured at the microscopic level with no mottling due to cement flocculation. This uniformity is often associated with the use of water-reducers. However, these microstructural features are by no means diagnostic. In fact, the original mix water content appears to be somewhat higher than typically encountered in concrete mixtures plasticized with some type of water-reducing agent.

The concrete represented by the sample is estimated to have been mixed at a moderate water to cement ratio (w/c). Though the ratio cannot be quantified petrographically, cement paste characteristics are consistent with a w/c in the range of the high 0.4's. The low 0.5's are possible as well. The microstructural characteristics used to estimate water contents include the capillary porosity of the cementitious binder. This microporosity represents the location of evaporable mix water in the freshly placed concrete. In this case, the cementitious hydrate is homogeneously developed with a moderate capillarity. The cement hydration is advanced and virtually all hydraulic calcium silicate has been consumed in hydration reactions. There is a low concentration of residual cement grains occurring as fine-grained agglomerates of former calcium silicate with an interstitial matrix of iron-bearing ferrite. Calcium hydroxide from the initial cement hydration can also be a useful indicator of original water content. Where not depleted during sample preparation, the hydroxide is found in moderate to moderately high abundance as medium-grained crystal masses within the paste. The non-compact nature of the hydroxide is characteristic of mix water contents greater than approximately 0.40.

The air content and microstructure are indicative of intentional air-entrainment. The total air content is estimated at 4-6% by volume. The voids representing the entrained air are moderately well distributed with no significant clustering throughout the examined area of the concrete. The spherical voids are fine in diameter but there is not a lot of the finest sizes below about 0.25 millimeters. A quantitative air-void analysis was not performed and the statistical parameter related to potential freeze-thaw resistance are not calculated. Based strictly of the qualitative petrographic observations, it is suspected that the spacing factor and specific surface might not meet most industry standards for an adequate entrained-air structure. This is based largely on the apparent size distribution of the air-voids.

5.3 - Original Placement and Hydration

The core sample is only about 2" in diameter and length. As such, relatively little can be said regarding the workmanship of the original concrete placement. The mortar fraction is well-blended and there are no sand streaks or cement lumps. Coarse aggregate is present near the formed face of the sample at a concentration that is typical for conventional mixtures. The mix water appears to have been well incorporated into the fresh mixture and there is no evidence for inappropriate late retempering. There are a few very minor water voids around aggregate particles but no other signs of significant bleed water migration or accumulation. The air-entrainment seems moderately well developed though possibly not ideally so. There are a great many factors that can affect the development of entrained air for a given dosage. These can include ambient temperature, mix duration, aggregate properties, and even the quality of the mixing blades in the truck. It is not possible to distinguish among these various factors through a laboratory analysis alone.

The portion of concrete available for study is monolithic without any cold joints. The mixture is well compacted with no coarse void concentrations or honeycombs. The largest voids are typically less than 3 millimeters in diameter. The formed surface is complete and planar with no laitance or incipient delaminations. Though covered with an elastomeric membrane, there are no bugholes observed and no defects that might be associated with forming or form-stripping.

The cementitious binder is well developed throughout the bulk of the sample. Paste-aggregate bonds are reasonably well-developed for the type of conventional concrete mixture represented by the core. There is no evidence for significant differential drying of the concrete and the hydration characteristics are mostly homogeneous throughout the examined cross section the sample.

5.4 - Features Related to Potential for Steel Corrosion
An assessment of the quality of any steel reinforcement is outside the scope of a petrographic examination. Nevertheless, several features of the concrete may influence the corrosion potential of any metal embedded within or adjacent to the placement. These may include permeability, chloride content, and depth of carbonation. It should be noted that no reinforcement is included with the sample and the author is not aware of the design specifics.

First, the moderate water to cement ratio has resulted in a cementitious matrix that is not especially water resistant. Though the overlying elastomeric coating is likely to slow the ingress of moisture from the surface, any water that can migrate beyond this barrier could potentially infiltrate the concrete even if at a somewhat slow rate. Oxygen, salts, and other deleterious agents can be transmitted along with external water. While the concrete is not especially deficient in this regard, it is not considered a high-performance mixture. This should be a consideration at any locations where the cast-in-place concrete does not shed water rapidly during or after precipitation. On vertical surfaces or areas where moisture evaporates rapidly, the concrete may be sufficiently dense to prevent any appreciable moisture intrusion.

Chloride testing was not performed for this sample so it is not known if there is a potential for corrosion due to excessive salt contents. Carbonation of the concrete is more advanced than usually desired. The total reaction extends to a depth between 18-25 millimeters from the outer surface. The reaction is gradational across this thickness suggesting that it is not densifying and self-limiting. The reaction is not detrimental to the concrete itself. However, any reinforcement lying within this zone could be subject to depassivation due to the pH reduction that accompanies carbonation. Of course, low cover can often lead to corrosion due to exposure of the steel to near-surface oxygen and water. If there is any steel emplaced shallowly within the casting, the carbonation may exacerbate the risk. Evidence for this type of corrosion would likely be visible along the concrete surface.

Of course, a more thorough evaluation of corrosion potential must be deferred to a corrosion engineer. The statements made here are relatively crude and offered without any firsthand knowledge of the jobsite conditions or electrical properties of the concrete and any embedments.

5.5 - Condition and Durability
The concrete examined for this report represents a conventional mixture adequate for many non-aggressive, low-performance applications. Though not especially durable, there is no evidence for any significant limiting factors that might reduce the design life relative to a normal service expectation. This statement refers to the material itself and not to any cracking that might be produced by the corrosion of embedded steel reinforcement. The one possible issue would be the potential for reduced freeze-thaw resistance due to an insufficiently low water to cement ratio coupled with what seems to be a marginally adequate entrained-air structure. To be clear, the durability is only questionable with respect to freeze-thaw cycling. Furthermore, the concrete would need to be installed in a place where saturation would be likely prior to freezing events for there to be any significant concern over long-term performance.

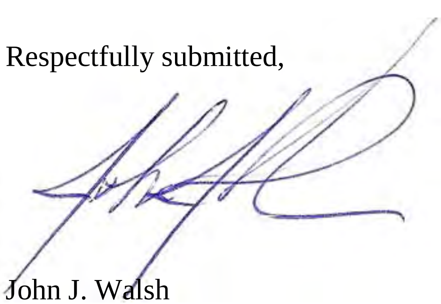
The sample examined for this report does not exhibit any cracking or signs of material distress. Aside from the expected carbonation, the cement paste does not exhibit evidence for deleterious chemical reactions. Air-voids within the uncarbonated regions of the concrete all contain exceptionally thin linings of secondary ettringite. However, this sulfate phase is a ubiquitous secondary mineral in portland cement concrete than can form from even negligible amounts of pore water movements. The minor ettringite does not indicate any underlying chemical attack that would be considered a concern.

The client has expressed a concern over the possibility of alkali-silica reaction (ASR). ASR is a reaction in which disordered or poorly crystalline forms of silica in the aggregate react with alkalis in the cement paste to form a gel that expands as it absorbs ambient moisture. The swelling of the gel is often capable of producing pervasive expansive cracking if the tensile strength of the concrete is exceeded. Technically speaking, the dolostone aggregate is not among those normally considered susceptible to ASR. However, dolostones can sometimes contain bands of chert or chalcedony or have a cryptocrystalline silicic cement. All of these silica varieties can be aggressively reactive. These types of dolostones are sometimes encountered in aggregates from the mid-Hudson valley as an example. In some cases, there are also occurrences of dedolomitization reactions that were historically considered signs of alkali-carbonate reaction. More recent research suggests that these may be innocuous manifestations of an incipient alkali-silica reaction.

In this case, there is no evidence to suggest that this particular dolostone is among the more problematic varieties. Chert is not identified within any of the grains observed petrographically. There are certainly no occurrences of ASR or even incipient aggregate cracking and no dedolomitization reactions are detected. The probability for an ASR threat appears quite low based on the evidence generated in this study. Of course, the sample size is quite small and ASR tends to be a localized reaction that often exhibits an inch-scale spacing at early to moderate phases of distress. If visible cracking is observed in the cast-in-place concrete, larger samples that include the cracking may assist in making a more confident statement regarding the possible causes of distress.

If it were found that this particular concrete mix was affected by ASR, there are no features intrinsic to the design that would serve to mitigate the reaction to any appreciable degree. Accessibility to moisture is an important control of reaction rates. In this case, the concrete is estimated to have a modest permeability due to the original water contents though this permeability may have been reduced through applied coatings. The reaction requires an alkaline environment. While carbonation has reduced the pH within the first inch of surface concrete, the deeper portions of the core are sufficiently alkaline to permit the solubilization of any unstable silica. Supplementary cementitious materials (SCMs) have often been employed to mitigate reactions when questionable aggregates must be used. No SCMs are included in this mix design. Furthermore, the more modern lithium admixtures are certainly not incorporated into this mixture since these were not used before the 1990's. The only other major control over ASR would be the residual alkali content. This requires a chemical analysis and cannot be evaluated through a petrographic examination. However, it is probably safe to assume that low-alkali cements were not used in this mix. If alkali contents were moderately high when the concrete was cast, only leaching due to water infiltration or consumption due to alkali-silica reactions would be expected to reduce the initial values.

Respectfully submitted,



John J. Walsh
President/ Senior Petrographer
Highbridge Materials Consulting, Inc.

Appendix I: Visual Description of Core Sample

Core ID	**#1**
Dimensions and Details	The sample consists of a 1.75" diameter core received in one intact piece. The length ranges from 1.5" to 2.5" due to a beveled exterior surface.
Outer Surface	Most of the face has a 45° angle to the core axis. The other side of the bevel is shallower but not perpendicular. The surface is covered by a very thin, gray elastomeric coating. Minor greenish biogrowth is present on the coating.
Inner Surface	The inner face is a somewhat irregularly fractured surface. There is very little aggregate present to judge the breaking behavior of the concrete but about three small grains are transected by the fracture face.
Core Circumference	Smooth and untextured with no differential erosion from coring.
Embedded Items	No embedded items are included in the core sample.
Visible Cracks	No macroscopic cracks are visible in hand sample.

Appendix II: Photographs and Photomicrographs

Microscopic examination is performed on an Olympus BX-51 polarized/reflected light microscope and a Bausch and Lomb Stereozoom 7 stereoscopic reflected light microscope. Both microscopes are fitted with an Olympus DP-11 digital camera. The overlays presented in the photomicrographs (e.g., text, scale bars, and arrows) are prepared as layers in Adobe Photoshop and converted to the jpeg format. Digital processing is limited to those functions normally performed during standard print photography processing. Photographs intended to be visually compared are taken under the same exposure conditions whenever possible.

The following abbreviations may be found in the figure captions and overlays and these are defined as follows:

cm	centimeters	PPL	Plane polarized light
mm	millimeters	XPL	Crossed polarized light
µm	microns (1 micron = 1/1000 millimeter)		
mil	1/1000 inch		

Microscopical images are often confusing and non-intuitive to those not accustomed to the techniques employed. The following is offered as a brief explanation of the various views encountered in order that the reader may gain a better appreciation of what is being described.

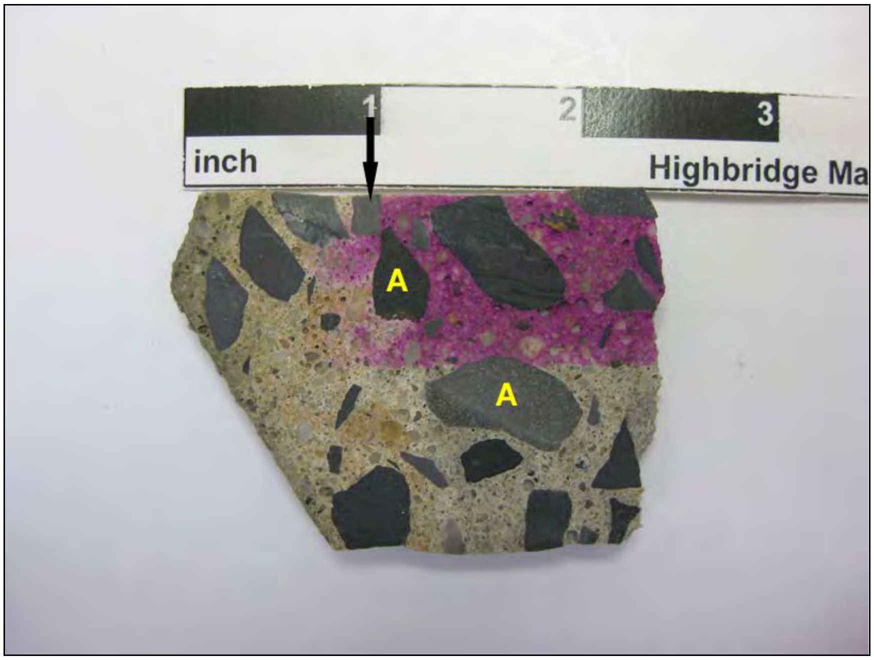
Reflected light images: These are simply magnified images of the surface as would be observed by the human eye. A variety of surface preparations may be employed including polished and fractured surfaces. The reader should note the included scale bars as minor deficiencies may seem much more significant when magnified.

Plane polarized light images (PPL): This imaging technique is most often employed in order to discern textural relationships and microstructure. To employ this technique, samples are milled (anywhere from 20 to 30 microns depending on the purpose) so as to allow light to be transmitted through the material. In many cases, Highbridge also employs a technique whereby the material is impregnated with a low viscosity, blue-dyed epoxy. Anything appearing blue therefore represents some type of void space (e.g.; air voids, capillary pores, open cracks, etc.) Hydrated cement paste typically appears a light shade of brown in this view (with a blue hue when impregnated with the epoxy). With some exceptions, most aggregate materials are very light colored if not altogether white. Some particles will appear to stand out in higher relief than others. This is a function of the refractive power of different materials with respect to the mounting epoxy.

Crossed polarized light images (XPL): This imaging technique is most often employed to distinguish components or highlight textural relationships between certain components not easily distinguished in plane polarized light. Using the same thin sections, this technique places the sample between two pieces of polarizing film in order to determine the crystal structure of the materials under consideration. Isotropic materials (e.g.; hydrated cement paste, pozzolans and other glasses, many oxides, etc.) will not transmit light under crossed polars and therefore appear black. Non-isotropic crystals (e.g.; residual cement, calcium hydroxide, calcium carbonate, and most aggregate minerals) will appear colored. The colors are a function of the thickness, crystal structure, and orientation of the mineral. Many minerals will exhibit a range of colors due to their orientation in the section. For example, quartz sand in the aggregate will appear black to white and every shade of gray in between. Color difference does not necessarily indicate a material difference. When no other prompt is given in the figure caption, the reader should appeal to general shapes and morphological characteristics when considering the components being illustrated.

Chemical treatments: Many chemical techniques (etches and stains typically) are used to isolate and enhance a variety of materials and structures. These techniques will often produce strongly colored images that distinguish components or chemical conditions.

Figure 1: Photograph of Core #1. The sample is shown in side view with the outer surface oriented toward the left of the image.



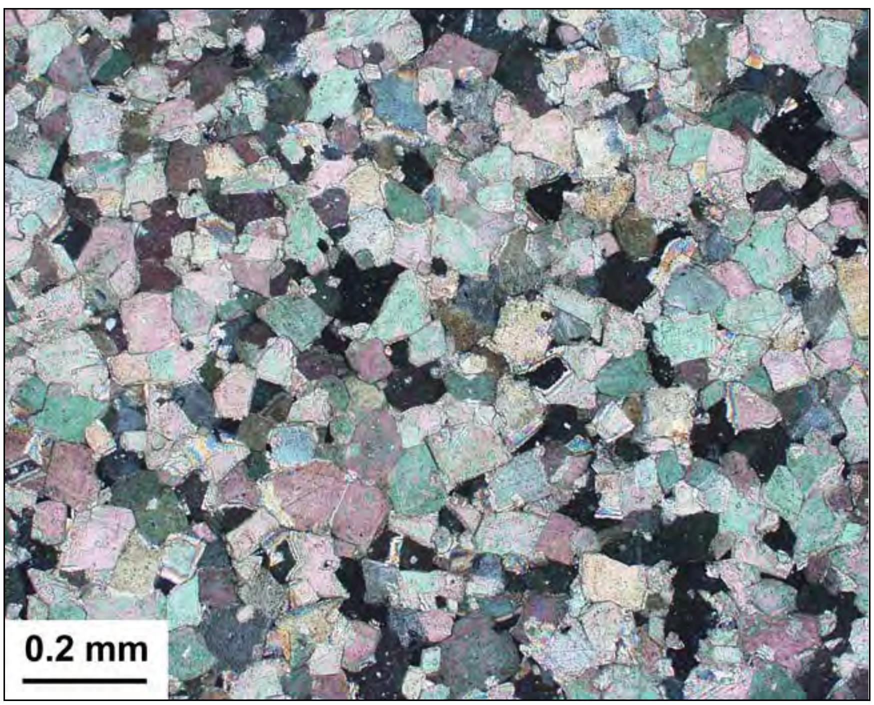


Figure 2: (Upper image) Photograph of the honed cross section of Core #1 with the outer surface oriented toward the left of the image. The crushed stone coarse aggregate (A) can be observed at this scale, though the sample is too small to accurately evaluate the size and distribution. Still, the stone appears to have a nominal top size at the 1/2" sieve. A No. 67 gradation profile is possible. The concentration of aggregate appears normal. A portion of the section is treated with a pH indicator solution. The pink color indicates that a high alkalinity is maintained below about 1" depth. The uncolored upper horizon coincides with the carbonation profile of the concrete. The depth of carbonation is a bit more than desirable at nearly one inch. Any steel reinforcement intersecting this zone could be at risk for depassivation. (Lower image) This XPL photomicrograph illustrates a typical microtexture within the coarse aggregate. The stone is a relatively pure, equigranular dolostone. The angular crystals all consist of dolomite. At this level of purity, the stone is not considered susceptible to alkali-silica reactions. However, dolostone of this character often contains inclusions of reactive chert or chalcedony. None are detected in this particular section.

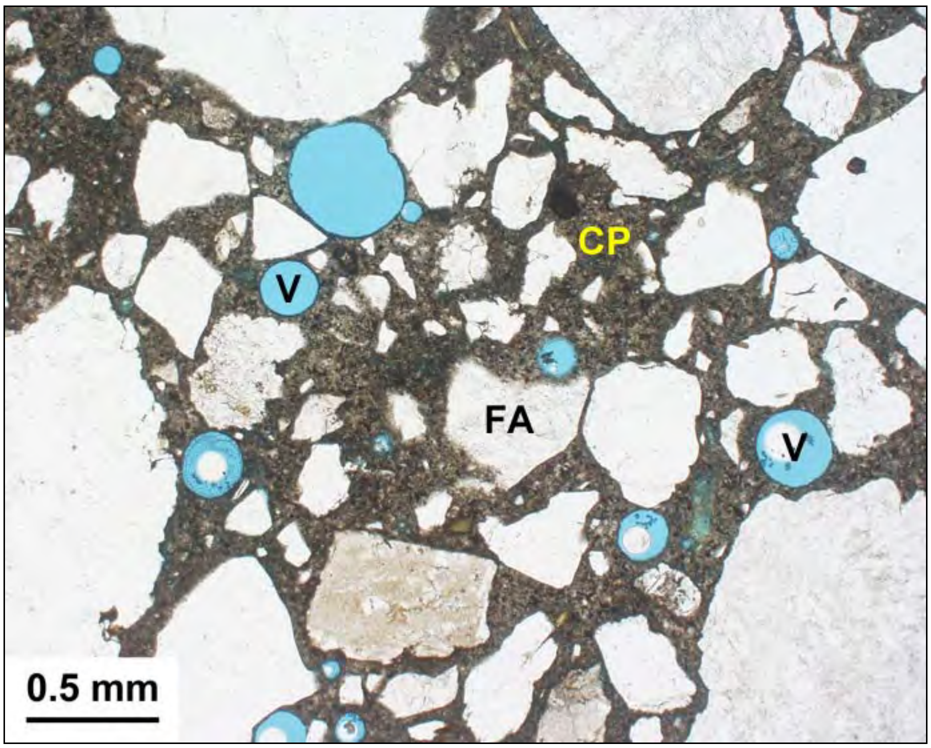


Figure 3: PPL photomicrograph illustrating the microstructure of the concrete in Core #1. The sample is impregnated with a low-viscosity, blue-dyed epoxy in order to highlight cracks, pores, and voids. The cement paste (CP) absorbs a moderate quantity of the dyed epoxy indicating a modest permeability. The microporosity suggests an original mix water content that was likely a little higher than desirable for concrete subject to exterior service but not necessarily excessive. Fine aggregate (FA) is evenly distributed throughout the matrix. The sand consists mostly of sharp-textured quartz grains. Air-voids (V) are present in moderate concentration. Though the abundance suggests intentional air-entrainment, there is a paucity of very fine void diameters. The air structure likely does not have the spacing factor or specific surface considered necessary for effective freeze-thaw resistance. This is not confirmed through an air-void analysis.

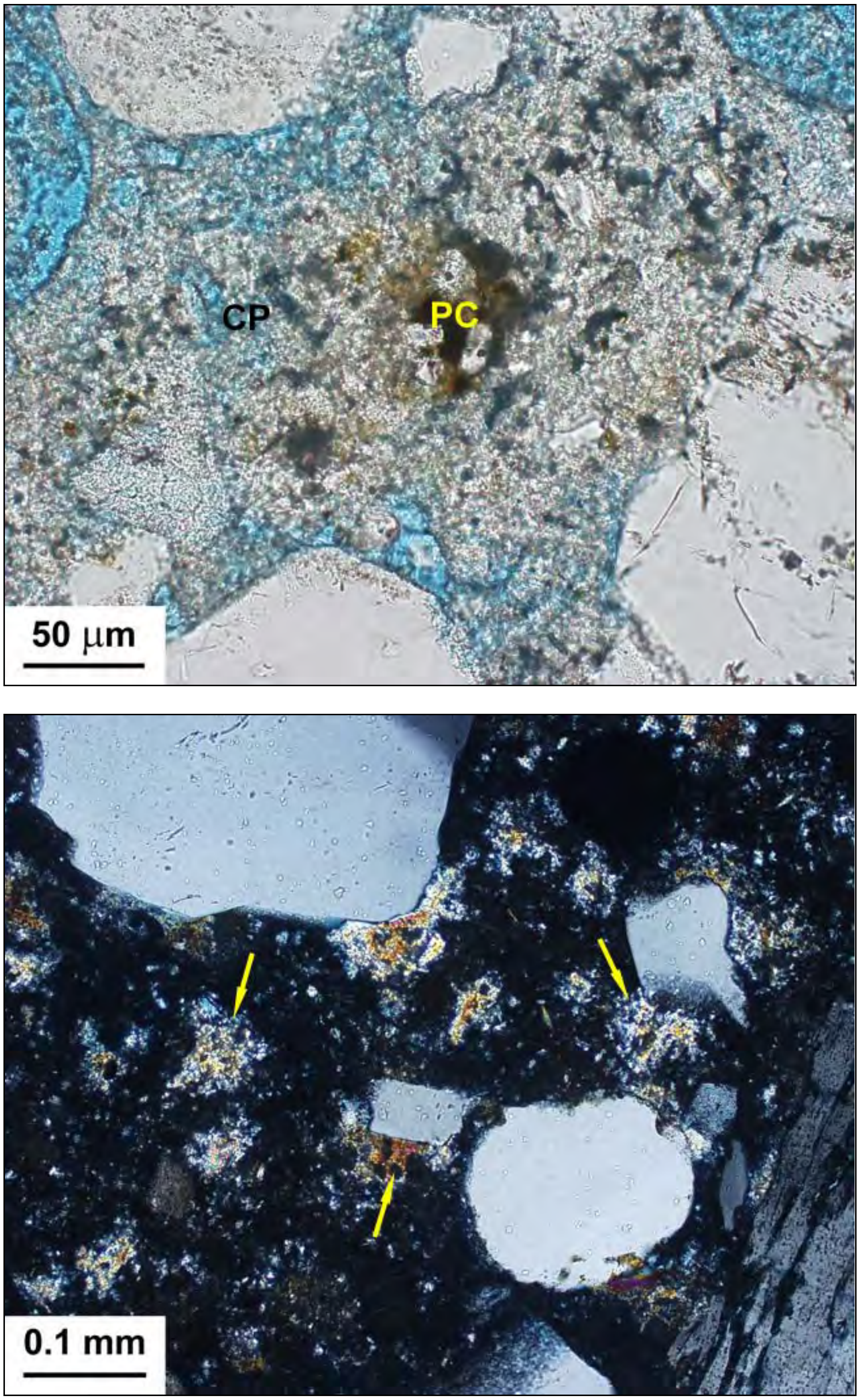


Figure 4: Photomicrographs illustrating the cement hydration characteristics for Core #1. (Upper PPL photomicrograph) Residual portland cement grains (PC) occur as fine agglomerates of former calcium silicate defined by a skeleton of brown-colored ferrite. The hydraulic calcium silicate once residing between these iron-bearing ferrite crystals is now fully consumed due to hydration. The adjacent cement paste (CP) is well-formed and has a moderate capillary porosity as indicated by the modest absorption of blue-dyed epoxy used in the sample preparation. (Lower XPL photomicrograph) The arrows illustrate medium-grained crystal masses of calcium hydroxide formed during the initial cement hydration. The non-compact morphologies are characteristic of water-cement ratios greater than approximately 0.40.

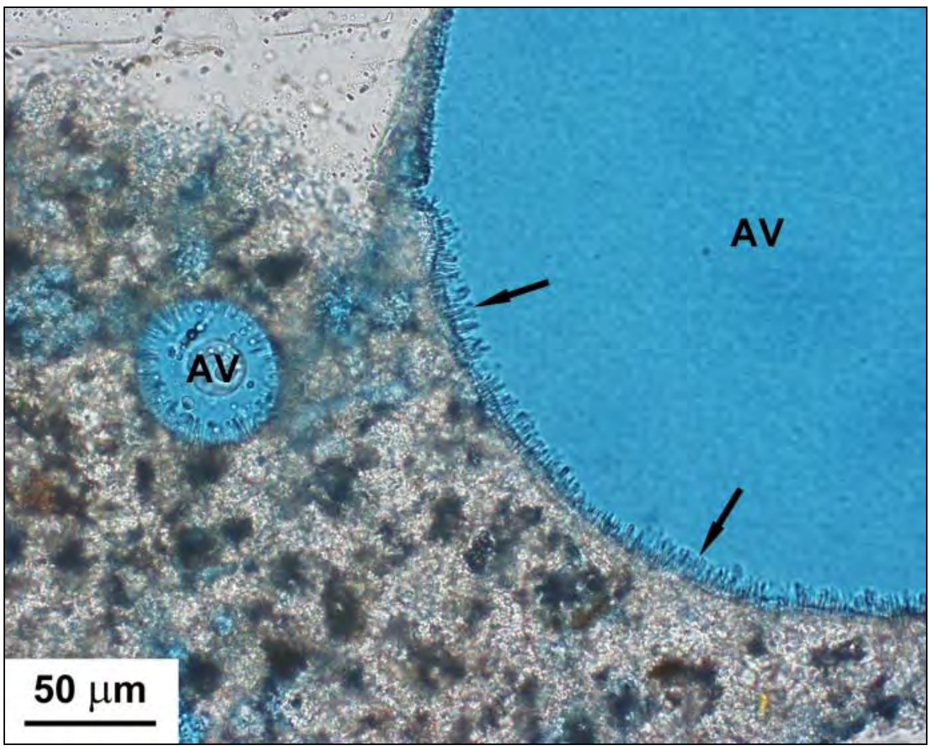


Figure 5: PPL photomicrographs. Air-voids (AV) are lined with exceptionally fine needles of secondary ettringite (arrows) wherever the cement paste is no carbonated. These are typical of even minor moisture fluxes and do not indicate any deleterious reactions within the concrete.

Appendix I
Laboratory Report: Petrographic Examination of Pre-Cast Concrete Panel

By Highbridge Materials Consulting, Inc.

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PETROGRAPHIC EXAMINATION REPORT

Client:	Building Conservation Associates, Inc.	**Client ID:**	BUIL002
Project:	First Presbyterian Church	**Report #:**	SL1113-02
Location:	Stamford, CT	**Date Received:**	01/19/17
Sample Type:	Concrete cores	**Report Date:**	02/16/17
Delivered by:	Client (L. Buchner)	**Petrographer:**	J. Walsh
		Page 1 of 15	

Report Summary

- Four core samples taken from various components along the exterior of the First Presbyterian Church in Stamford, CT are provided for analysis. This report presents the results of a petrographic examination on Core #2, a sample of pre-cast concrete.
- The material is identified as a normal weight, portland cement concrete with no supplementary cementitious materials and no air-entrainment. The water to cement ratio (w/c) is estimated to have been moderately high and likely within the 0.6's. This results in a highly permeable concrete matrix. The coarse aggregate is a natural gravel composed almost entirely of strained quartzite. The type of stone is known to be susceptible to alkali-silica reaction at moderate to long time scales. The fine aggregate is a well-graded natural quartz sand.
- Though the sample is rather small, there are no obvious deficiencies in the mixing, placement, or hydration of the concrete.
- The concrete is not especially suitable for exterior applications primarily due to its higher water-cement ratio. It is probable that a higher degree of drying shrinkage was experienced at early ages. The permeable matrix should be considered subject to water infiltration and the influx of any other deleterious agents in the service environment. Freeze-thaw susceptibility due to a lack of air-entrainment may be a subordinate concern.
- The concrete is certainly susceptible to alkali-silica reaction over longer time scales due to a potentially reactive aggregate, permeable matrix, and sufficiently alkaline hydrate. However, the sample contains nothing more than exceptionally minor gel development with no associated cracking. It is possible that the reaction is better developed elsewhere in the construction.

1. Introduction

On January 19, 2017, Highbridge received four core samples from Ms. Laura Buchner of Building Conservation Associates. These are reported to represent various components taken from the exterior of the First Presbyterian Church in Stamford, CT, a building constructed in 1958. It is understood from discussions with the client that the exterior includes dalle de verre panels that are themselves set in larger panels of pre-cast concrete. In turn, the pre-cast units are assembled in a structure of cast-in-place concrete. The cores represent each of these components as well as the concrete base below the decorative assembly. Ms. Buchner identifies the samples as follows:

Core #1: Concrete core removed from the cast-in-place concrete on the north elevation, between pre-cast panels 13/14.
Core #2: Concrete core removed from the pre-cast concrete panel #2 on the north elevation.
Core #3: Concrete core removed from the concrete base on the north elevation, below pre-cast panels 13/14.
Core #4: Concrete sample from a dalle de verre panel previously removed from the south elevation.

At the client's request, a petrographic examination is performed on each of the samples. For the concrete materials (Cores #1 through #3), the client has asked for an emphasis on any features related to the existence or potential for alkali-silica reaction. Additionally, the petrography is used to identify constituents, assess overall quality, and investigate the potential cause of any observed distress. At the laboratory's recommendation, the dalle de verre sample is treated as a mortar rather than a concrete and a full compositional analysis is performed on Core #4. Additional goals of this level of analysis are to characterize the types of binders present, understand their performance characteristics, and estimate component proportions where possible.

Given the differences in materials, the laboratory has chosen to issue separate, stand-alone reports for each sample. This report presents the results for Core #2 representing the pre-cast concrete panel that holds the dalle de verre.

2. Methods of Examination

The petrographic examination is conducted in accordance with the standard practices contained in ASTM C856. Data collection is performed or supervised by a degreed geologist who by nature of his/her education is qualified to operate the analytical equipment employed. Analysis and interpretation is performed or directed by a supervising petrographer who satisfies the qualifications as specified in Section 4 of ASTM C856.

3. Standard of Care

Highbridge has performed its services in conformance with the care and skill ordinarily exercised by reputable members of the profession practicing under similar conditions at the same time. No other warranty of any kind, expressed or implied, in fact or by law, is made or intended. Interpretations and results are based strictly on samples provided and/or examined.

4. Confidentiality

This report presents the results of laboratory testing requested by the client to satisfy specific project requirements. As such, the client has the right to use this report as necessary in any commercial matters related to the referenced project. Any reproduction of this report must be done in full. In offering a more thorough analysis, it may have been necessary for Highbridge to describe proprietary laboratory methodologies or present opinions, concepts, or original research that represent the intellectual property of Highbridge Materials Consulting and its successors. These intellectual property rights are not transferred in part or in full to any other party. Presentation of any or all of the data or interpretations for purposes other than those necessary to satisfy the goals of the investigation are not permitted without the express written consent of the author. The findings may not be used for purposes outside those originally intended. Unauthorized uses include but are not limited to internet or electronic presentation for marketing purposes, presentation of findings at professional venues, or submission of scholarly articles.

5. Petrographic Findings and Discussion

5.1 - General Summary

A core sample from the pre-cast concrete along the exterior of the First Presbyterian Church is examined petrographically for this report. The material is identified as a normal weight, portland cement concrete with no supplementary cementitious materials and no air-entrainment. The water to cement ratio (w/c) is estimated to have been moderately high and likely within the 0.6's. This results in a highly permeable concrete matrix. The coarse aggregate is a natural gravel composed almost entirely of strained quartzite. The type of stone is known to be susceptible to alkali-silica reaction at moderate to long time scales. The fine aggregate is a well-graded natural quartz sand. Though the sample is rather small, there are no obvious deficiencies in the mixing, placement, or hydration of the concrete.

The concrete is not especially suitable for exterior applications primarily due to its higher water-cement ratio. It is probable that a higher degree of drying shrinkage was experienced at early ages. The permeable matrix should be considered subject to water infiltration and the influx of any other deleterious agents in the service environment. Freeze-thaw susceptibility due to a lack of air-entrainment may be a subordinate concern. The concrete is certainly susceptible to alkali-silica reaction over longer time scales due to a potentially reactive aggregate, permeable matrix, and sufficiently alkaline hydrate. However, the sample contains nothing more than exceptionally minor gel development with no associated cracking. It is possible that the reaction is better developed elsewhere in the construction.

5.2 - Materials

The coarse aggregate is a siliceous natural gravel. Based on the small sample examined, the aggregate packing appears reasonably dense with a hardened volume content estimated at 35-40%. In thin section, virtually all of the aggregate particles consist of strained quartzite exhibiting varying levels of geological deformation. One grain of gneiss and one grain of pelletal ironstone are observed. From a physical perspective, the rock types are interpreted to be hard, inelastic, and non-porous. However, the strained quartz is susceptible to alkali-silica reactivity at moderate to long time scales. This is discussed at greater length below. Coarse aggregate grains are mostly equidimensional and rounded in shape. Overall, the particle shapes are mostly appropriate for aggregate to be used in portland cement concrete. Rounded aggregates can have smoother surfaces that result in lower paste-aggregate bond strength for the same water-cement ratio. This possibility is not easily quantified through a petrographic examination. Nonetheless, this is not considered a major deficiency. The gradation cannot be quantified petrographically and the sample size is insufficient to make a reasonable estimate. The nominal top size could be at the 1/2" sieve and the gradation appears rich in the range of the 3/8" based on the area examined. A No. 7 or No. 67 gradation profile could be possible for the range of particles noted in hand sample.

The fine aggregate is a siliceous natural sand estimated at 35-40% by hardened mortar fraction. This represents a modest but appropriate sanding. The aggregate consists largely of quartz with minor to trace alkali feldspar. Minor components include an assemblage of accessory metamorphic minerals and rock grains. Minor to trace ironstone is also present. Traces include "ZTR" minerals and chert. No clay coatings are identified along sand surfaces. There are traces of organic material most of which appears to be plant matter. However, this is not estimated to be excessive. The sand is considered hard, non-porous, and durable for use in portland cement concrete. Fine aggregate grains are equidimensional and subangular to angular in shape. Based on the qualitative petrographic observations, the particle size distribution is estimated to comply with the gradation requirements of ASTM C33. The nominal top size is estimated at the No. 8 sieve though it is difficult to distinguish coarse sand from fine stone due to the similar rock types. The profile is rich between the No. 16 and No. 30 sieves and the peak abundance is possibly in the range of the No. 30 mesh. The fines content is moderate.

Ordinary gray portland cement is the sole binder and no supplementary cementitious materials are identified. Liquid admixtures cannot be identified petrographically though their influence on paste microstructure can often be discerned. An absence of fine air-voids suggests that no air-entraining agents were employed. Though the cement microtexture is uniform, the estimated mix water content is higher than would be expected for a mix that was designed with a water-reducing agent. The concrete represented by the sample is estimated to have been mixed at a moderately high water to cement ratio (w/c). Though the ratio cannot be quantified petrographically, cement paste characteristics are consistent with a w/c somewhere in the 0.6's.

The microstructural characteristics used to estimate water contents include the capillary porosity of the cementitious binder. This microporosity represents the location of evaporable mix water in the freshly placed concrete. In this sample, the high capillarity evident throughout the homogeneously distributed hydrate is indicative of a fairly fluid suspension of portland cement when originally mixed. The higher water content is also suggested by the extreme hydration of the portland cement. No unhydrated calcium silicate remains and even the ferrite phase is highly depleted. Residual cement particles are detected in very low abundance as ferrite flakes that sometimes define the shapes of former calcium silicate agglomerates. Fully hydrated impressions of belite and alite agglomerates are better defined in the carbonated zone but there is still no unhydrated calcium silicate present. Calcium hydroxide from the initial cement hydration can also be a useful indicator of original water content when preserved. In this case, the hydroxide is present in moderately high concentration as medium to coarse-grained crystal plates and masses within the paste and as similarly-shaped deposits on aggregate interfaces. The coarseness of the hydroxide is notable and characteristic of relatively high mix water contents. The abundance and non-compact morphology are also characteristic.

5.3 - Original Placement and Hydration

The core sample is limited in size and relatively little can be said regarding the workmanship of the original concrete placement. The mortar fraction is well-blended and there are no sand streaks or cement lumps. Coarse aggregate is present at a concentration that is typical for conventional mixtures. If it is assumed that the mix water content is higher than intended, then it is likely that additional water was added to the concrete on site. However, the mix water appears to have been moderately well incorporated into the fresh mixture without the creation of heterogeneous mortar lumps. The higher water content has resulted in some bleed water migration and a few very porous bleed water channels are identified near the formed surface of the concrete. However, no significant water voids are entrapped around aggregate particles.

The portion of concrete available for study is monolithic without any cold joints. The mixture is well compacted with no coarse void concentrations or honeycombs. The concrete was clearly a high-slump mixture and this is supported by an air content estimated at less than 1% by volume. Any voids present are mostly spherical and less than 2 millimeters in diameter. The formed surface is complete and planar with no laitance or incipient delaminations. Though covered with an elastomeric membrane, there are no bugholes observed and no defects that might be associated with forming or form-stripping.

Though the cement hydration is extreme, the cementitious binder is well developed throughout the bulk of the sample. Paste-aggregate bonds are adequately developed though these represent the weakest component of the concrete. Fracturing of the concrete tends to produce cracks that deflect cleanly around the gravel aggregate particles. There is no evidence for significant differential drying of the concrete and the hydration characteristics are homogeneous throughout the examined cross section the sample.

5.4 - Features Related to Potential for Steel Corrosion

An assessment of the quality of any steel reinforcement is outside the scope of a petrographic examination. Nevertheless, several features of the concrete may influence the corrosion potential of any metal embedded within or adjacent to the placement. These may include permeability, chloride content, and depth of carbonation. It should be noted that no reinforcement is included with the sample and the author is not aware of the design specifics.

First and foremost, the moderately high water to cement ratio has resulted in a cementitious matrix that is not highly water resistant. Though the overlying cementitious coating is likely to slow the ingress of moisture from the surface, any water that can migrate beyond this barrier is likely to move readily through the concrete. Oxygen, salts, and other deleterious agents may be similarly transmitted. Depending on how representative this particular core is of the entire placement, and whether discrete cracks or joints intersect any overlying membranes, the permeability of the concrete alone is sufficient to increase the probability of corrosion assuming that any reinforcement is present in the structure.

Chloride testing was not performed for this sample so it is not known if there is a potential for corrosion due to excessive salt contents. The degree of carbonation is moderate and certainly not as deep as might be expected from such a permeable mix. The total depth of effect is about 15-17 millimeters from the exposed surface of the concrete. The boundary between carbonated and uncarbonated paste is relatively sharp and there is only a thin transitional zone. Only steel with very low cover would be subject to depassivation due to the pH reduction that accompanies carbonation. Of course, low cover could potentially lead to corrosion in the absence of carbonation simply due to the ingress of water and oxygen.

Of course, a more thorough evaluation of corrosion potential must be deferred to a corrosion engineer. The statements made here are relatively crude and offered without any firsthand knowledge of the jobsite conditions or electrical properties of the concrete and any embedments.

5.5 - Condition and Durability

The concrete examined for this report represents a conventional mixture that is not especially suited to exterior applications. The main deficiency is a high permeability resulting from an excessive water-cement ratio when originally mixed. Though the concrete may be susceptible to freeze-thaw cycling damage due to a lack of air-entrainment, the high permeability leaves the concrete subject to any number of distress mechanisms that rely on the absorption of water or other external agents. The high water content may also have caused the concrete to experience a greater degree of drying shrinkage within the first one or two years after casting. The author is not aware if there are any crack patterns on site that might be characteristic of early shrinkage. It should be noted that the sample examined for this study is in sound condition and does not include any cracks.

Since the concrete is a ca. 1950's pre-cast material, it is also important to look carefully for any evidence of delayed ettringite formation (DEF). This is a type of chemical distress that is more common in older steam-cured pre-cast units or other types of concrete that experience high temperatures during curing. Essentially, a metastable sulfate phase that is produced during setting, converts to ettringite at a later date as water is absorbed by the concrete. The crystallization of ettringite is expansive when it occurs in the hardened state and this leads to a bulk expansion of the cement paste ultimately followed by tensile cracking. In this case, there is no evidence for the characteristic ring-fissures that represent one of the earlier indicators of the reaction. There is also a near absence of ettringite within the cement paste and air-voids. It is tentatively suggested that DEF is not an issue for this concrete. However, it should be ensured that the sample was not taken from an area that could have remained dry during its service. Concrete prone to DEF may remain metastable indefinitely if not exposed to moisture.

The client has expressed a concern over the possibility of alkali-silica reaction (ASR). ASR is a reaction in which disordered or poorly crystalline forms of silica in the aggregate react with alkalis in the cement paste to form a gel that expands as it absorbs ambient moisture. The swelling of the gel is often capable of producing pervasive expansive cracking if the tensile strength of the concrete is exceeded. The strained quartzite in the coarse aggregate has the potential for relatively slow reactivity at moderate to long time scales. In some cases, cracking caused by ASR in this type of concrete mix results in a complete loss in integrity. However, there are many examples of older concrete made with similar aggregate that remain provisionally stable for many decades. Sometimes, both intact and compromised concrete of the same mix design may be found in the same construction.

In this particular sample, there is only trace evidence for early stage ASR, none of which would normally pose a durability threat to the affected concrete. There are no visible cracks and no microscopic cracks within the paste itself. Petrographically, there are a few quartzites that contain exceptionally fine internal microcracks but most of these are likely geological in origin. None are associated with ASR plugs or even early-stage hydrous silica gel. In fact, no ASR gel is detected petrographically anywhere within the sample. Though no gel is apparent microscopically, there are visible exudates of viscous gel around coarse aggregate particles that developed after the sample was cut. Several of these are colorless gels that were produced after coring and are visible along the core circumference. One of these is a white exudate that developed after cutting a cross-sectional slab.

If these were the only occurrences of ASR in a concrete that has been in service for over fifty years, it would be safe to assume that the concrete would continue to remain stable for many years. However, it is understood that visible cracks are present in the pre-cast panels and that previous studies may have identified alkali-silica reaction. ASR can be a localized reaction and it is important to study concrete in areas where there is visible distress. Cracking caused by ASR is expansive and usually exhibits patterns that are influenced by the geometry of the affected structure. The client has asked for some commentary regarding what further testing might be useful to help assess the continued serviceability of the concrete. At this point, it would be important to simply confirm that any visible cracking has been caused by ASR before continuing with any more specific tests. Larger core samples that intersect visible cracks would be the most appropriate for additional petrographic examination. It would also be helpful to look for other visible signs of ASR such as gel-like exudates or spalls that transect aggregate grains with concentric reaction rims.

Even though no evidence for reaction is apparent in this core sample, the examined concrete is certainly considered susceptible to such reactions, especially in areas where there is regular water infiltration. Ignoring the protection offered by any elastomeric membranes, the high permeability is expected to allow sufficient water into the matrix to facilitate reactions and for absorption into any hygroscopic gels. The paste is sufficiently alkaline to permit solubilization of any unstable aggregate. There is definitely no supplementary cementitious materials and presumably no lithium admixtures. The former would be obvious petrographically. The latter can only be detected chemically but were not available until the 1990's.

The only feature that would have the ability to mitigate and possibly inhibit any reaction would be a low residual alkali content. In cases where most of the aggregate is potentially reactive, there can be enough competition for sodium and potassium that any reactivity is diluted. Since the alkalis are one of the required reactants in ASR, consumption of these can arrest the reaction indefinitely unless there are additional external sources of alkali. This type of dilution only occurs in aggregate that has a sharply defined "pessimum effect". This is one in which maximum expansion occurs at some smaller proportion of the reactive stone. This type of effect can only be determined empirically. If ASR is detected in any future petrographic examination, measurement of residual alkali can be an effective tool that may help assess the potential for future expansion. These tests are reasonably straightforward and can be complete in a short period of time. There are also more direct tests that are used to measure the residual expansion itself. However, these tests require a much longer time to complete. Residual expansion tests are more justifiable for structures where replacement or reconstruction are problematic.

Respectfully submitted,

John J. Walsh
President/ Senior Petrographer
Highbridge Materials Consulting, Inc.

Appendix I: Visual Description of Core Sample

Core ID	**#2**
Dimensions and Details	The sample consists of a 1.75" diameter core with a length of 2.7" received in one intact piece.
Outer Surface	The surface is planar and cover by a very thin, gray elastomeric coating. Moderate greenish biogrowth is present on the coating.
Inner Surface	The inner face is a clean, artificial drilling break that both transects and deflects around coarse aggregate.
Core Circumference	Smooth and untextured with no differential erosion from coring. There are about four coarse aggregate particles that have adjacent paste that is slightly darker and wet looking. However, there are no obvious gel exudates.
Embedded Items	No embedded items are included in the core sample.
Visible Cracks	No macroscopic cracks are visible in hand sample.

Appendix II: Photographs and Photomicrographs

Microscopic examination is performed on an Olympus BX-51 polarized/reflected light microscope and a Bausch and Lomb Stereozoom 7 stereoscopic reflected light microscope. Both microscopes are fitted with an Olympus DP-11 digital camera. The overlays presented in the photomicrographs (e.g., text, scale bars, and arrows) are prepared as layers in Adobe Photoshop and converted to the jpeg format. Digital processing is limited to those functions normally performed during standard print photography processing. Photographs intended to be visually compared are taken under the same exposure conditions whenever possible.

The following abbreviations may be found in the figure captions and overlays and these are defined as follows:

cm	centimeters	PPL	Plane polarized light
mm	millimeters	XPL	Crossed polarized light
µm	microns (1 micron = 1/1000 millimeter)		
mil	1/1000 inch		

Microscopical images are often confusing and non-intuitive to those not accustomed to the techniques employed. The following is offered as a brief explanation of the various views encountered in order that the reader may gain a better appreciation of what is being described.

Reflected light images: These are simply magnified images of the surface as would be observed by the human eye. A variety of surface preparations may be employed including polished and fractured surfaces. The reader should note the included scale bars as minor deficiencies may seem much more significant when magnified.

Plane polarized light images (PPL): This imaging technique is most often employed in order to discern textural relationships and microstructure. To employ this technique, samples are milled (anywhere from 20 to 30 microns depending on the purpose) so as to allow light to be transmitted through the material. In many cases, Highbridge also employs a technique whereby the material is impregnated with a low viscosity, blue-dyed epoxy. Anything appearing blue therefore represents some type of void space (e.g.; air voids, capillary pores, open cracks, etc.) Hydrated cement paste typically appears a light shade of brown in this view (with a blue hue when impregnated with the epoxy). With some exceptions, most aggregate materials are very light colored if not altogether white. Some particles will appear to stand out in higher relief than others. This is a function of the refractive power of different materials with respect to the mounting epoxy.

Crossed polarized light images (XPL): This imaging technique is most often employed to distinguish components or highlight textural relationships between certain components not easily distinguished in plane polarized light. Using the same thin sections, this technique places the sample between two pieces of polarizing film in order to determine the crystal structure of the materials under consideration. Isotropic materials (e.g.; hydrated cement paste, pozzolans and other glasses, many oxides, etc.) will not transmit light under crossed polars and therefore appear black. Non-isotropic crystals (e.g.; residual cement, calcium hydroxide, calcium carbonate, and most aggregate minerals) will appear colored. The colors are a function of the thickness, crystal structure, and orientation of the mineral. Many minerals will exhibit a range of colors due to their orientation in the section. For example, quartz sand in the aggregate will appear black to white and every shade of gray in between. Color difference does not necessarily indicate a material difference. When no other prompt is given in the figure caption, the reader should appeal to general shapes and morphological characteristics when considering the components being illustrated.

Chemical treatments: Many chemical techniques (etches and stains typically) are used to isolate and enhance a variety of materials and structures. These techniques will often produce strongly colored images that distinguish components or chemical conditions.

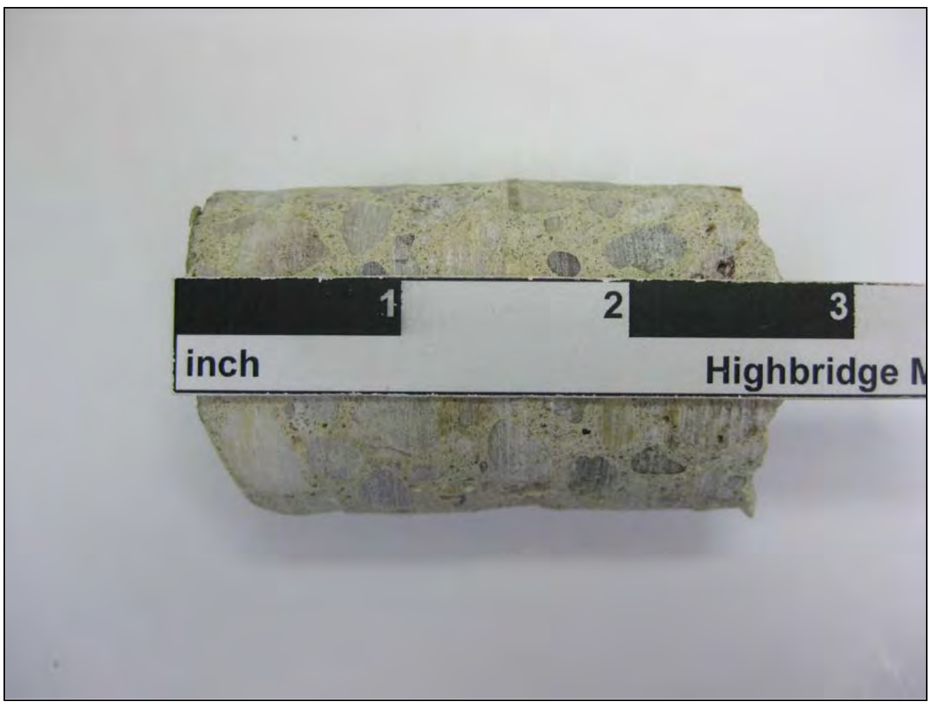
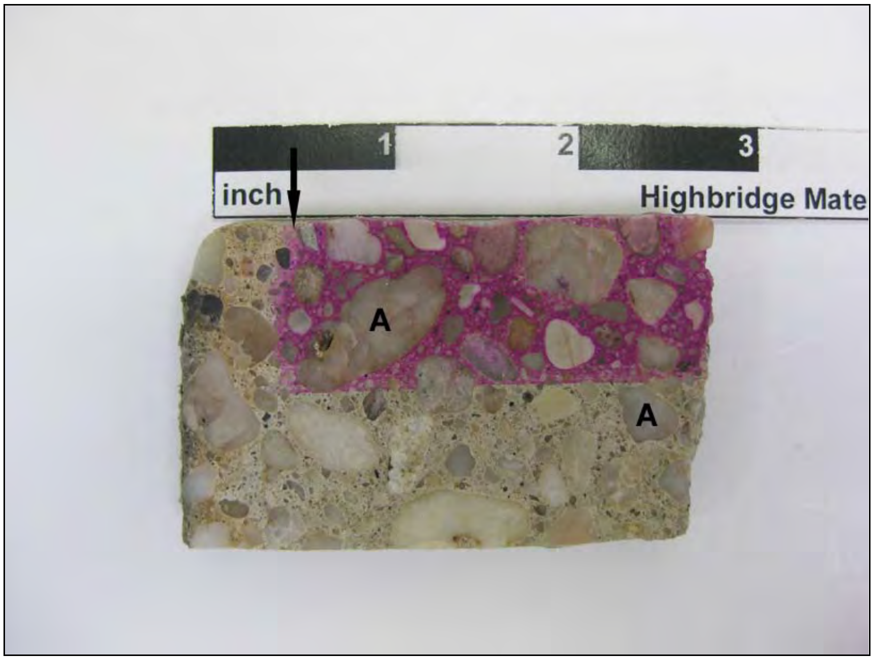


Figure 1: Photograph of Core #2. The sample is shown in side view with the outer surface oriented toward the left of the image.



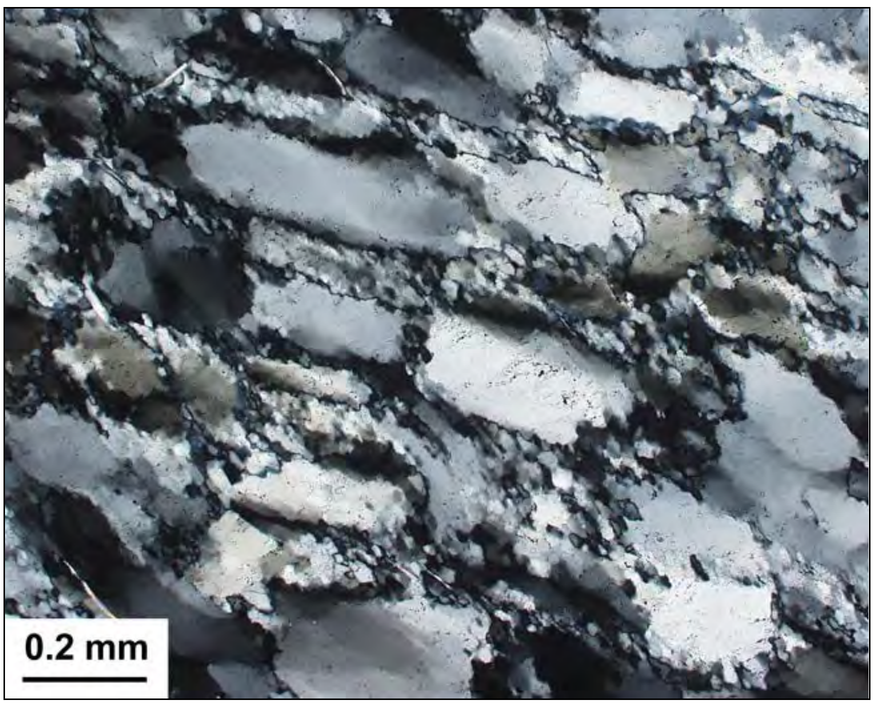
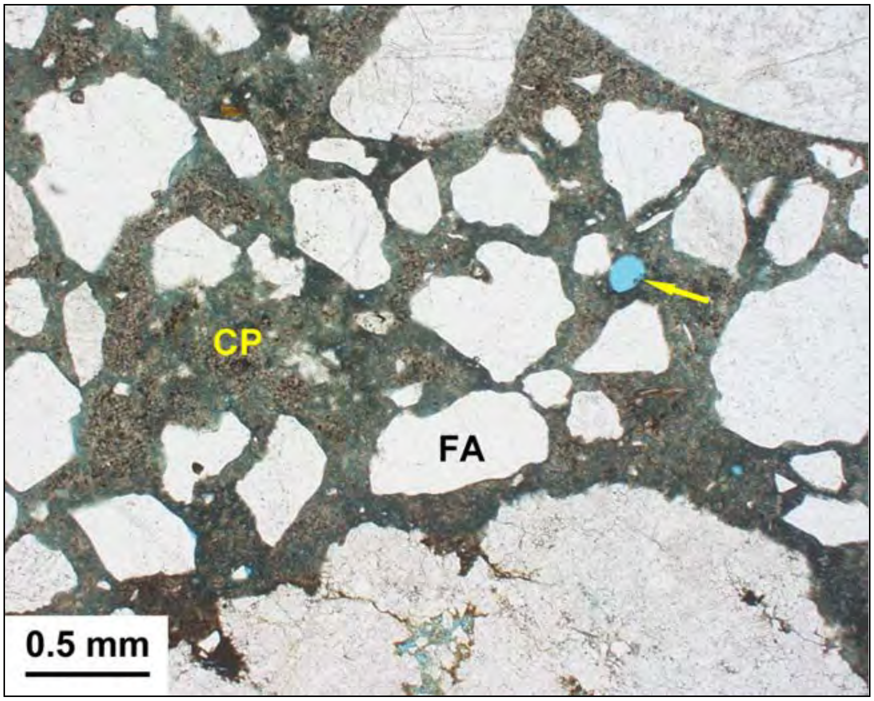


Figure 2: (Upper image) Photograph of the honed cross section of Core #2 with the outer surface oriented toward the left of the image. The natural gravel coarse aggregate (A) can be observed at this scale, though the sample is too small to accurately evaluate the size and distribution. Still, the stone appears to be sufficiently concentrated and the particle size distribution seems to be rich in the range of the 3/8" sieve. A portion of the section is treated with a pH indicator solution. The pink color indicates that a high alkalinity is maintained below about 5/8" depth. The uncolored upper horizon coincides with the carbonation profile of the concrete. The depth of carbonation is moderate. Only steel reinforcement with little concrete cover would be at risk for depassivation. (Lower image) This XPL photomicrograph illustrates a typical microtexture within the coarse aggregate. The mosaic of grays and whites represents deformed quartz crystals. The stone consists almost exclusively of strained quartzite. Rock types such as this are known to be slowly alkali-silica reactive.



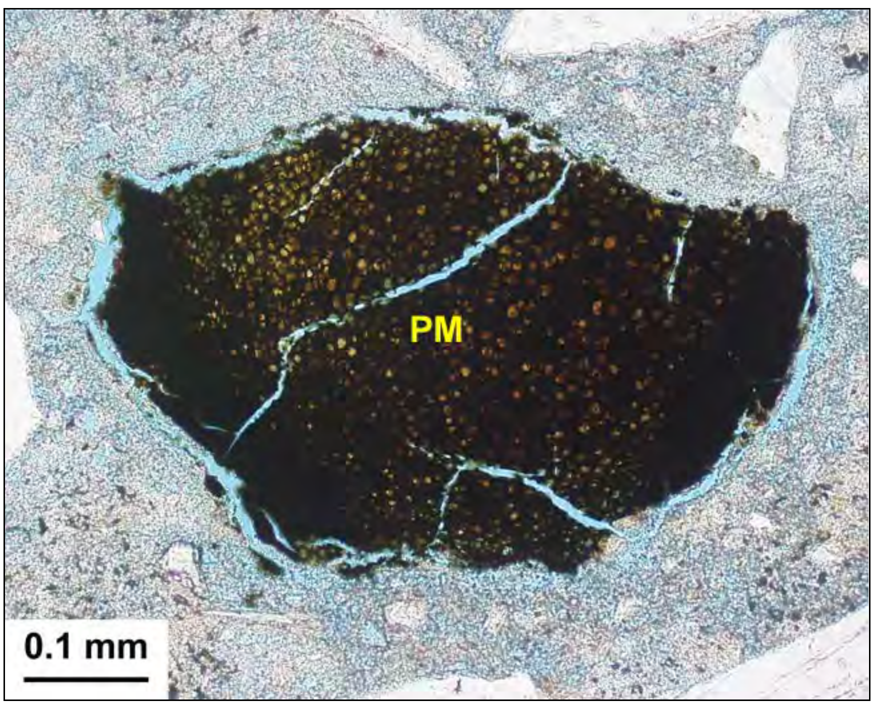


Figure 3: PPL photomicrographs of Core #2. (Upper image) The microstructure of the concrete is shown in this image. The sample is impregnated with a low-viscosity, blue-dyed epoxy in order to highlight cracks, pores, and voids. The cement paste (CP) strongly absorbs the dyed epoxy indicating a high permeability produced by a relatively high mix water content. The concrete is not considered water-resistant and this causes the material to be generally susceptible to a variety of distress mechanisms. Fine aggregate (FA) is evenly distributed throughout the matrix if a little sparse. The sand consists mostly of sharp-textured quartz grains. Air-voids are not at all abundant (arrow indicates an example). The concrete is not air-entrained and the very low content indicates a fresh concrete with moderately high slump. This is consistent with the higher water-cement ratio estimated from the hydration properties of the cement paste. (Lower image) Trace amounts of plant matter (PM) are interpreted to have been introduced with the fine aggregate. The organic contaminants are not considered excessive.

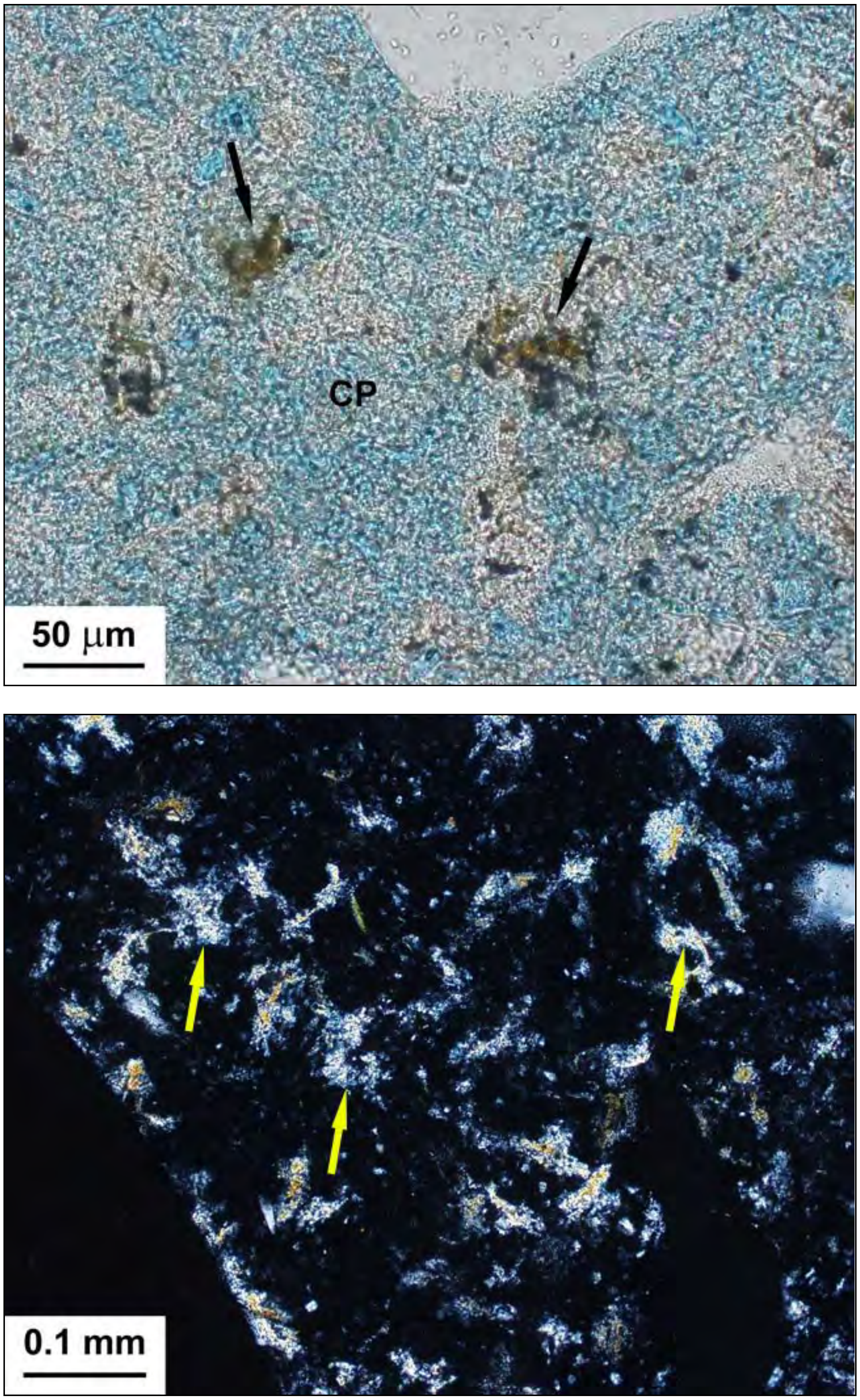


Figure 4: Photomicrographs illustrating the cement hydration characteristics in Core #2. (Upper PPL photomicrograph) The arrows indicate flakes of iron-bearing ferrite that just barely define the shapes of original calcium silicate agglomerates. These are residual portland cement grains that are extremely hydrated. The degree of hydration is consistent with a higher water content. The surrounding cement paste (CP) is uniform but rather sparse and this is also indicative of a more fluid mixture. Note the strong absorption of blue-dyed epoxy used in the sample preparation. These micropores, now filled with the epoxy, were once sites of evaporable mix water. (Lower XPL image) The arrows illustrate coarser-grained crystal masses of calcium hydroxide formed during the initial cement hydration. The abundance and non-compact morphologies are characteristic of a higher water-cement ratio.

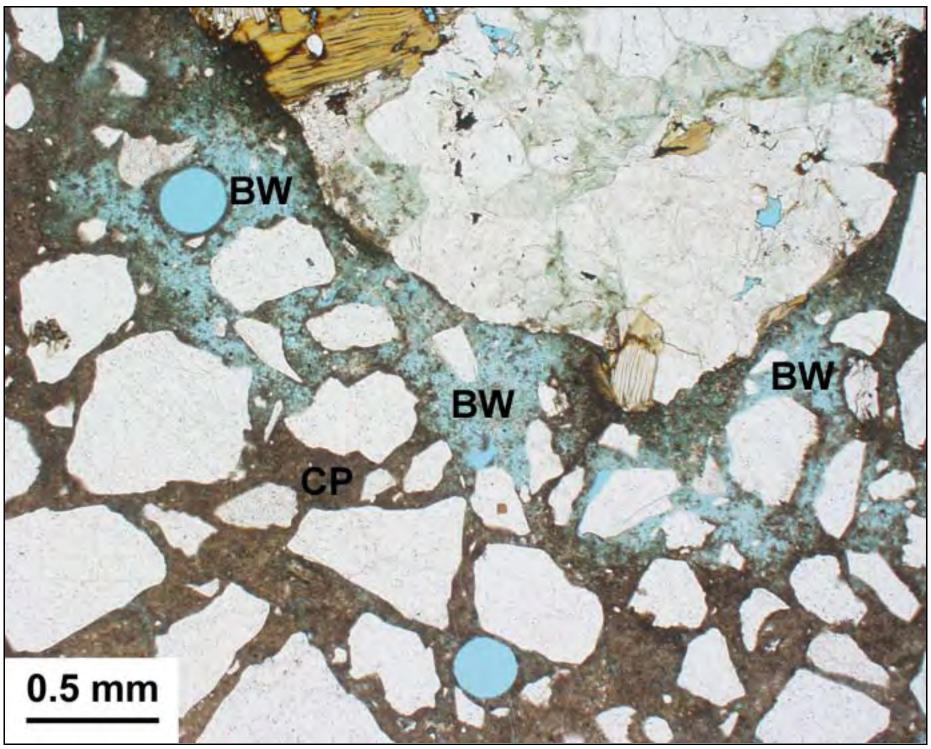
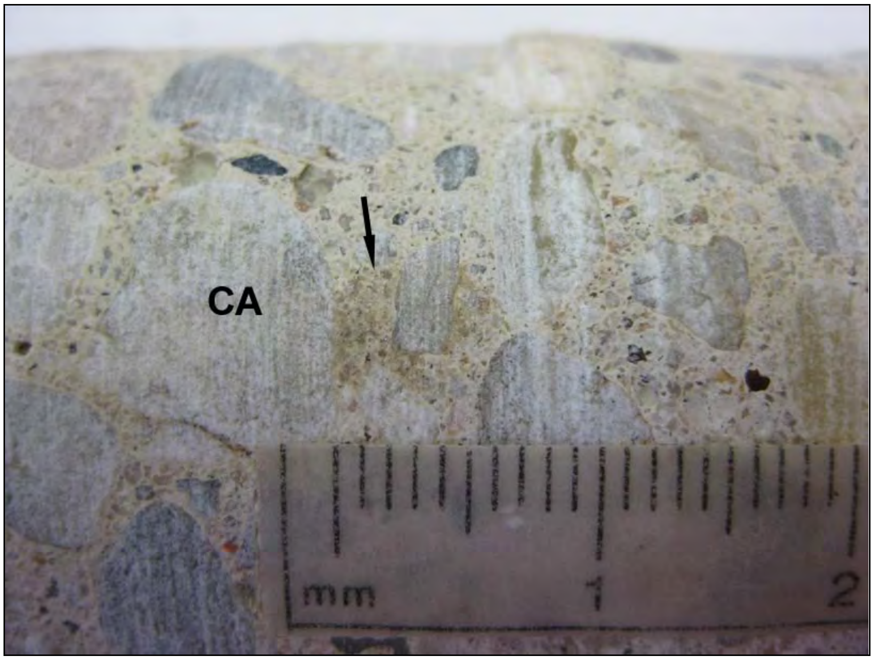


Figure 5: PPL photomicrograph of Core #2. The band of paste with increased microporosity is a bleed water channel (BW). Note the increased absorption of blue-dyed epoxy relative to the adjacent cement paste (CP). A few of these channels are noted close to the formed surface. However, there is no entrapment of bleed water as discrete voids below coarse aggregate grains. The features are considered relatively minor.



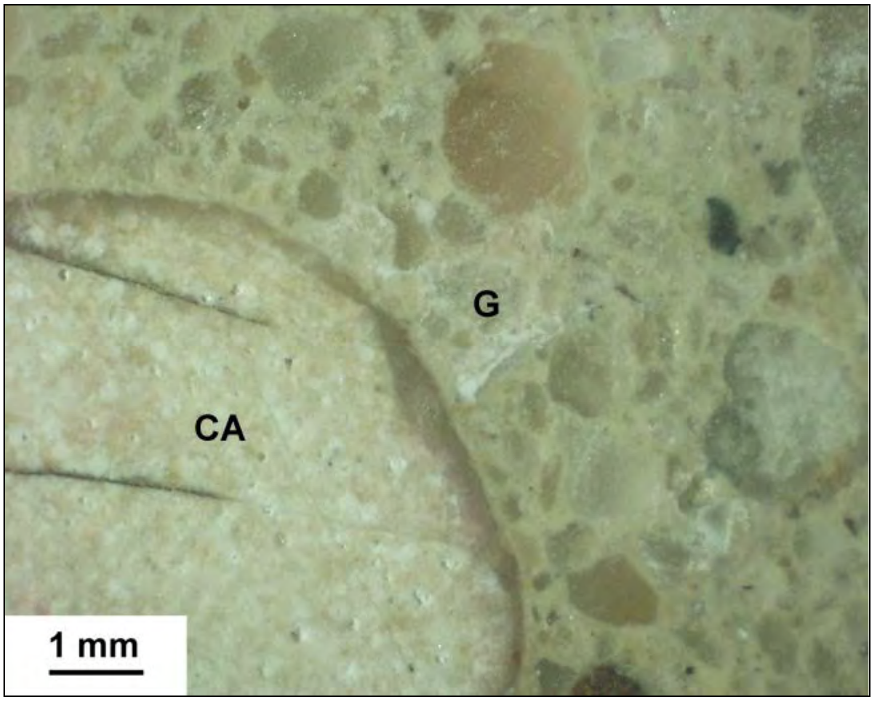


Figure 6: Despite the potential reactivity of the strained quartzite coarse aggregate, there is virtually no sign of reaction in the studied core sample. There are a few minor occurrences of gel phases that have exuded from the concrete after cutting. In the upper image, the arrow indicates a "wet patch" of translucent gel adjacent to a coarse aggregate grain (CA) along the cored surface. A reflected light photomicrograph of a sawn surface is shown in the lower image. A patch of white gel (G) is present in the mortar adjacent to a strained quartzite coarse aggregate that exhibits a darker reaction rim. These exudates show that some unexpanded gel is present in the micropores of the concrete and this likely represents innocuous reactions that have occurred very slowly over the service life of the concrete. No cracking of any kind is associated with these incipient reactions.

Appendix J
Laboratory Report:
Petrographic Examination of
Cast-in-Place Concrete Base

By Highbridge Materials Consulting, Inc.

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PETROGRAPHIC EXAMINATION REPORT

Client:	Building Conservation Associates, Inc.	**Client ID:**	BUIL002
Project:	First Presbyterian Church	**Report #:**	SL1113-03
Location:	Stamford, CT	**Date Received:**	01/19/17
Sample Type:	Concrete cores	**Report Date:**	02/16/17
Delivered by:	Client (L. Buchner)	**Petrographer:**	J. Walsh
		Page 1 of 15	

Report Summary

- Four core samples taken from various components along the exterior of the First Presbyterian Church in Stamford, CT are provided for analysis. This report presents the results of a petrographic examination on Core #3, a sample of concrete from the base below the pre-cast panels.
- The material is identified as a normal weight, portland cement concrete with no supplementary cementitious materials and no air-entrainment. The water to cement ratio (w/c) is estimated to have been moderately low and likely within the low 0.4's. This results in a relatively water-resistant concrete matrix. The coarse aggregate is a natural gravel composed mostly of strained quartzite. The type of stone is known to be susceptible to alkali-silica reaction at moderate to long time scales. The fine aggregate is a well-graded natural quartz sand.
- The only deficiency evident in the original preparation of the concrete are bugholes along the formed surface. These had been subsequently filled with cementitious repairs of variable quality.
- The concrete is a conventional mixture that may be considered suitable for many exterior applications. Freeze-thaw susceptibility due to a lack of air-entrainment may be mitigated by the moderately dense concrete matrix. The same may be said for the susceptibility to alkali-silica reactivity. Strained quartzite is known to be slowly reactive but access to moisture is required for the reaction to initiate and progress. The concrete represented by the sample is in sound condition with no evidence for significant cracking or secondary mineralizations. Of course, it is possible that alkali-silica reactions could be better developed elsewhere in the construction.

1. Introduction

On January 19, 2017, Highbridge received four core samples from Ms. Laura Buchner of Building Conservation Associates. These are reported to represent various components taken from the exterior of the First Presbyterian Church in Stamford, CT, a building constructed in 1958. It is understood from discussions with the client that the exterior includes dalle de verre panels that are themselves set in larger panels of pre-cast concrete. In turn, the pre-cast units are assembled in a structure of cast-in-place concrete. The cores represent each of these components as well as the concrete base below the decorative assembly. Ms. Buchner identifies the samples as follows:

Core #1: Concrete core removed from the cast-in-place concrete on the north elevation, between pre-cast panels 13/14.
Core #2: Concrete core removed from the pre-cast concrete panel #2 on the north elevation.
Core #3: Concrete core removed from the concrete base on the north elevation, below pre-cast panels 13/14.
Core #4: Concrete sample from a dalle de verre panel previously removed from the south elevation.

At the client's request, a petrographic examination is performed on each of the samples. For the concrete materials (Cores #1 through #3), the client has asked for an emphasis on any features related to the existence or potential for alkali-silica reaction. Additionally, the petrography is used to identify constituents, assess overall quality, and investigate the potential cause of any observed distress. At the laboratory's recommendation, the dalle de verre sample is treated as a mortar rather than a concrete and a full compositional analysis is performed on Core #4. Additional goals of this level of analysis are to characterize the types of binders present, understand their performance characteristics, and estimate component proportions where possible.

Given the differences in materials, the laboratory has chosen to issue separate, stand-alone reports for each sample. This report presents the results for Core #3 representing the concrete base below the pre-cast panels.

2. Methods of Examination

The petrographic examination is conducted in accordance with the standard practices contained in ASTM C856. Data collection is performed or supervised by a degreed geologist who by nature of his/her education is qualified to operate the analytical equipment employed. Analysis and interpretation is performed or directed by a supervising petrographer who satisfies the qualifications as specified in Section 4 of ASTM C856.

3. Standard of Care

Highbridge has performed its services in conformance with the care and skill ordinarily exercised by reputable members of the profession practicing under similar conditions at the same time. No other warranty of any kind, expressed or implied, in fact or by law, is made or intended. Interpretations and results are based strictly on samples provided and/or examined.

4. Confidentiality

This report presents the results of laboratory testing requested by the client to satisfy specific project requirements. As such, the client has the right to use this report as necessary in any commercial matters related to the referenced project. Any reproduction of this report must be done in full. In offering a more thorough analysis, it may have been necessary for Highbridge to describe proprietary laboratory methodologies or present opinions, concepts, or original research that represent the intellectual property of Highbridge Materials Consulting and its successors. These intellectual property rights are not transferred in part or in full to any other party. Presentation of any or all of the data or interpretations for purposes other than those necessary to satisfy the goals of the investigation are not permitted without the express written consent of the author. The findings may not be used for purposes outside those originally intended. Unauthorized uses include but are not limited to internet or electronic presentation for marketing purposes, presentation of findings at professional venues, or submission of scholarly articles.

5. Petrographic Findings and Discussion

5.1 - General Summary

A core sample from the concrete base along the exterior of the First Presbyterian Church is examined petrographically for this report. The material is identified as a normal weight, portland cement concrete with no supplementary cementitious materials and no air-entrainment. The water to cement ratio (w/c) is estimated to have been moderately low and likely within the low 0.4's. This results in a relatively water-resistant concrete matrix. The coarse aggregate is a natural gravel composed mostly of strained quartzite. The type of stone is known to be susceptible to alkali-silica reaction at moderate to long time scales. The fine aggregate is a well-graded natural quartz sand. The only deficiency evident in the original preparation of the concrete are bugholes along the formed surface. These had been subsequently filled with cementitious repairs of variable quality.

The concrete is a conventional mixture that may be considered suitable for many exterior applications. Freeze-thaw susceptibility due to a lack of air-entrainment may be mitigated by the moderately dense concrete matrix. The same may be said for the susceptibility to alkali-silica reactivity. Strained quartzite is known to be slowly reactive but access to moisture is required for the reaction to initiate and progress. The concrete represented by the sample is in sound condition with no evidence for significant cracking or secondary mineralizations. Of course, it is possible that alkali-silica reactions could be better developed elsewhere in the construction.

5.2 - Materials

The coarse aggregate is a siliceous natural gravel. The content is difficult to assess due to the small sample size. However, the concentration is within a normal range for conventional concrete mixes and is estimated roughly between 30-40% by hardened concrete volume. The aggregate consists mostly of strained quartzite exhibiting varying levels of geological deformation. Granite is a minor component. In petrographic thin section, one particle each of biotite schist, fine-grained graphitic metaquartzite, and amphibolite are identified. From a physical perspective, the rock types are interpreted to be hard, inelastic, and non-porous. However, the strained quartz is susceptible to alkali-silica reactivity at moderate to long time scales. This is discussed at greater length below. Coarse aggregate grains are equant to subequant in aspect ratio. Grain shapes are variable from rounded to subangular. Overall, the particle shapes are mostly appropriate for aggregate to be used in portland cement concrete. Rounded aggregates can have smoother surfaces that result in lower paste-aggregate bond strength for the same water-cement ratio. This possibility is not easily quantified through a petrographic examination. Nonetheless, this is not considered a major deficiency. The gradation cannot be quantified petrographically and the sample size is insufficient to make a reasonable estimate. The nominal top size is at least as coarse as the 3/4" sieve and particles are observed throughout the finer grain sizes. A No. 57 gradation would be the most likely profile assuming the aggregate complied with the permissible limits of ASTM C33.

The fine aggregate is a siliceous natural sand estimated at 35-40% by hardened mortar fraction. This represents a modest but appropriate sanding. The aggregate consists predominantly of quartz with minor feldspar. There is also a minor assemblage of various metamorphic minerals and rock grains most of which have a pelitic provenance. Traces include diabase and zircon. No clay coatings or friable materials are identified and the sand is considered hard, non-porous, and durable for use in cementitious mixtures. Fine aggregate grains are equidimensional and angular in shape. Fewer subangular particles are also present. Based on the qualitative petrographic observations, the particle size distribution is estimated to comply with the gradation requirements of ASTM C33. The nominal top size is estimated at the No. 8 sieve though it is difficult to distinguish coarse sand from fine stone due to the similar rock types. The particle size distribution is broad with a peak likely in the range of the No. 30 to No. 50 sieves. The fines content is moderate to moderately high but these are not considered excessive.

Ordinary portland cement is the sole binder and no supplementary cementitious materials are detected. Liquid admixtures cannot be identified petrographically though their influence on paste microstructure can often be discerned. An absence of fine air-voids suggests that no air-entraining agents were employed. The paste has a uniform microtexture suggesting a highly effective dispersal of cement particles in the paste prior to initial set. This type of texture can sometimes be an indication of the plasticizing effects of water-reducing agents. However, these associations are not at all diagnostic and cannot be used to positively identify the presence of a plasticizer. The concrete represented by the sample is estimated to have been mixed at a moderately low water to cement ratio (w/c). Though the ratio cannot be quantified petrographically, cement paste characteristics are consistent with a w/c somewhere in the low 0.4's.

The microstructural characteristics used to estimate water contents include the capillary porosity of the cementitious binder. This microporosity represents the location of evaporable mix water in the freshly placed concrete. In this case, the cementitious hydrate is densely distributed with a moderately low capillary porosity. This indicates a fresh mix that was reasonably workable without an excessive slump. Despite the lower water content, the cement hydration is advanced and very little hydraulic calcium silicate remains unhydrated. Still, residual cement grains are present in moderate concentration as fine to medium-grained agglomerates of former calcium silicate with an interstitial matrix of iron-bearing ferrite. Impressions of single alite crystals are also common. There is only a very slight increase in unhydrated cement near the outer surface of the concrete. Calcium hydroxide from the initial cement hydration can also be a useful indicator of original water content where preserved. In this case, the hydroxide is present in moderately low concentration as fine to medium-grained crystal masses within the paste and as discontinuous deposits on aggregate interfaces. The non-compact nature of the hydroxide is characteristic of mix water contents greater than approximately 0.40. However, the relatively low abundance indicates that the water content was not significantly higher than this.

5.3 - Original Placement and Hydration

The core sample is limited in size and any comments regarding the original workmanship may not have statistical significance. Still, the mortar fraction is well-blended and there are no sand streaks or cement lumps. Coarse aggregate is present at a concentration that is typical for conventional mixtures. The mix water is well incorporated into the mixture and there is no evidence for inappropriate late retempering. There is no evidence for significant bleed water migration or entrapment. The cementitious binder is well developed throughout the bulk of the sample. There is no evidence for significant differential drying of the concrete and the hydration characteristics are homogeneous throughout the examined cross section the sample. Paste-aggregate bonds are adequately developed though these represent the weakest component of the concrete. Fracturing of the concrete tends to produce cracks that deflect cleanly around the gravel aggregate particles.

The portion of concrete available for study is monolithic without any cold joints. The mixture is mostly well compacted at depth with no coarse void concentrations. The concrete was likely a lower slump mixture and the 2-3% air content is probably an indication of the relative stiffness of the mix. The voids are irregular to spherical in shape and are usually less than 3 millimeters in diameter. A few coarser centimeter-scale voids are also noted. The entrapped air-voids are not considered a significant deficiency. However, the original formed surface is irregular in shape with bugholes that extend up to several millimeters from the outer surface. At the microscopic level, the paste just beyond the bugholed surface is sometimes "clumpy" and sometimes sparse. The deficiency is strictly superficial and the concrete at depth is in good condition. Nonetheless, repairs had been made to the deficient surface at some point in the service history. Two cementitious layers are followed by an elastomeric coating. The inner cementitious layer is overwatered and has a sparse, porous cement paste. The outer layer is dense and was prepared with a low water-cement ratio.

5.4 - Features Related to Potential for Steel Corrosion

An assessment of the quality of any steel reinforcement is outside the scope of a petrographic examination. Nevertheless, several features of the concrete may influence the corrosion potential of any metal embedded within or adjacent to the placement. These may include permeability, chloride content, and depth of carbonation. It should be noted that no reinforcement is included with the sample and the author is not aware of the design specifics.

The intrinsic properties of the concrete do not especially favor corrosion. There is only a veneer of carbonation along the original concrete surface to a depth of only 1-2 millimeters. Any embedded steel would not be at risk for depassivation due to pH reductions. The concrete was mixed at an appropriate water-cement ratio for an exterior application and this has resulted in a sufficiently dense matrix that is expected to be reasonably water-resistant. This microstructure should assist in slowing the ingress of moisture, oxygen, and salts. Chloride testing was not performed for this sample so it is not known if there is a potential for corrosion due to excessive salt contents. Despite the low permeability, salts could still be elevated along the base of the building if deicing salts have been used during the service history.

Of course, a more thorough evaluation of corrosion potential must be deferred to a corrosion engineer. The statements made here are relatively crude and offered without any firsthand knowledge of the jobsite conditions or electrical properties of the concrete and any embedments.

5.5 - Condition and Durability

The concrete examined for this report represent a conventional mixture that could be considered suitable for a range of exterior applications provided these are not especially aggressive. The water-cement ratio is estimated to have been within a range generally considered acceptable for concrete exposed to cold weather service. The moderately dense cement paste is expected to resist regular saturation and the infiltration of salts and other deleterious agents. This should help to mitigate any other deficiencies in the mixture. For example, it would always be desirable to have an adequate entrained-air structure in any grade-level concrete application to protect against damage due to freeze-thaw cycling. The concrete represented by Core #3 lacks an adequate structure and should be considered at risk. However, freeze-thaw damage cannot occur unless the concrete reaches a critical level of saturation. The denser paste in this sample may have helped to reduce the number of freezing events that occurred under critically saturated conditions.

As discussed in previous reports, the client has expressed a concern over the possibility of alkali-silica reaction (ASR). Again, ASR is a reaction in which disordered or poorly crystalline forms of silica in the aggregate react with alkalis in the cement paste to form a gel that expands as it absorbs ambient moisture. The swelling of the gel is often capable of producing pervasive expansive cracking if the tensile strength of the concrete is exceeded. The majority of the aggregate in Core #3 is a strained quartzite exhibiting a range of geological deformation. This type of material has the potential for relatively slow reactivity at moderate to long time scales. The aggregate has the same type of reactive potential as the stone identified in Core #2 (Highbridge Report SL1113-02). As discussed in the previous report, cracking caused by ASR in strained quartzite gravel often results in a complete integrity loss in very old concrete. At the same time, there are many examples where the same general type of aggregate remains provisionally stable for many decades. Further, the same structure can exhibit both highly distressed and highly stable concrete due to differences in water infiltration, temperature, pre-existing cracks, alkalis, and other factors.

Core #3 exhibits no more evidence for incipient ASR than did Core #2. Petrographically, there is no positive identification of even early-stage reaction features. Exceptionally fine microcracks within the stone are all interpreted to be pre-existing geological structures. As in Core #2, there are minor gel-like exudates observed leaking from paste adjacent to strained quartzite aggregate in freshly cored or cut sections of the concrete. These are even less obvious than in Core #2 and are also found to fade with exposure. Some are virtually invisible in direct light and can only be observed as a local sheen when viewed at a very low angle. These all likely represent extremely minor reactions of the strained quartz with the alkaline cement paste to produce precursor hydrous silica gels that are not an immediate threat to the represented concrete.

As discussed in Highbridge Report SL1113-02, if these were the only occurrences of reaction in a concrete that has been in service for over fifty years, it would be safe to assume that the concrete would continue to remain stable for many years. However, it is understood that visible cracks are present in the concrete and that previous studies may have identified alkali-silica reaction. It is possible that any identified alkali-silica reaction is a secondary effect that has only occurred at locations where water has infiltrated into cracks created by other forces (e.g. reinforcement corrosion). But it is also possible for ASR to occur in localized areas. As stated in the last report, any next level of testing should seek to confirm that any visible cracking has been caused by ASR. Larger core samples that intersect visible cracks would be the most appropriate for additional petrographic examination. Those working on site may also find it helpful to look for other visible signs of ASR such as gel-like exudates or spalls that transect aggregate grains with concentric reaction rims.

Even though no evidence for reaction is apparent in this core sample, the inclusion of slowly unstable aggregate causes the examined concrete to be susceptible to such reactions. The high alkalinity of the paste and the lack of any mitigating additives such as fly ash or slag do not reduce the potential for ASR. However, the relatively water-resistant matrix may help slow the expansion of any gels that may have formed elsewhere in the construction by restricting the amount of water permitted to access the gels. As discussed in Highbridge Report SL1113-02, measurement of residual alkali contents might be helpful in assessing the possibility of future expansion if ASR is ultimately detected elsewhere in the concrete. Residual expansion tests might also be helpful though significantly longer to execute.

Respectfully submitted,

John J. Walsh
President/ Senior Petrographer
Highbridge Materials Consulting, Inc.

Appendix I: Visual Description of Core Sample

Core ID	**#3**
Dimensions and Details	The sample consists of a 1.75" diameter core with a length of 2.9" received in one intact piece.
Outer Surface	The surface is planar and cover by a very thin, gray elastomeric coating. Dark greenish biogrowth is present on the coating.
Inner Surface	The inner face is a clean, artificial drilling break that transects the four or five coarse aggregate grains observed along the base.
Core Circumference	Smooth and untextured with no differential erosion from coring. There are a few coarse aggregate particles that have adjacent paste that is slightly darker and wet looking. However, there are no obvious gel exudates.
Embedded Items	No embedded items are included in the core sample.
Visible Cracks	No macroscopic cracks are visible in hand sample.

Appendix II: Photographs and Photomicrographs

Microscopic examination is performed on an Olympus BX-51 polarized/reflected light microscope and a Bausch and Lomb Stereozoom 7 stereoscopic reflected light microscope. Both microscopes are fitted with an Olympus DP-11 digital camera. The overlays presented in the photomicrographs (e.g., text, scale bars, and arrows) are prepared as layers in Adobe Photoshop and converted to the jpeg format. Digital processing is limited to those functions normally performed during standard print photography processing. Photographs intended to be visually compared are taken under the same exposure conditions whenever possible.

The following abbreviations may be found in the figure captions and overlays and these are defined as follows:

cm	centimeters	PPL	Plane polarized light
mm	millimeters	XPL	Crossed polarized light
µm	microns (1 micron = 1/1000 millimeter)		
mil	1/1000 inch		

Microscopical images are often confusing and non-intuitive to those not accustomed to the techniques employed. The following is offered as a brief explanation of the various views encountered in order that the reader may gain a better appreciation of what is being described.

Reflected light images: These are simply magnified images of the surface as would be observed by the human eye. A variety of surface preparations may be employed including polished and fractured surfaces. The reader should note the included scale bars as minor deficiencies may seem much more significant when magnified.

Plane polarized light images (PPL): This imaging technique is most often employed in order to discern textural relationships and microstructure. To employ this technique, samples are milled (anywhere from 20 to 30 microns depending on the purpose) so as to allow light to be transmitted through the material. In many cases, Highbridge also employs a technique whereby the material is impregnated with a low viscosity, blue-dyed epoxy. Anything appearing blue therefore represents some type of void space (e.g.; air voids, capillary pores, open cracks, etc.) Hydrated cement paste typically appears a light shade of brown in this view (with a blue hue when impregnated with the epoxy). With some exceptions, most aggregate materials are very light colored if not altogether white. Some particles will appear to stand out in higher relief than others. This is a function of the refractive power of different materials with respect to the mounting epoxy.

Crossed polarized light images (XPL): This imaging technique is most often employed to distinguish components or highlight textural relationships between certain components not easily distinguished in plane polarized light. Using the same thin sections, this technique places the sample between two pieces of polarizing film in order to determine the crystal structure of the materials under consideration. Isotropic materials (e.g.; hydrated cement paste, pozzolans and other glasses, many oxides, etc.) will not transmit light under crossed polars and therefore appear black. Non-isotropic crystals (e.g.; residual cement, calcium hydroxide, calcium carbonate, and most aggregate minerals) will appear colored. The colors are a function of the thickness, crystal structure, and orientation of the mineral. Many minerals will exhibit a range of colors due to their orientation in the section. For example, quartz sand in the aggregate will appear black to white and every shade of gray in between. Color difference does not necessarily indicate a material difference. When no other prompt is given in the figure caption, the reader should appeal to general shapes and morphological characteristics when considering the components being illustrated.

Chemical treatments: Many chemical techniques (etches and stains typically) are used to isolate and enhance a variety of materials and structures. These techniques will often produce strongly colored images that distinguish components or chemical conditions.

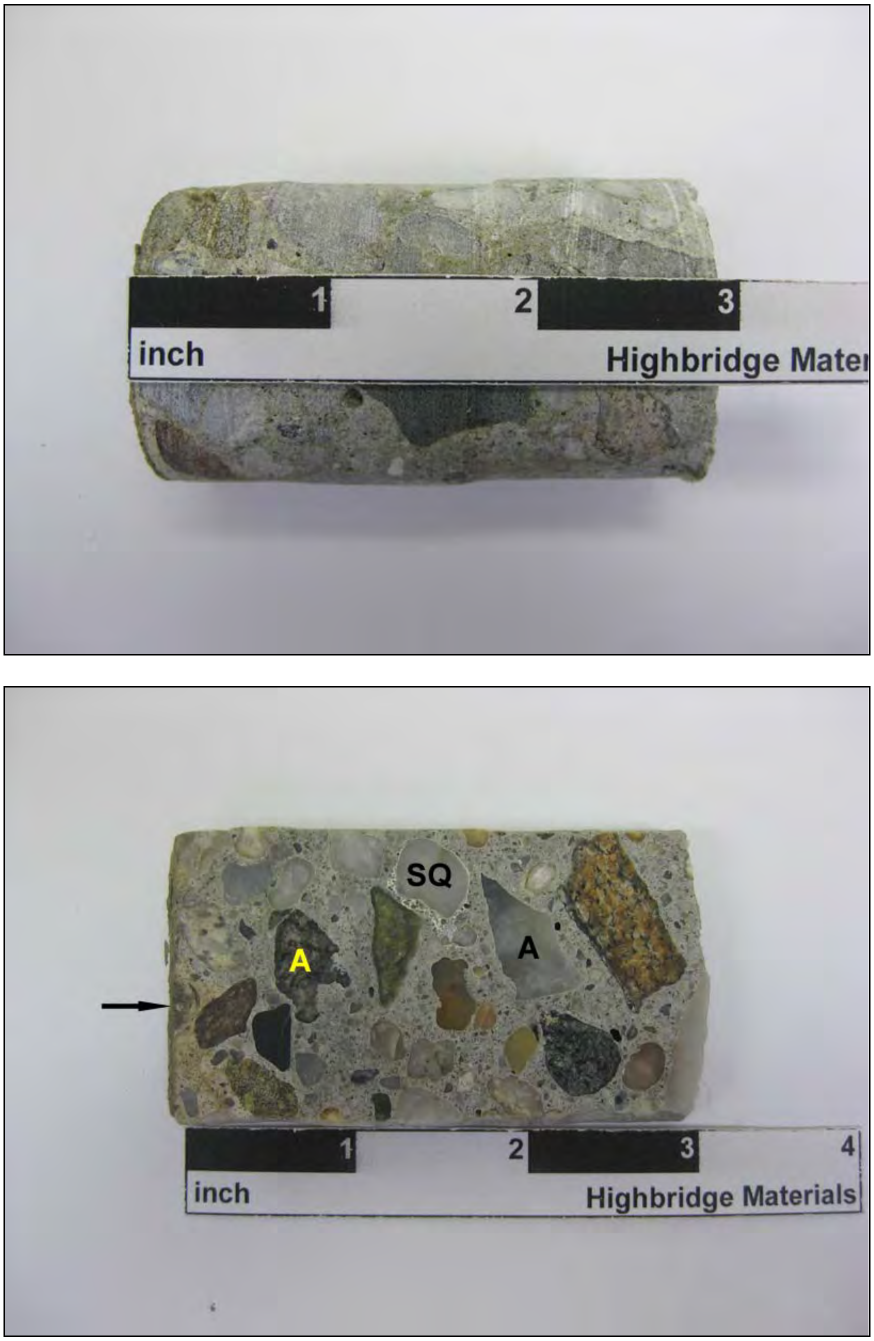
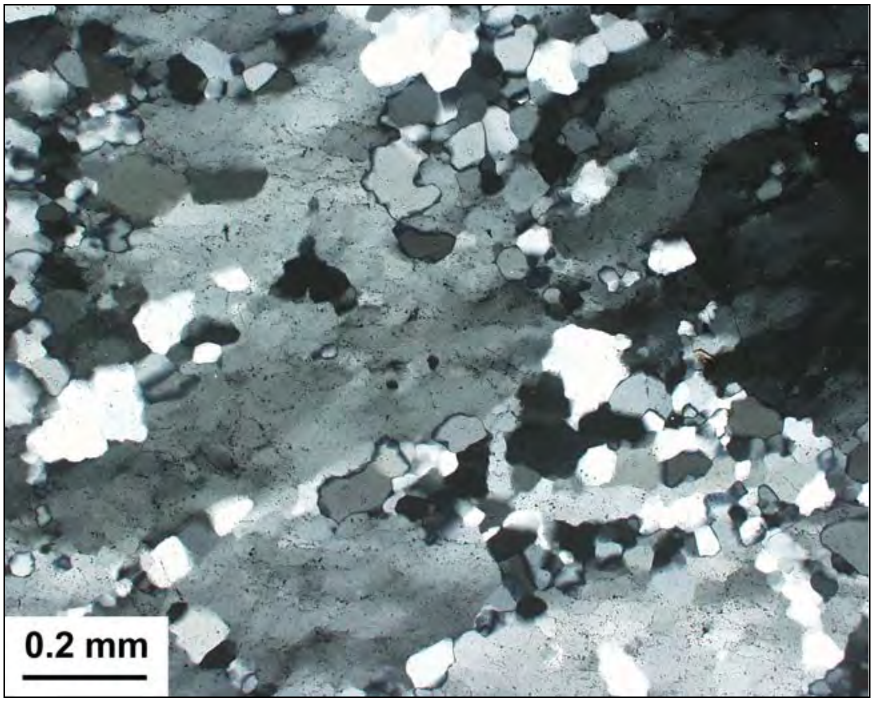


Figure 1: (Upper image) Photograph of Core #3. The sample is shown in side view with the outer surface oriented toward the left of the image. (Lower image) Photograph of the honed cross section of Core #32 with the outer surface oriented toward the left of the image. The natural gravel coarse aggregate (A) can be observed at this scale, though the sample is too small to accurately evaluate the size and distribution. Note that the stone exhibits different colors and grain shapes due to a more variable composition. The nominal top size in this case is at least as coarse as the 3/4" sieve. The particle size distribution is possibly consistent with a No. 57 stone. Note that one of the strained quartzite grains (SQ) is lined with a white gel deposit. The mortar has clearly absorbed some minor reaction gel from a very early stage ASR reaction in the coarse aggregate. No cracking is found in association and the reaction is considered innocuous. The arrow indicates a cross section through a small bughole that intersects the formed face. As shown in Figure 5, the forming defects have since been filled with a number of cementitious repairs.



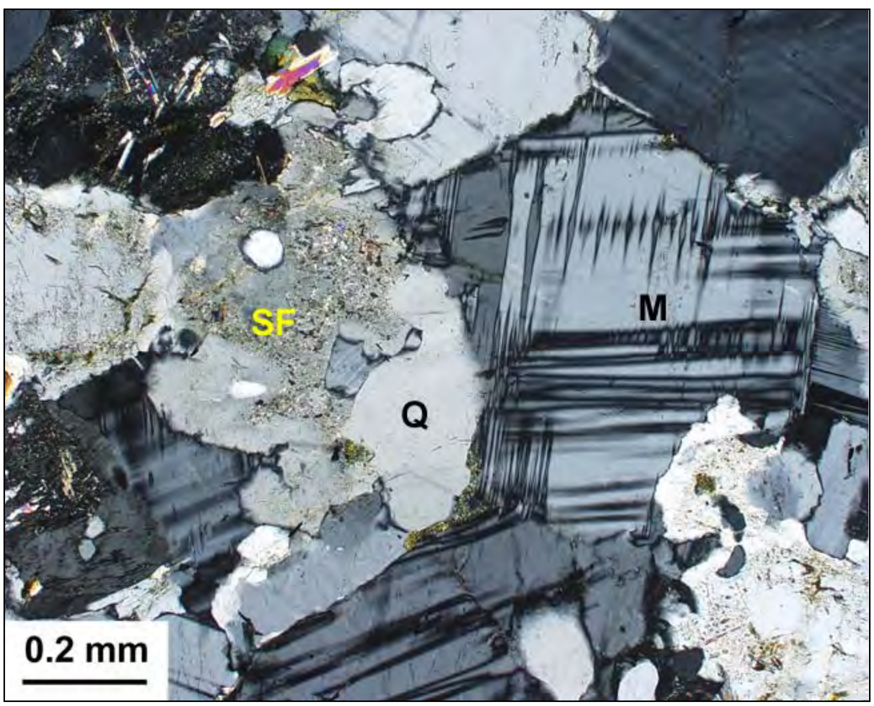


Figure 2: XPL photomicrographs illustrating some more common grain types in the coarse aggregate. (Upper image) The mosaic of grays and whites represents deformed quartz crystals in a strained quartzite. This type of rock comprises the largest percentage of the gravel and is known to be slowly alkali-silica reactive. (Lower image) Granite is a minor constituent. The grain shown here includes microcline (M), sodic feldspar (SF), and quartz (Q) along with several minor accessory minerals.

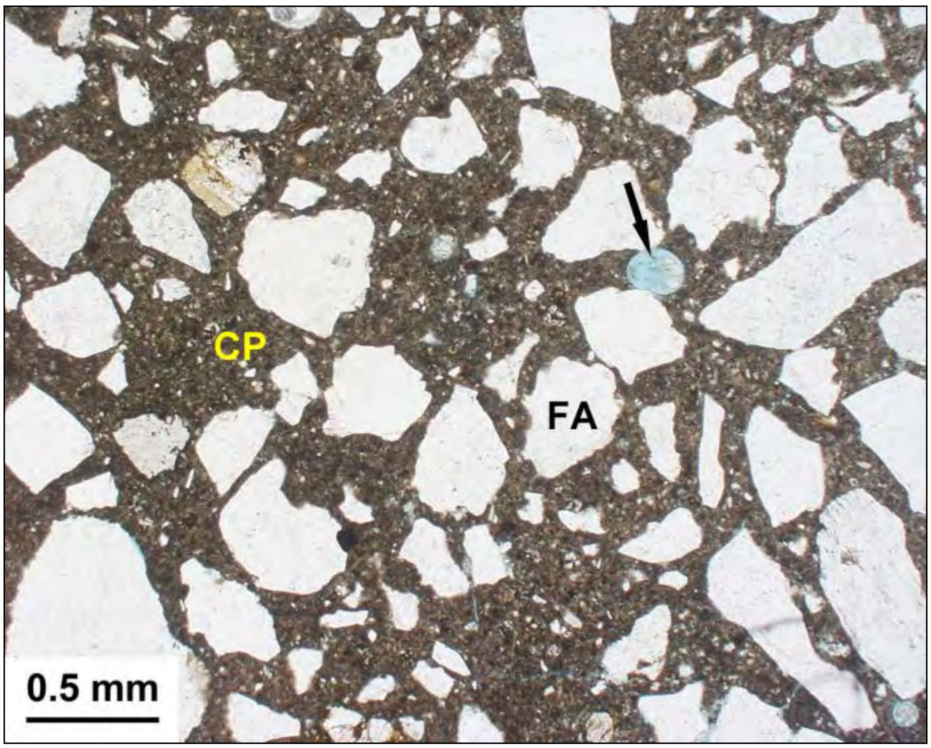
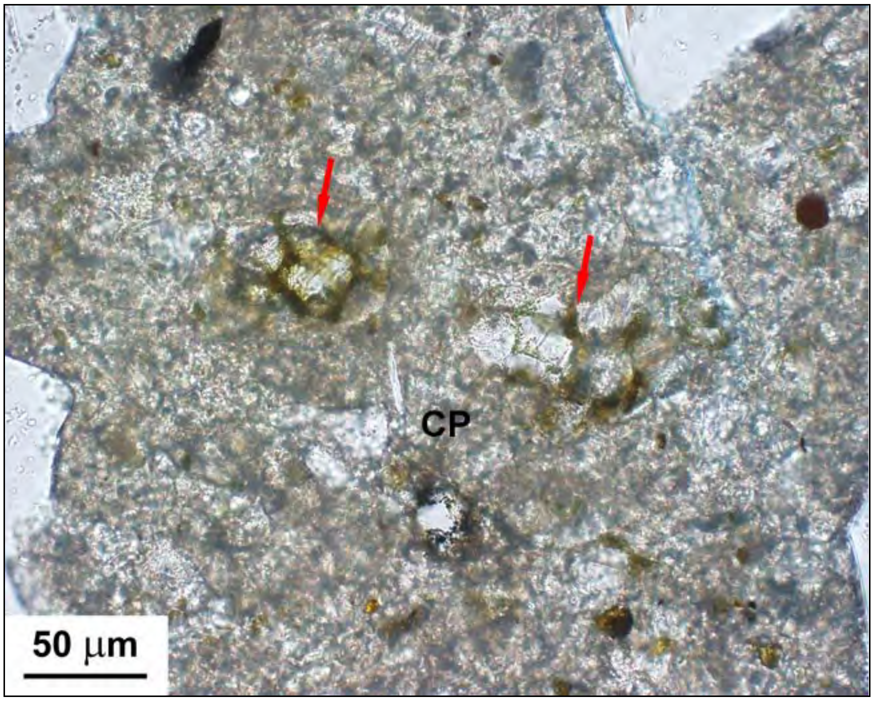


Figure 3: PPL photomicrograph illustrating the microstructure of the concrete in Core #3. The sample is impregnated with a low-viscosity, blue-dyed epoxy in order to highlight cracks, pores, and voids. The cement paste (CP) absorbs very little of the dyed epoxy. This shows that the matrix has a rather low permeability and is expected to be reasonably water-resistant and generally durable. The lower microporosity is the result of a moderately low water-cement ratio when originally mixed. Fine aggregate (FA) is evenly distributed throughout the matrix if a little sparse. The sand consists mostly of sharp-textured quartz grains. The arrow indicates a fine air-void. This particular region is not an especially good representation of the air content throughout the core. In many areas, air contents are as high as 3% by volume even though there is no entrained-air structure. The "bubbly" quality is indicative of a lower slump when fresh. Nevertheless, the concrete is well compacted without any segregations.



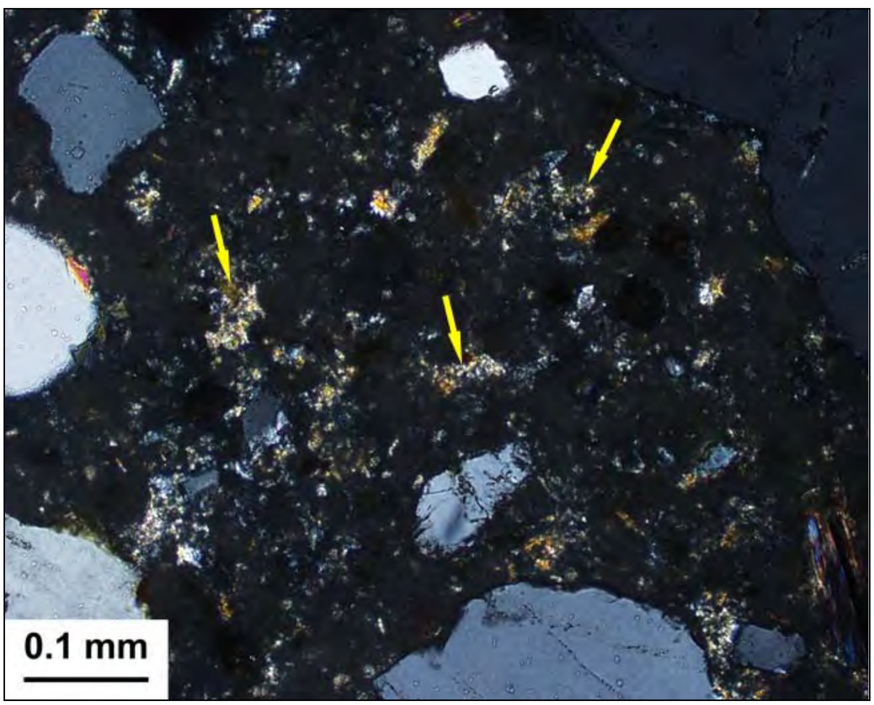


Figure 4: Photomicrographs illustrating the cement hydration characteristics in Core #3. (Upper PPL photomicrograph) Residual portland cement grains (arrows) occur as fine agglomerates of former calcium silicate defined by a skeleton of brown-colored ferrite. Much of the hydraulic calcium silicate once residing between these iron-bearing ferrite crystals is now fully consumed due to hydration. Still, the hydrated cement grains are present in moderate concentration. The adjacent cement paste (CP) is well-formed and has a moderately low capillary porosity as indicated by the very minimal absorption of blue-dyed epoxy used in the sample preparation. These features are indicative of a moderately low mix water content. (Lower XPL photomicrograph) The arrows illustrate finer-grained crystal masses of calcium hydroxide formed during the initial cement hydration. The non-compact morphologies are characteristic of water-cement ratios greater than approximately 0.40. However, the relatively low abundance suggests that the ratio was not much higher than this.

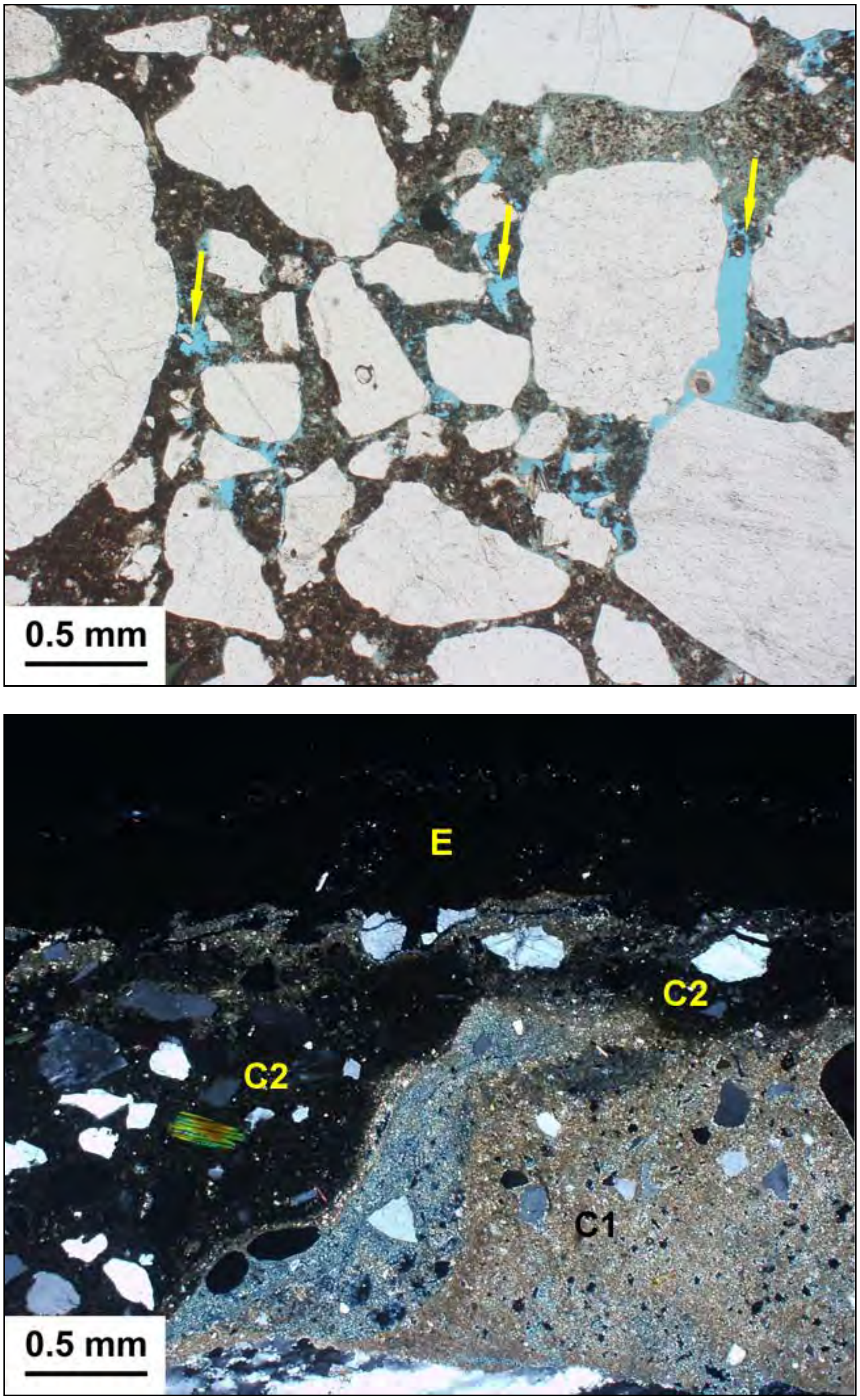


Figure 5: Photomicrographs illustrating the quality of the formed surface in Core #3. (Upper PPL image) The arrows indicate irregularly-shaped air-voids associated with some bugholing near the surface. (Lower XPL image) The bugholes are filled with several materials. An earlier cementitious coating (C1) is porous and fully carbonated. The carbonation is shown by the golden color under crossed polars. An overlying cementitious layer (C2) is much denser due to a lower mix water content. Both mixtures include a fine quartz sand. An elastomeric coating (E) overlies all secondary repairs.

Figure 6: The side of the core sample is shown before further preparation. A few small exudates of gel (G) were observed along the surface when the sample was received. As in Core #2 (Highbridge Report SL1113-02), these exudates show that some unexpanded gel is present in the micropores of the concrete and this likely represents innocuous reactions that have occurred very slowly over the service life of the concrete. No cracking of any kind is associated with these incipient reactions.

Appendix K
Laboratory Report:
Petrographic Examination of
Concrete Dalle de Verre Panel

By Highbridge Materials Consulting, Inc.

HIGHBRIDGE MATERIALS CONSULTING, INC.

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MATERIAL ANALYSIS REPORT (DALLE DE VERRE)

Client:	Building Conservation Associates, Inc.	**Client ID:**	BUIL002
Project:	First Presbyterian Church	**Report #:**	SL1113-01
Location:	Stamford, CT	**Date Received:**	01/19/17
Sample Type:	Concrete cores	**Report Date:**	02/16/17
Delivered by:	Client (L. Buchner)	**Petrographer:**	J. Walsh
		Chemist:	H. Hartshorn
		Analyst:	S. Sauer
		Page 1 of 20	

Report Summary

- Four core samples taken from various components along the exterior of the First Presbyterian Church in Stamford, CT are provided for analysis. This report presents the results of a compositional analysis on Core #4, a sample of a dalle de verre panel.
- The material is identified as a coarse-grained, cementitious mortar employing a calcium aluminate cement as the binder. The aggregate contains pebbles and coarse sand consisting of angular chert, quartz grains that are more rounded in the finer fraction, and soft-textured limestone grains throughout the full gradation. The aluminate-based binder is likely a Ciment Fondu produced in France. The binder to sand ratio is roughly estimated at 1 : 1.7 by volume.
- The mortar is well mixed and thoroughly compacted. The total air content is less than 1% by volume.
- The hydrated paste is particulate, highly porous, and not especially hard. The properties could suggest that the mix was prepared at a water-cement ratio higher than about 0.40. As curing progresses, aluminate mortars with originally higher mix water contents are expected to experience a greater increase in porosity and a greater reduction in strength due to the normal conversion reaction that occurs in these cements.
- It is possible that differences in the degree of conversion could explain the performance of the dalle de verre on site. Differences in conversion could result in differences in volume stability. They could also simply result in differences in permeability and durability. One place where this could cause increased cracking would be where the lower quality cement paste allowed for corrosion of the embedded steel wire reinforcement. A moderate amount of corrosion product is noted in the sample provided for study. Of course, no correlations can be drawn from the one sample and a larger study would be needed to make these associations.

1. Introduction

On January 19, 2017, Highbridge received four core samples from Ms. Laura Buchner of Building Conservation Associates. These are reported to represent various components taken from the exterior of the First Presbyterian Church in Stamford, CT, a building constructed in 1958. It is understood from discussions with the client that the exterior includes dalle de verre panels that are themselves set in larger panels of pre-cast concrete. In turn, the pre-cast units are assembled in a structure of cast-in-place concrete. The cores represent each of these components as well as the concrete base below the decorative assembly. Ms. Buchner identifies the samples as follows:

Core #1: Concrete core removed from the cast-in-place concrete on the north elevation, between pre-cast panels 13/14.
Core #2: Concrete core removed from the pre-cast concrete panel #2 on the north elevation.
Core #3: Concrete core removed from the concrete base on the north elevation, below pre-cast panels 13/14.
Core #4: Concrete sample from a dalle de verre panel previously removed from the south elevation.

At the client's request, a petrographic examination is performed on each of the samples. For the concrete materials (Cores #1 through #3), the client has asked for an emphasis on any features related to the existence or potential for alkali-silica reaction. Additionally, the petrography is used to identify constituents, assess overall quality, and investigate the potential cause of any observed distress. At the laboratory's recommendation, the dalle de verre sample is treated as a mortar rather than a concrete and a full compositional analysis is performed on Core #4. Additional goals of this level of analysis are to characterize the types of binders present, understand their performance characteristics, and estimate component proportions where possible.

Given the differences in materials, the laboratory has chosen to issue separate, stand-alone reports for each sample. This report presents the results for Core #4 representing the dalle de verre panel.

2. Methods of Examination

The petrographic examination is conducted in accordance with the standard practices contained within ASTM C1324. Data collection is performed or supervised by a degreed geologist who by nature of his/her education is qualified to operate the analytical equipment employed. Analysis and interpretation is performed or directed by a supervising petrographer who satisfies the qualifications as specified in Section 4 of ASTM C856.

Though not part of the original scope, a point-count analysis was used to supplement the petrographic examination with quantitative data regarding component volumes. The point-count analysis is a micrometric method adapted from methods contained in ASTM C457.

Chemical analysis is conducted according to the procedures outlined in ASTM C1324. Water, carbon dioxide and aggregate weight percentages are determined gravimetrically. Oxide weight percentages are determined by inductively coupled plasma optical emission spectroscopy.

3. Standard of Care

Highbridge has performed its services in conformance with the care and skill ordinarily exercised by reputable members of the profession practicing under similar conditions at the same time. Interpretations and results are based strictly on samples provided and/or examined.

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5. Petrographic Findings and Discussion

5.1 - General Summary

A core sample from a dalle de verre panel removed from the façade of the First Presbyterian Church is examined for this report. The material is identified as a coarse-grained, cementitious mortar employing a calcium aluminate cement as the binder. The aggregate contains pebbles and coarse sand consisting of angular chert, quartz grains that are more rounded in the finer fraction, and soft-textured limestone grains throughout the full gradation. The aluminate-based binder is likely a Ciment Fondu produced in France. The binder to sand ratio is roughly estimated at 1 : 1.7 by volume. The mortar is well mixed and thoroughly compacted. The total air content is less than 1% by volume.

The hydrated paste is particulate, highly porous, and not especially hard. The properties could suggest that the mix was prepared at a water-cement ratio higher than about 0.40. As curing progresses, aluminate mortars with originally higher mix water contents are expected to experience a greater increase in porosity and a greater reduction in strength due to the normal conversion reaction that occurs in these cements. It is possible that differences in the degree of conversion could explain the performance of the dalle de verre on site. Differences in conversion could result in differences in volume stability. They could also simply result in differences in permeability and durability. One place where this could cause increased cracking would be where the lower quality cement paste allowed for corrosion of the embedded steel wire reinforcement. A moderate amount of corrosion product is noted in the sample provided for study. Of course, no correlations can be drawn from the one sample and a larger study would be needed to make these associations.

5.2 - Materials (Aggregate)

The aggregate consists of three grain types including crushed chert, natural quartz sand, and limestone sand. Though all three materials can be part of the same rock, the grain types are not normally found together in a single sand deposit in the range of sizes and shapes present in this sample. It is probable that the chert is a separate addition and it is possible the quartz and limestone are also individual constituents. A micrometric point-count analysis was performed on the petrographic thin section to quantify the volume proportions of each grain type (see Section 7 below). Based on this analysis, the chert, quartz, and limestone are present at 51%, 34% and 15% respectively. Weight ratios are probably slightly different due to differences in density between the various materials. However, the differences would be relatively minor.

The chert is mostly uniform in texture and many of the grains are iron-rich. The quartz contains a mixture of monocrystalline grains, polycrystalline grains, and strained quartzite. A single grain of sandy ironstone was counted along with the quartz-based sand. The limestone consists mostly of micritic particles. Micrite is an ultrafine-grained carbonate "mud" that is essentially the same type of material comprising lithographic limestone. Fewer of the carbonate grains consist of bioclasts and bioclastic limestone. No clay coatings or friable materials are identified and the sand is considered hard, non-porous, and durable for use in this particular cementitious product. Chert is considered to be one of the more aggressively reactive rock types when employed in portland cement-based mixtures. However, this reactivity is obviated by the use of an aluminate-based casting cement.

The grain shapes are highly variable due to the different rock types present in the mix. The cherts are mostly angular to subangular in shape. The quartz is subrounded on average and the limestone is mostly rounded to subrounded. Sand particles are mostly equidimensional in the finer grain sizes. Some of the coarser chert grains are sharper and more shard-like. An aggregate sample was extracted through acid digestion and the gradation profile measured for this material is presented in Section 6. It was not possible to recover all of the material since the limestone comprising 15% of the aggregate is highly acid-soluble. As such, the limestone grains were lost in the process and are not included in the calculated gradation profile. Though this is a modest error, the recovered sand is considered a reasonable representation of the materials used in the mixture. The aggregate has a bimodal particle size distribution. The chert dominates the coarser portion of the gradation having a nominal top size at the No. 4 sieve and almost all retained above the No. 30 mesh. The coarser of the two gradation peaks lies between the No. 4 and No. 8 sieves and includes the chert aggregate. The quartz sand dominates the finer portion of the gradation with a strong peak abundance between the No. 30 and No. 50 sieves. A few strained quartzite grains are found above the No. 16 mesh and very little of the sand passes the No. 100 sieve. Though the limestone is not included in the recovered gradation, petrographic observations indicate that it is distributed broadly throughout the range of the chert and quartz sands combined.

The visual appearance of the extracted aggregate also reflects these differences. The sand has a variegated character. The coarser chert portion is opaque with a somewhat waxy luster. Most of the chert is found in rich shades of rusty orange and orange-brown due to the iron-rich composition. Grayish grains are included in lesser proportion. The fine quartz fraction is much more uniform with a semi-translucent luster. The average color is a light brownish gray (Munsell code approximately 2.5Y 7/1.25). Though the sand has a distinctive appearance, it has almost no influence on the appearance of the mortar in the submitted core sample. The binder has a rich brown color that effectively masks the aggregate. The outer face is coated with a cementitious skim coat and it is not known if there would have been some visible aggregate exposure below this apparently later coating application.

5.3 - Materials (Binder)

The binder is identified as a calcium aluminate cement. Of the various types that could have been available in the 1950's, the approximate chemistry and the darker color of the cured binder suggests a Ciment Fondu, a cement originating in France that was often used for castings and refractory purposes in the later part of the twentieth century. Several high-profile failures in the 1970's caused the material to fall out of favor for structural concrete applications.

The hydrated binder is homogeneously developed throughout the depth of the sample. There is a slight darkening of the paste at the inner surface of the dalle de verre though this is not accompanied by any significant microstructural differences. It is suspected that this may have been caused by a small amount of mix water absorption into the formwork during casting. Petrographically, the binder has a highly particulate texture with a sparse hydrate and a relatively high microporosity distributed throughout the closely packed cement particles. This pore structure is interpreted to have been the result of secondary conversion. This is a process that occurs in aluminate cements where metastable hydrates of calcium aluminate convert to a stable and more compact cubic form as curing progresses. The author has not observed a sufficient quantity of Ciment Fondu mortars and does not appreciable experience judging original mix water contents for this type of binder. However, the high porosity makes it clear that conversion has resulted in a high degree of alteration and this is expected to be observed in aluminate-based mortars mixed at higher than desirable water-cement ratios (i.e. greater than 0.40). Conversion is typically less dramatic and results in a much lower secondary porosity when mix water contents are maintained below this value.

Residual cement grains are present in very high concentration throughout the binder. These are relatively coarse-grained with sizes up to and just retained on the No. 100 sieve. All are very angular and sharp-textured. Several general categories of cement texture are identified petrographically. Many exhibit complex intergrowth patterns of unhydrated ferrite phase interlayered with empty impressions of former calcium aluminate (CA) that has fully hydrated. Other hydrated aluminates may also have been present in these empty impressions. The intergrowths sometimes exhibit a "cross-hatch" texture and other times a "weave" texture. It may be that these represent different orientations of the same grain type. A very low percentage of these grains have intergrowths intersecting at an acute angle and these contain pleochroite between the ferrite crystals. Pleochroite is a distinctive phase that displays a strong blue-colored pleochroism. Though not abundant, it is a diagnostic phase of many aluminate cements. Other common particle types include wholly non-crystalline glasses that display various levels of consumption. Sometimes these contain a core of greenish-brown glass with a reaction rim that is orange-colored and isotropic. In some cases, the rims exhibit concentric growth rings. In other cases, no glass remains at all and only the reaction phase is present. There are also orange-colored grains that some contain a "feathery" texture with or without faint pleochroism. It is not clear if these are necessarily related to the glass.

The various aluminate-ferrite intergrowths are fully characteristic of Ciment Fondu and aluminate cements in general. The glasses are not completely unexpected. However, Ciment Fondu is reported to contain only a small proportion of glass (Taylor, 1997) and the amount detected in this sample appears greater than what could reasonably be called a small proportion. Technically, it is possible that the binder is actually a mixture of Ciment Fondu and a ground blast furnace slag. However, the color of the glass and its reaction product are unlike those of any slags typically used as pozzolans. In fact, the various binder grains are so consistent in color and grind that it seems much more likely that only the one cement product is present. For the remainder of this report, only a single binder is interpreted and the possibility of a slag additive is dismissed. It is possible that this particular product is a bit different compositionally than products that are more well-known. The author is not aware of the number of manufacturers of this product during the 1950's (other than Lafarge) and whether any variability in composition should be expected. It may be that some varieties were glassier than others.

The aluminate identification is also evident in the chemical composition of the binder. A portion of the binder was decomposed and its major element chemistry estimated as presented in Table 5.3a. Unfortunately, the combination of materials made it impossible to measure the chemistry accurately. All of the limestone aggregate would have dissolved during the mortar digestion. The consequent release of calcium would have artificially elevated the amount of CaO measured for the binder. Similarly, some of the chert would be expected to leach during the alkaline digestion and this would artificially elevate the SiO_2. It was also found that the binder could not be fully decomposed without a much more aggressive digestion which would have further incorporated elements from the aggregate. It is not known whether the undigested binder contains the same proportion of elements as the dissolved material, or if there was a preferential decomposition of some elements over others. All of these factors reduce the accuracy of the chemical estimate.

Despite the chemical interferences, there are several features of the measured chemistry that more or less confirm the Ciment Fondu interpretation. First is the high Al_2O_3 content at over 25% by weight. Admittedly, Ciment Fondu should have about 40% alumina. However, the 25% value is significantly higher than the several percent usually present in cements and limes. It is assumed that alumina is the most refractory of the measured elements and this would explain its underrepresentation in the soluble chemistry. Admittedly, a separate slag addition would dilute the alumina content and this could easily explain a lower Al_2O_3 measurement. But again, a separate slag addition appears to be discounted by the petrographic observations. Assuming that the alumina is underrepresented due to incomplete digestion, this still allows other types of high alumina cements with Al_2O_3 contents as high as 80%. However, many of these cements are white in color. Furthermore, these typically do not contain iron oxides at greater than about 4%. The total measured iron content is about 14% for the dalle de verre sample. Finally, a titanium oxide content of 10% is measured for the sample. Though this is much higher than the 2-4% expected for Ciment Fondu, there are few if any other cements that have TiO_2 contents within the major element composition. Again, it is assumed that incongruous dissolution of the cement has resulted in depletion of some elements and enrichment of others.

Table 5.3a: Cement Chemistry Comparison

The chemical composition reported for the dalle de verre is calculated from the soluble portions of the chemical analysis presented in Section 9. The values are considered somewhat inaccurate due to incomplete digestion of the cement and some interference from the aggregate. The corrected values in the second column adjust for the dissolved limestone sand though this does not correct for all of the errors. The remaining three columns present typical compositions for pure Ciment Fondu, a high aluminate cement with approximately 70% Al_2O_3, and an ordinary gray portland cement.

Component (wgt. %)	Dalle de verre (as-measured) [1]	Dalle de verre (corrected) [2]	Ciment Fondu [3]	70% Alumina [4]	Portland cement [5]
SiO_2	5.4	6.2	3-5	< 0.8	19 - 23
CaO	48.5	40.9	37 - 39	27-29	60 - 66
MgO	0.9	1.1	< 1.5	< 0.3	1 - 5
Al_2O_3	22.3	25.7	38 - 40	69 - 72	3 - 6
Fe_2O_3 (+FeO)	12.1	13.9	15 - 18	< 0.3	2 - 6
TiO_2	8.8	10.1	2.4	< 0.1	tr.
Other	2.0	2.0	-	-	-

Notes:
1. The reported soluble binder chemistry is estimated on a non-volatile basis assuming the six measured oxides represent approximately 98% of the total.
2. Table 9.1 presents a corrected chemical analysis based on the return of dissolved $CaCO_3$ to the aggregate based on an estimated quantity of dissolved limestone sand. This corrected chemistry is used to estimate the soluble binder chemistry in the same manner as described in Note 1.
3. From Table 10.1 in Taylor, 1997.
4. Ibid.
5. Range of portland cement chemistries from various sources.

5.4 - Component Proportions

It was not possible to make a highly accurate estimate of the original component proportions from the chemical analysis due to the various interferences. Using arguments from the micrometric point-count analysis, the binder to sand ratio is estimated at 1 : 1.7 by volume and this is consistent with the binder-rich texture observed qualitatively through petrography.

In order to make the estimate, the acid digestion was used to estimate the weight percentage of acid-insoluble aggregate (i.e. chert and quartz). The point-count analysis gives the volume percentage of soluble limestone in the total aggregate. Making the approximation that limestone and the other components have roughly the same density, the aggregate was mathematically reconstructed by adding back the percentage of limestone assumed to have dissolved in the acid digestion. The hydrated binder was simply assumed to be the difference from 100%. As a rough estimate, 75% of this value was assumed to represent the dry binder with the remaining 25% consisting of water and carbon dioxide. Finally, the dry binder to sand ratio was estimated assuming that both components had bulk densities of 80 lbs./ft.^{3}. Table 8.1 also presents the weight ratios on which this estimate was based.

5.5 - Condition and Service Performance

It is understood that cracks are evident in the dalle de verre. Furthermore, a large quantity of the panels have been removed from the building as a result of the deterioration. Core #4 was taken from one of these removed panels. The core did not sample any cracks directly so it is not possible to evaluate the specific qualities of the deterioration. Though moderately soft and permeable, there is no obvious damage to the matrix. There is some minor corrosion observed along the wire reinforcement embedded in the tile. The sample is fully carbonated and the matrix is clearly permeable to both water and oxygen. It is certainly plausible for cracks to have been caused by the corrosion of embedded metals. The author is not aware if the deterioration patterns are consistent with expansion of the reinforcement.

Due to the use of an aluminate cement rather than portland cement, there are certain types of chemical deterioration that are not a concern. Of these, the resistance to alkali-silica reaction (ASR) is the most important. The dalle de verre contains chert aggregate that is among the most aggressively reactive rock types when used in portland cement-based mixtures. If one were to try to repair or replicate this mixture with portland cement, it would be inadvisable to use a similar aggregate without performing the requisite durability tests. With the Ciment Fondu, the only hydroxide to form during hydration is gibbsite and this is not reactive with poorly crystalline forms of silica in the same way that calcium hydroxide is.

The one reaction that would be a concern with Ciment Fondu specifically is referred to as conversion. Essentially, this is a normal part of the cement curing where certain calcium aluminate hydrates from the initial hydration convert to the more stable C_3AH_6 over time. Since the conversion product is a more compact phase, the reaction can result in a significant increase in microporosity and a reduction in strength. Changes in volume also occur and these tend to be difficult to predict. While all aluminate cements undergo some degree of conversion, the magnitude of the reaction strongly depends on water contents and temperatures during mixing and curing.

The author has not observed enough mixtures using Ciment Fondu to be able to accurately estimate original mix water contents and whether a particular degree of conversion is excessive. However, it is clear that the hydrated cement paste has a rather high porosity and this suggests that an unnecessarily high water to cement ratio might have been used in the original preparation. In order to evaluate whether the degree of conversion correlates with the distribution of cracking on the building, it would be necessary to perform a larger study of both distressed and unaffected dalle de verre. Compressive strength and porosity measurements would be useful if these could be performed on a statistically significant sample. The only way to do this properly would be to take small-diameter core samples in the laboratory. Unfortunately, such tests would be destructive to the dalle de verre panels chosen to represent the good conditions. In advance of any destructive study, the client might wish to develop a field-based non-destructive evaluation to serve as a proxy for strength and porosity. For example, certain types of impact or penetration testing can be crude proxies for strength, while Karsten tubes can provide some information regarding bulk porosity. Given the crudeness of that approach, a larger number of areas would be desirable for statistical significance.

6. Aggregate Sieve Analysis

In order to extract an aggregate sample from this material, an intact fragment of the core was gently disaggregated in an agate mortar and pestle. An effort was made to minimize the crushing of any sand particles. The disaggregated sample was digested in an acid sufficient to dissolve or at least decompose the binder. Petrographic observations indicate that the aggregate contains very little material passing the No. 100 sieve. This permitted most of the decomposed binder to be decanted off after levigation of the acidified sample. Several rinsings and decantations were used to decant off as much residual binder as possible. Microscopic examination of the residues indicate that much of the material passing a No. 200 sieve is incompletely digested binder and this fraction is removed from the gradation calculations below. Unfortunately, the limestone portion of the sand that represents about 15% of the total aggregate was completely dissolved in the process and is not represented in the reported gradation. However, petrographic observations indicate that the limestone is broadly distributed throughout the gradation meaning that the shape of the curve is not likely to be very different from what is reported here. A qualitative description of the sand is given in the discussion above and the recovered sample is returned to the client.

Table 6.1: Acid Digestion Data

	Retention (g)	**Cumulative passing (%)**	**Cumulative retained (%)**
No. 4	0.18	98.1	1.9
No. 8	2.51	71.9	28.1
No. 16	1.64	54.8	45.2
No. 30	1.47	39.4	60.6
No. 50	2.64	11.8	88.2
No. 100	0.99	1.5	98.5
Pan	0.14	0.0	100.0
Fineness Modulus			**3.23**

7. Point-Count Analysis

A micrometric point-count analysis was performed on the petrographic thin section. Polarized light microscopy was used at a magnification of 200x. The counting was necessary in order to determine the proportion of soluble carbonate aggregate in the sand. This proportion was used to correct the chemically measured insoluble residue such that it could be used to represent the total aggregate weight. It was also possible to quantify the air-void content in the process. Any differences from 100% are the result of rounding.

Table 7.1: Point-Count Results

Component	Points counted	Volume percentages of all components	Aggregate volume normalized to 100%
Chert sand	137	26.7	51.1
Quartz-based sand	90	17.5	33.5
Limestone sand	41	8.0	15.3
Binder	242	47.1	-
Air-voids	4	0.8	-
Total	**514**	**100.1**	**99.9**

8. Component Proportions

The component ratios are estimated somewhat crudely from a combination of data including the point-count analysis and the acid digestion. The reported values should be considered approximate.

Table 8.1: Calculated Components

Sample ID	**#4**
Component	
Cement (wgt. %)	37
Sand (wgt. %)	63
Binder : sand ratio (by volume)	1 : 1.7

Notes:

1. The residue from the acid digestion (47.52%) is estimated to represent chert and quartz sand. The amount of dissolved limestone is added back to the total aggregate by proportionalizing the 15.3% of limestone sand calculated through point-count analysis. This assumes that all sand components have the same density, a modest error. The sum of these components is assumed to represent the sand weight. The hydrated binder is calculated by difference from 100%. 75% of this is assumed to represent the original dry cement with the remaining 25% representing the water of hydration and the absorbed carbon dioxide from carbonation. The 75% value is assumed to represent the binder. The total sand and binder weights are normalized to 100%. Volumetric ratios are calculated assuming bulk weights for both components at 80 lbs./ft.^{3}.

9. Chemical Analysis

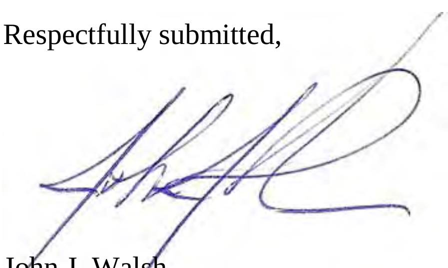
Table 9.1: Chemical Analysis Results

A typical chemical analysis procedure was not performed since the aggregate contains a significant amount of chert that is expected to interfere with the soluble chemistry upon digestion. In order to minimize this interference, the composite material was broken with a hammer and subsampled. The broken fragments were chosen to avoid the embedded steel, corrosion product, and the cementitious skim coat in addition to large chert particles. The broken fragments were then bluntly disaggregated in an agate mortar and pestle with a force chosen to minimize any fracturing of the sand grains. Given the petrographic observations, most of the chert is concentrated over the No. 30 sieve. As such, the bluntly crushed sample is sieved across this mesh, and the finer portion retained for digestion and chemical analysis. This fraction is concentrated in binder, and the results of its chemical analysis are presented in the following table. Some contamination from dissolved limestone aggregate is also expected. An attempt to correct for this interference is presented in the last column. It should be emphasized that this chemical analysis does not represent the bulk composition of the dalle de verre. It is only useful in evaluating the binder chemistry.

Component (wgt. %)	**As-measured**	**Corrected [1]**
SiO_2	1.84	1.84
CaO	16.52	12.12
MgO	0.32	0.32
Al_2O_3	7.61	7.61
Fe_2O_3	4.11	4.11
TiO_2	3.00	3.00
Insoluble residue	43.20	51.07
LOI to 110°C	1.36	1.36
LOI 110°C-550°C	9.96	9.96
LOI 550°C-950°C	12.42	8.96
Measured Totals	**100.34**	**100.34**

Notes:
1. The corrected chemistry attempts to remove the effects of dissolved limestone aggregate from the measured CaO and loss on ignition and reapply this to the rest of the aggregate captured in the insoluble residue. The amount of limestone is calculated by applying the percentage determined through point count analysis to the percentage of chert and quartz recovered through acid digestion. This assumes that all materials have the same density. This results in a modest error. The total limestone is added to the insoluble residue. The limestone is then split into a CaO component and a loss on ignition and these are each subtracted from the originally measured values.

Respectfully submitted,



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References
1. Taylor, H.F.W. *Cement Chemistry*. 2nd ed. , London, Thomas Telford Publishing. 1997. Print.

Appendix I: Visual Description of Samples as Received

Core ID	**#4**
Dimensions and Details	The sample consists of a 1.75" diameter core with a 1.1" length received in one intact piece.
Outer Surface	The outer face is smooth and planar with a cementitious skim coat covering most of the surface. The skim coat is much less than 1 millimeter in thickness.
Inner Surface	The inner face is highly smooth and planar. The paste just adjacent to the forming is somewhat darker.
Core Circumference	Smooth and untextured with no differential erosion from coring.
Hardness / Friability	The hardness of the paste is moderate to moderately soft though the matrix is cohesive and nonfriable.
Appearance	Freshly exposed surfaces have a dull luster and are brown in color (Munsell code approximately 10YR 4.75/1.75).
Embedded Items	Steel wire with a 3/32" diameter intersects the core circumference at three positions. The wire is well encased. Mild corrosion is evident along the wire surface once broken out of the mortar matrix.
Visible Cracks	No macroscopic cracks are visible in hand sample.
Other Details	Freshly exposed surfaces are moderately rapidly water-absorptive.

Appendix II: Photographs and Photomicrographs

Microscopic examination is performed on an Olympus BX-51 polarized/reflected light microscope and a Bausch and Lomb Stereozoom 7 stereoscopic reflected light microscope. Both microscopes are fitted with an Olympus DP-11 digital camera. The overlays presented in the photomicrographs (e.g., text, scale bars, and arrows) are prepared as layers in Adobe Photoshop and converted to the jpeg format. Digital processing is limited to those functions normally performed during standard print photography processing. Photographs intended to be visually compared are taken under the same exposure conditions whenever possible.

The following abbreviations may be found in the figure captions and overlays and these are defined as follows:

cm	centimeters	PPL	Plane polarized light
mm	millimeters	XPL	Crossed polarized light
µm	microns (1 micron = 1/1000 millimeter)		
mil	1/1000 inch		

Microscopical images are often confusing and non-intuitive to those not accustomed to the techniques employed. The following is offered as a brief explanation of the various views encountered in order that the reader may gain a better appreciation of what is being described.

Reflected light images: These are simply magnified images of the surface as would be observed by the human eye. A variety of surface preparations may be employed including polished and fractured surfaces. The reader should note the included scale bars as minor deficiencies may seem much more significant when magnified.

Plane polarized light images (PPL): This imaging technique is most often employed in order to discern textural relationships and microstructure. To employ this technique, samples are milled (anywhere from 20 to 30 microns depending on the purpose) so as to allow light to be transmitted through the material. In many cases, Highbridge also employs a technique whereby the material is impregnated with a low viscosity, blue-dyed epoxy. Anything appearing blue therefore represents some type of void space (e.g.; air voids, capillary pores, open cracks, etc.) Hydrated cement paste typically appears a light shade of brown in this view (with a blue hue when impregnated with the epoxy). With some exceptions, most aggregate materials are very light colored if not altogether white. Some particles will appear to stand out in higher relief than others. This is a function of the refractive power of different materials with respect to the mounting epoxy.

Crossed polarized light images (XPL): This imaging technique is most often employed to distinguish components or highlight textural relationships between certain components not easily distinguished in plane polarized light. Using the same thin sections, this technique places the sample between two pieces of polarizing film in order to determine the crystal structure of the materials under consideration. Isotropic materials (e.g.; hydrated cement paste, pozzolans and other glasses, many oxides, etc.) will not transmit light under crossed polars and therefore appear black. Non-isotropic crystals (e.g.; residual cement, calcium hydroxide, calcium carbonate, and most aggregate minerals) will appear colored. The colors are a function of the thickness, crystal structure, and orientation of the mineral. Many minerals will exhibit a range of colors due to their orientation in the section. For example, quartz sand in the aggregate will appear black to white and every shade of gray in between. Color difference does not necessarily indicate a material difference. When no other prompt is given in the figure caption, the reader should appeal to general shapes and morphological characteristics when considering the components being illustrated.

Chemical treatments: Many chemical techniques (etches and stains typically) are used to isolate and enhance a variety of materials and structures. These techniques will often produce strongly colored images that distinguish components or chemical conditions.

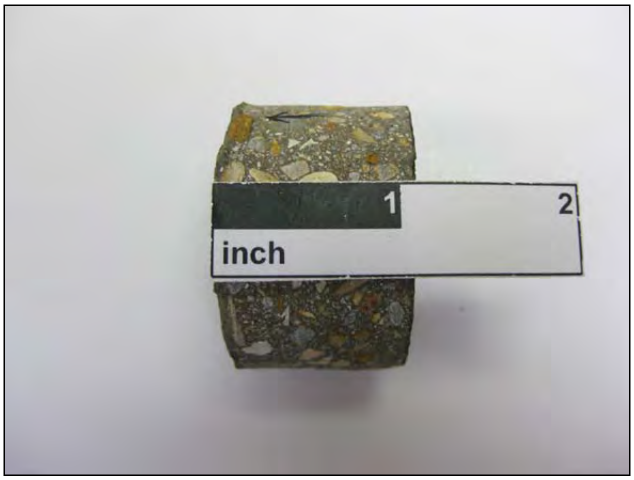


Figure 1: (Upper left) Photograph of Core #1. The sample is shown in side view with its outer surface oriented toward the left. (Upper right) A honed cross section of the dalle de verre is shown. Again, the outer surfaces is oriented toward the left of the image. The numbered units on the scale bar are in centimeters. The binder has a rich brown color typical of aluminate cements with high iron contents. The aggregate is coarse-grained and evenly distributed throughout the thickness. (Lower image) Wire reinforcement is embedded within the core. Note that some moderate corrosion product is evident along the wire. Corrosion of embedded metals could be one possible reason for any cracking noted in the dalle de verre. This is not confirmed in this analysis.

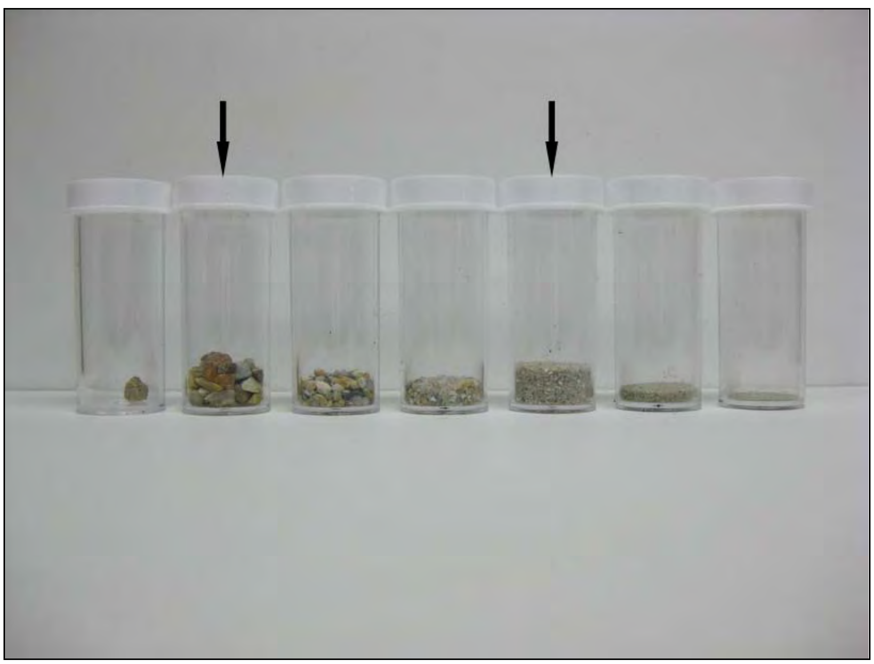


Figure 2: Photographs of the sand extracted from the mortar through acid digestion. The 85% of the aggregate that is siliceous in composition is recovered. The remaining 15% consists of acid-soluble limestone and this fraction was necessarily lost in the processing. (Upper image) The total extraction is shown. Note that there is a buff-colored background color produced by relatively pure quartz in the finer fractions. The coarse fraction is dominated by crushed chert. The iron-rich chert tends to be orange in color. (Lower image) The extraction is shown after gradation through a standard sieve stack. There is a bimodal distribution indicative of the separate additions of chert and quartz. The limestone would have been more evenly distributed throughout the full profile had it not dissolved. The left arrow indicates the peak in the chert gradation found between the No. 4 and No. 8 sieves. The peak in the quartz fraction is found between the No. 30 and No. 50 sieves and this is shown by the right arrow.

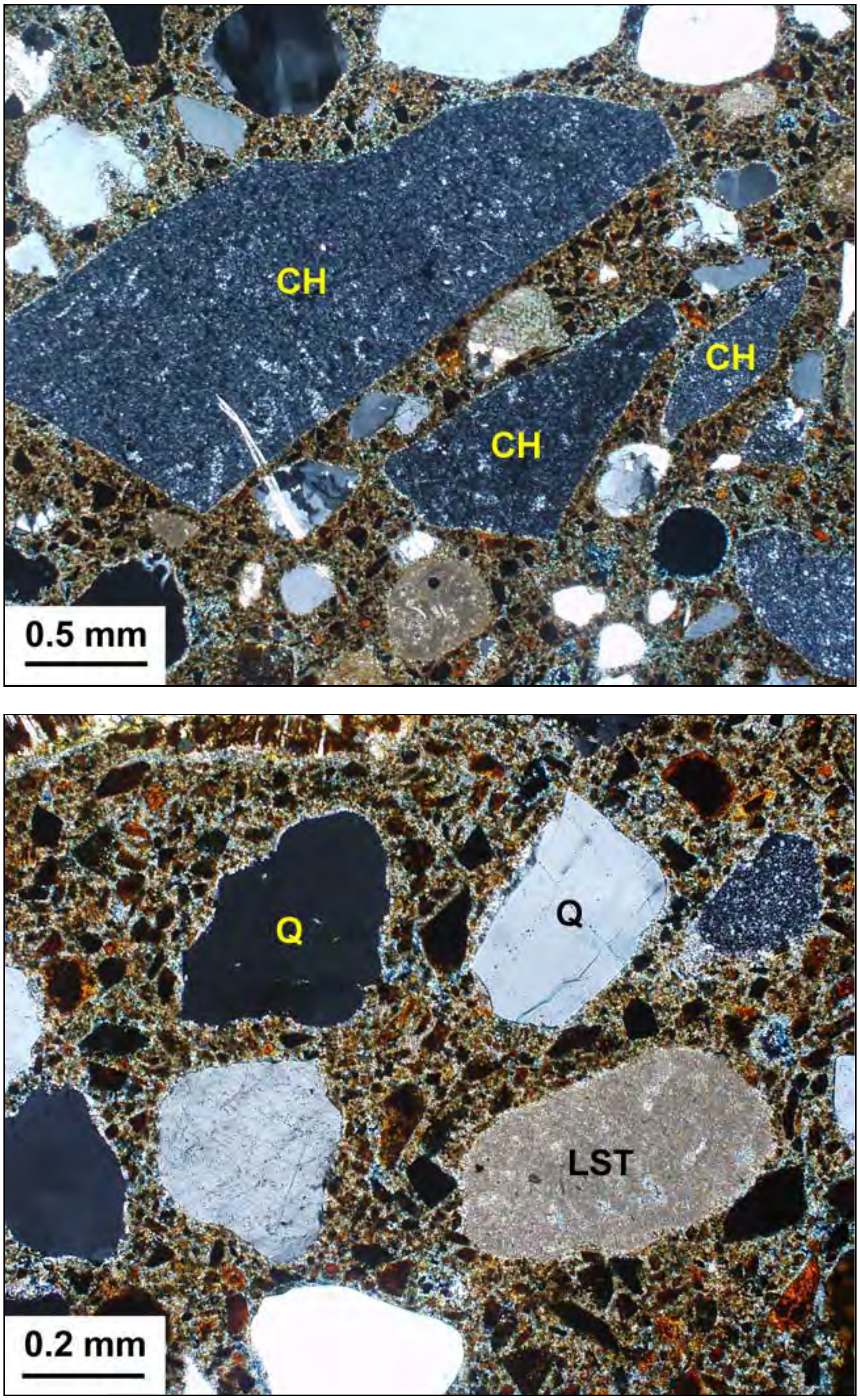
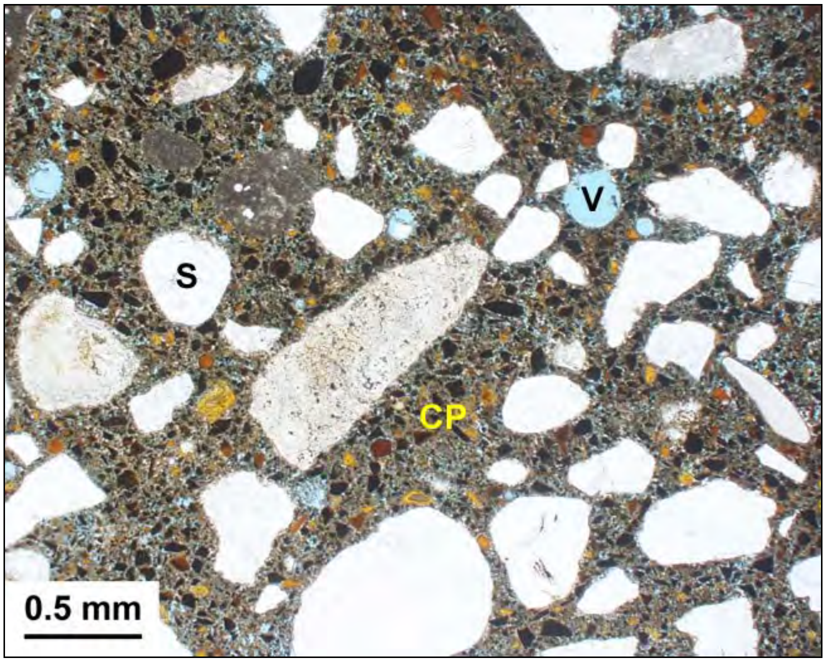


Figure 3: XPL photomicrographs illustrating the various major components of the sand. (Upper image) Chert (CH) has a uniform internal texture. Grains are angular and sometimes shard-like. The cryptocrystalline quartz can be highly reactive in portland cement-based materials. It is not considered a threat in the aluminate-based matrix. (Lower image) Quartz (Q) is abundant and somewhat narrowly graded. The grains are equidimensional and more often soft-textured. Limestone (LST) is present at about 15% of the total aggregate. Most is a fine-grained micrite such as the one shown here. Limestone particles tend to be rounded.



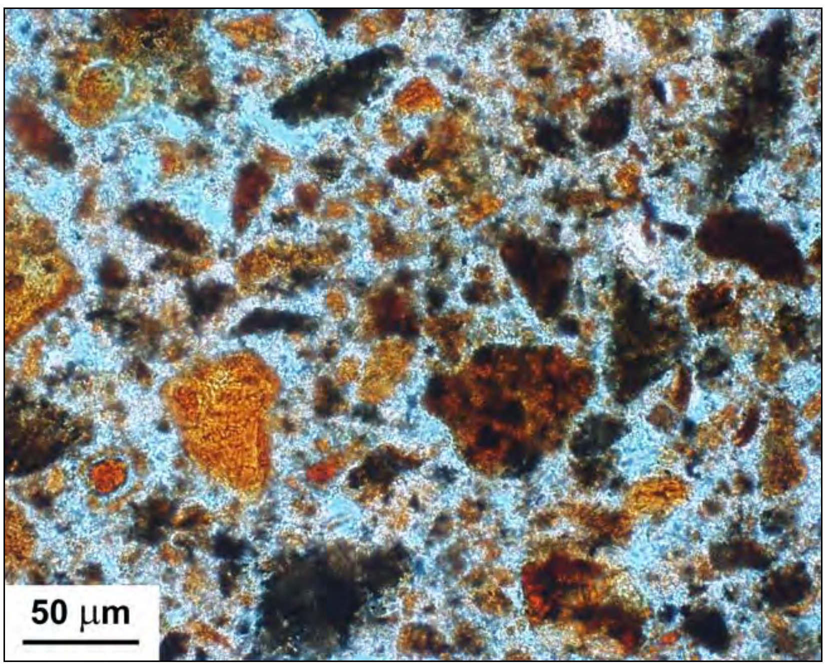


Figure 4: PPL photomicrograph illustrating the microstructure of the dalle de verre. The sample is impregnated with a low-viscosity, blue-dyed epoxy in order to highlight cracks, pores, and voids. (Upper image) This image is taken under a relatively low magnification. The cement paste (CP) absorbs a moderately high quantity of the dyed epoxy indicating a liquid permeable matrix. Sand grains (S) are well-coated with binder and sparsely distributed throughout the matrix. The low concentration is consistent with the 1 : 1.7 binder to sand ratio estimated for the mixture. Air-voids (V) are present at less than 1% by volume. The excellent compaction suggests a more fluid mix when fresh. (Lower image) This image is taken at higher magnification to illustrate the hydration quality of the cement. Though the hydraulic phases of the cement are well hydrated, there is a very high concentration of residual grains. These are highly particulate and angular in shape. The cement particles are closely clustered with only a sparse cementitious hydrate binding them. There is a high degree of blue-dyed epoxy absorption between the particles indicating a high permeability. This high microporosity is attributed to conversion of the cement during curing. Though not quantified, it is suspected that the water-cement ratio was higher than desirable to prevent a notable reduction in strength and increase in porosity as conversion progressed.

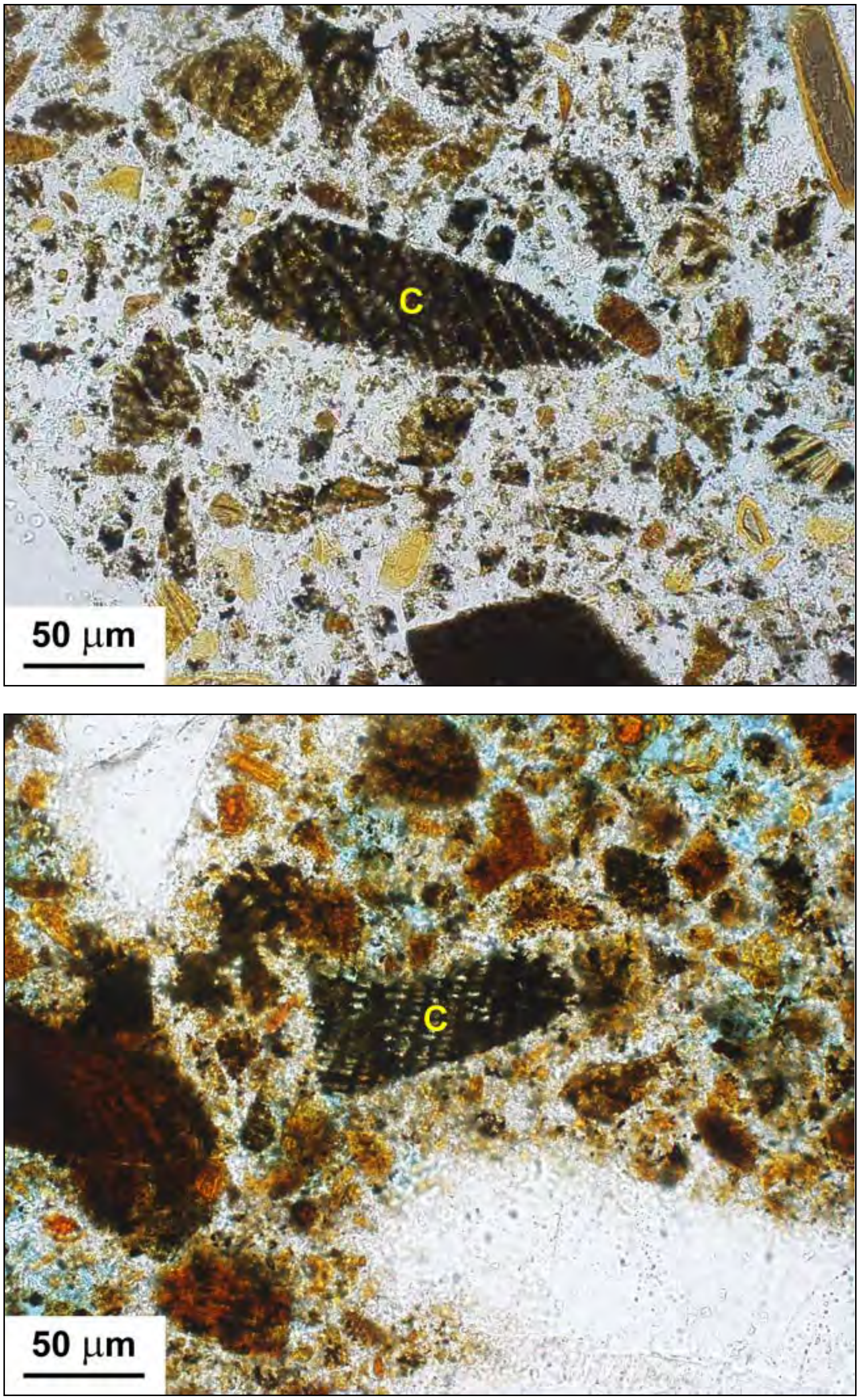


Figure 5: PPL photomicrographs illustrating examples of the aluminate cement texture. Many cement residuals (C) have bands of dark-colored ferrite separated by voids where CA (hydraulic calcium aluminate) once resided. The upper grain displays a "cross-hatch" texture while the lower exhibits a "weave" texture. It is possible that these are different orientations of the same type of structure.

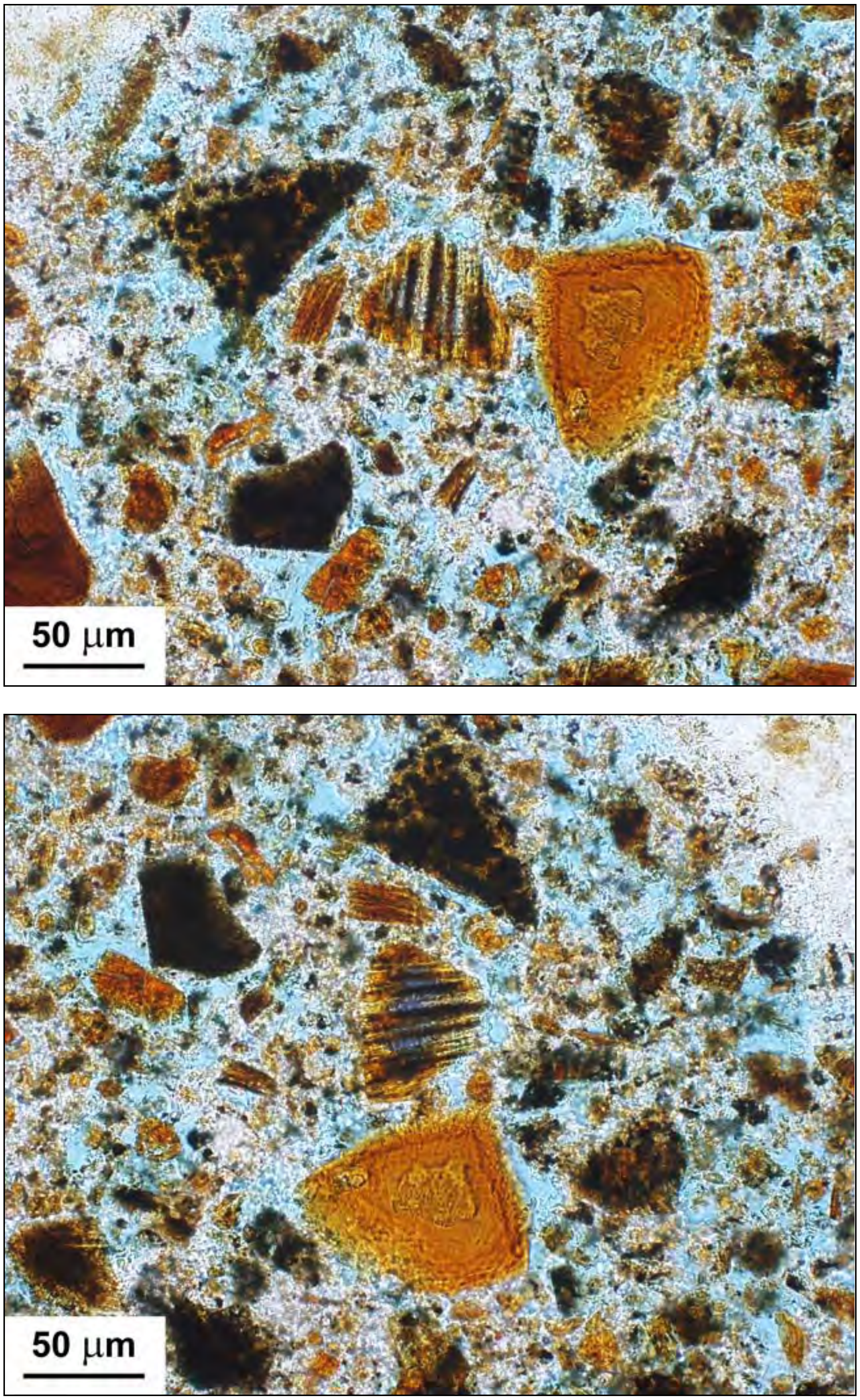


Figure 6: PPL photomicrographs of the same region taken at different orientations under plane polarized light. In the upper image, the striped grain in the center contains dark ferrite bands and lighter-colored interstitial bands. In the lower image, the thin section is rotated 90°. The light-colored area has turned a rich blue color. The difference in color upon rotation is a property called "pleochroism" and is a characteristic of an aluminate mineral called "pleochroite". Pleochroite is diagnostic of aluminate cements in general.

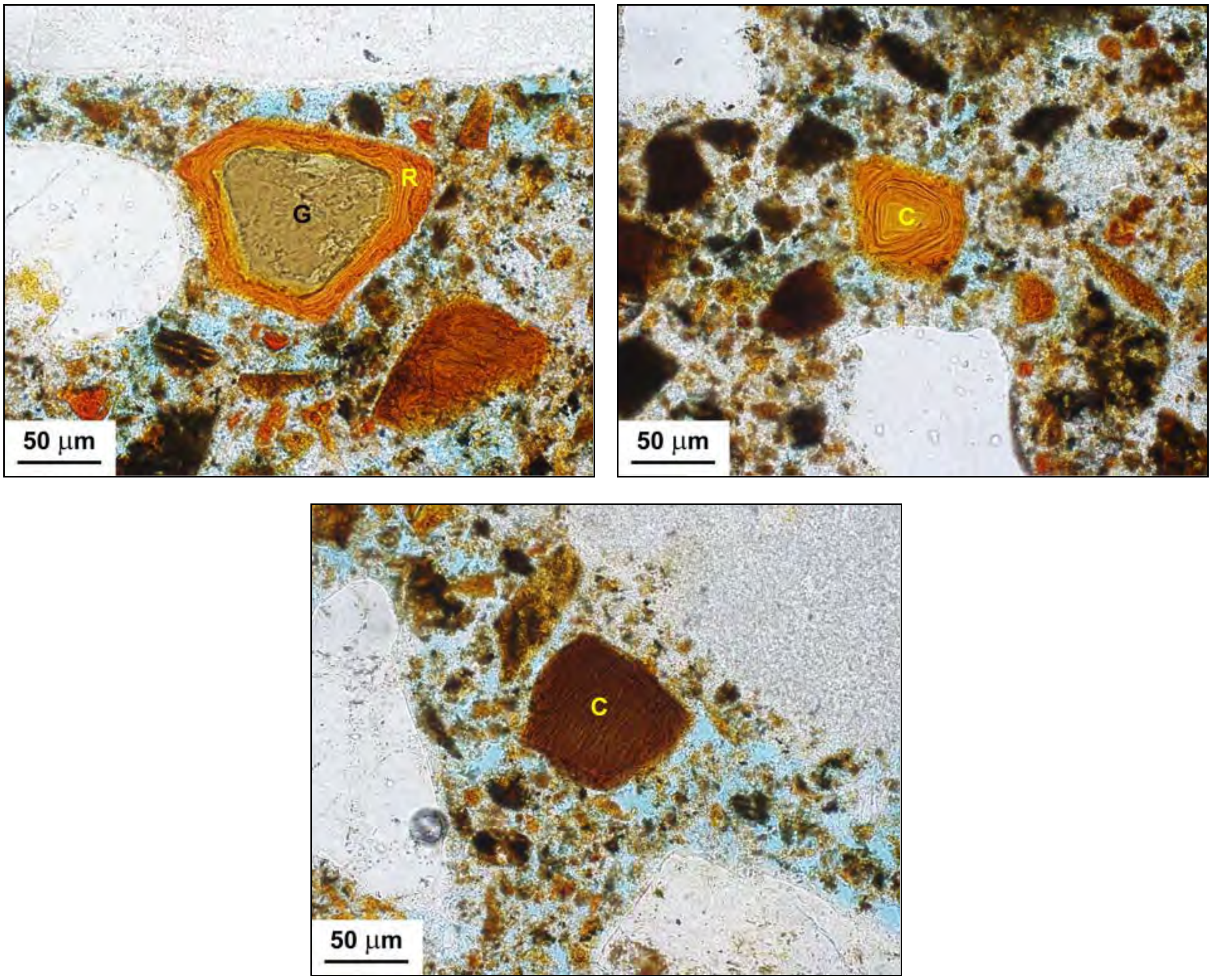


Figure 7: PPL photomicrographs illustrating other cement particles in the dalle de verre. In the upper left image, a brownish glass (G) is surrounded by an orange reaction rim (R) containing concentric rings. In the upper right, a similar cement grain (C) lacks the glass phase in the core. Glasses are known to be present in Ciment Fondu though the quantity observed in this sample seems higher than expected. Still, it does not appear that the glass is a separate addition. The cement grain in the lower image has a similar orange color but has a "feathery" internal texture. It is not known if these grains are associated with the glasses.

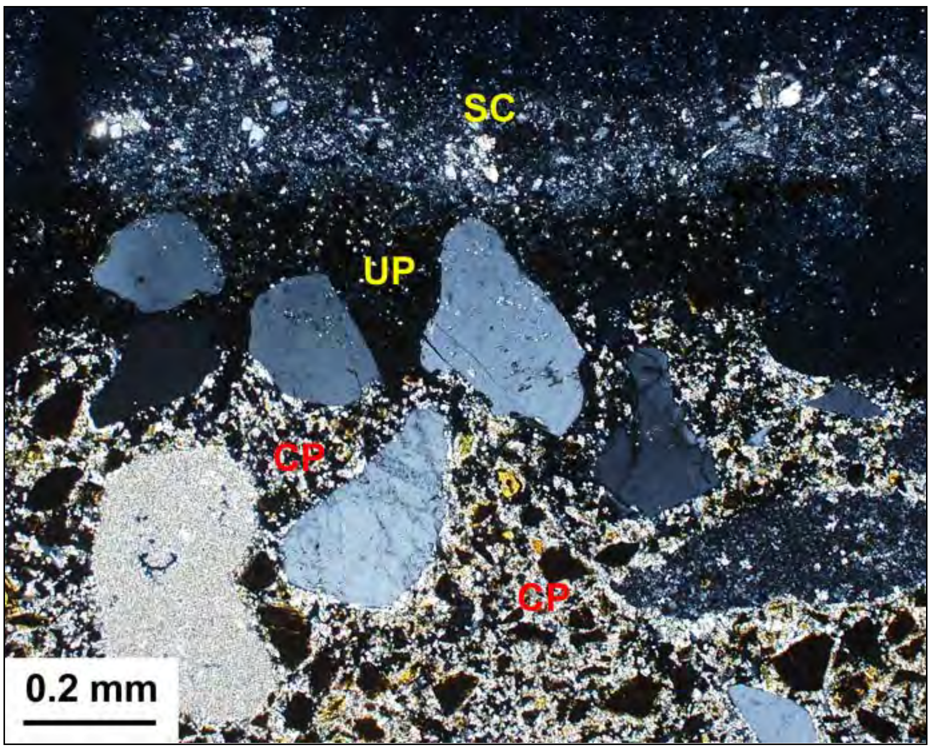


Figure 8: XPL photomicrograph. The outer surface of the dalle de verre panel is shown in cross section. Most of the material consists of a carbonated cement paste (CP) that appears brightly colored under crossed polars. The carbonation reaction may result in depassivation of any embedded steel. There is a thin veneer of uncarbonated paste (UP) along the outermost surface. The client reports that some type of sealant application may have been applied early in the history of the material. This could explain the lack of carbonation in this region. Finally, a thin cementitious skim coat (SC) was applied over the outer surface masking any original finish texture that may have been present. It is assumed that this skim coat was applied at a later date.

Appendix 7 Structural Engineer's Report

At the request of Old Structures Engineering, their report has been excluded from the published report.

Appendix 8 Mechanical, Electrical and Plumbing Systems Report

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MECHANICAL, ELECTRICAL AND PLUMBING SYSTEMS CONDITION REPORT

For:

Prudon & Partners LLP
135 West 70th Street
New York, NY 10023
January 30, 2017

A. GENERAL

The existing building consists of a Wallace K Harrison designed sanctuary, Carillon Tower, community/education wing, and grounds. The engineering scope included is to detail the existing condition of the building mechanical and electrical systems.

We will also review the proposed Air Conditioning system for the Sanctuary.

On December 20th, 2016, we visited the site to evaluate, investigate, review and analyze the existing mechanical and electrical systems currently installed and proposed for the Sanctuary. Our report concentrates on identifying the existing system capacities and propose upgrades as required.

The procedure used to obtain the information was the visual observation of the system components and the review of the proposed electrical and mechanical design drawings dated March 04, 2016 prepared by JP Engineering, Inc.

B. DEFINITIONS AND CODES

- 2012 International Building Code (IBC)
- 2012 International Mechanical Code (IMC)
- 2012 International Plumbing Code (IPC)
- 2012 International Energy Conservation Code (IECC)
- 2014 National Electrical Code (NEC)
- ASPE = American Society of Plumbing Engineers
- AHU = air handler unit
- BCFH = BTU/cubic feet/hour of heat release. Is the heat input divided by the furnace volume.
- CFM = cubic feet per minute
- DW = dishwasher
- GPH = gallons per hour
- HP = horse power
- HWD = hot water demand
- OS&Y = outside screw and yoke valve
- MBH = thousand Btu/Hr
- SEER = Seasonal Energy Efficiency Ratio
- WM = washing machine

C. FINDINGS

C.1. Mechanical Systems

C1.1 Heating system:

The existing Heating system is a hydronic hot water system recently upgraded from with three (3) new installed gas fired condensing boilers located in the basement Boiler Room of the Parish House building. The boilers are producing hot water distributed by a hot water pump to hot water coils in air handlers, radiators and cabinet unit heaters throughout all buildings in the Complex. The heating plant consists of the following major equipment:

1. Three (3) Viessmann model Vitocrossal 200 CM2 620, 2,245 MBH Gas Input and ,1854 MBH net output-see picture#1.
2. Bladder type Expansion tank–see picture#2
3. A set of 15HP hot water pumps (one active, one stand by) with variable speed drives-see picture#3
4. A 6" air separator
5. Air Handler No.1 with new hot water coil installed
6. Air handler No.2 With new hot water coil installed serving Fellowship Hall and Classrooms
7. Air handler No.3 with new hot water coil serving the Sanctuary

The boiler plant appears to be installed in 2016 and is in good working condition with no reported issues.

Boiler water temperature is controlled by an outdoor reset temperature controller. The panel is staging the boiler output and hot water temperature according to the outdoor temperature. When the outdoor temperature decreases the hot water temperature increases. The heating system is shut down when the outdoor temperature rises above an adjustable set point.

The glass Passage corridor between the Parish House and Narthex is provided with continuous grille for ventilation and heating. At the time of our survey it was cold. Church staff reported that this corridor has never been heated.

All heating is done by forced air from the existing air handlers.

C1.2. Proposed Air conditioning system for the Sanctuary

We also reviewed the proposed air conditioning system for the Sanctuary as per the drawings prepared by JP Engineering, Inc. dated March 3, 2016. The scope of work consists of adding Direct Expansion coils (DX) into the existing Air Handler No. 3 and installing a new Air Handler#5 in the Fan Room of the Sanctuary. Three (2) 75 ton condensing units are proposed to be installed in the Courtyard.

C1.3. Ventilation system:

Kitchen and bathrooms are ventilated by exhaust fans. Kitchen area was under construction in Fellowship Hall, however, air makeup for the kitchen hood has not been observed forcing the building into a negative pressure which is increasing the outdoor air infiltration into the building. Makeup is also required by IMC section 508.

The Sanctuary as well as the Fellowship Hall have floor mounted grilles for ventilation.

C.2. Plumbing Systems:

C.2.1 - Cold Water Service:

The existing domestic water service is a 2" service entering the basement of the Parish House next to the electrical and gas services (see Picture #4). The water service is missing the required backflow protection as per IPC Section 608.

The piping and valves appear to be in good working condition.

C.2.2 - Hot Water Service:

The domestic hot water is produced by one indoor gas fired hot water heater AO Smith GCV 50 300, 50 Gallons, 40,000 Btu/Hr input with 40.94 Recovery (see picture#5). The hot water heater and storage tank appears to be in good working condition.

C.2.3 - Gas Service:

The gas service is located in the basement, Mechanical Room of the Parish House building. The gas supply is serving the boilers, hot water heater and kitchen stove.

C.3. Electrical Systems

The original electrical service for the church building was initially installed in the mid 1950's of the last century and was not significantly upgraded within last years. The incoming service for the Complex is a 120/208 volt, 3 phase, 4 wire + ground service and is located in the cellar of the Parish House building. The service terminates in the main 1,200 Amp service switch fused at 1200 amp (see picture# 6). The main switch enclosure shows traces of rust at the bottom and on the sides.

All three buildings are monitored by a single metering device located adjacent to the main service switch.

The existing main service switch energizes the existing 1,200-amp main power distribution panel which feeds multiple building power, lighting and mechanical panels throughout the building. The distribution panel is the switch and fuse type with no spare switches.

It also contains (1) – 400-amp switch for the Fellowship Hall, and (1) – 600 amp switch for the Church.

The existing main distribution board is in fair condition with traces of water damage at the bottom of the cabinet. (see picture#7).

Some of the electrical panels and conduits are in fair condition and should be replaced soon. Existing panels are mostly old fashion circuit breaker type. The insulation on some wires is brittle and cracking. New electrical wiring, conduits, and panel boards are recommended (see picture #8).

The church is currently lit with various types of fluorescent and halogen lighting. In some areas lighting is controlled manually without any automatic controls.

The church's lighting doesn't provide proper lighting levels in all areas.

All exit doors are supplied with exit lights which appear to be in satisfactory condition.

Emergency battery packs are installed in corridors and passages.

C.4. Fire Alarm Systems

The fire alarm system is a temporal-3 system; it has been recently upgraded throughout the building and is in the good working condition. The main fire alarm control panel is located in cellar adjacent to the main electrical distribution panel (see picture #9).

The following was observed:

- Some of the pull stations are mounted above 48" above finished floor.
- Some of the classrooms are missing Carbon monoxide detectors.
- Carbon Smoke detectors are still required if the school is closed but spaces are still used as classrooms for occasional programs.
- If school is renovated and the occupancy class is changed, then, carbon monoxide detectors may not be required. The final decision shall be made at future date when the new occupancy is known.
- Restrooms by the Chapel are missing strobe lights.

Fellowship Hall and Kitchen area are under renovation – many fire alarm devices are not presently installed in these areas. The work is in progress and will be commenced soon.

D. Recommendations

D.1. Mechanical Systems

D1.1 Heating system:

The existing hot water system boilers are new. The existing infiltration load in the Parish House can be significantly reduced by approximately 25% by changing the windows, wall insulation and ventilation method and limiting the amount of infiltration (outside air).

Heating capacity shall be verified by the measuring the amount of air provided into each space and the temperature of the air supplied and returned from the respective space. This should be verified by performing a load calculation for the entire building.

In the Passage corridor between the Parish House and Narthex we recommend the system to be checked for working condition and repairs be made as required. Otherwise a new trench mounted finned tube radiators can be added.

D1.2. Proposed Air conditioning system for the Sanctuary:

The submitted drawings do not show in details the connections between the AHU-3 and new AHU-5 as well as the required maintenance space. Our comments are as follows:

1. Fire Smoke Dampers shall be verified if installed in compliance with IMC section 607.5.6 requirements.
2. Consultant shall verify whether the IECC is applicable for this application or not.
3. List on drawings efficiency of the proposed equipment
4. The listed leaving air temperature on the new air handler AHU-5 is 49.5°F and on the existing AHU-3 is 52.9°F. This seems to be too low. Supply air temperatures for underfloor applications should typically be kept at 60°F or higher to reduce the risk of condensation or mold growth.
5. Temperature setbacks for night or unoccupied periods shall be reduced to minimize plenum condensation or thermal mass effect of the floor.
6. The size of the new panel proposed by JP Engineering shall be equal to 400 amps, not 600 amps as shown in their design drawings dated 3/4/16.
7. The Organ tuning varies with the ambient temperature and not all pipes are affected equally. The best will be to tune the organ at its playing temperature. Ambient temperature needs to be kept as possible constant and to the temperature at which the organ was tuned. Temperature should be raised or lowered gradually at a maximum rate of plus or minus 2 degrees Fahrenheit per hour- see attached guideline for Pipe Organ Temperature Control.

D1.3. Ventilation system:

The current design with constant air supply is not in compliance with ASHRAE Standard 62.1 and IECC requirements. This system often provides over ventilation in same cases or underventilation in other. Sometimes, because of the poor performance, the system is kept off. We recommend using a motorized outdoor air damper instead of a fixed open damper to prevent outdoor air from entering during the unoccupied periods when the unit may recirculate air to maintain setback or setup temperatures. The motorized outdoor air damper should be closed during the full unoccupied period except where it may open in conjunction with an economizer cycle.

The amount of outdoor air could be controlled by carbon dioxide sensors that measure the change in carbon dioxide levels in a zone relative to the levels in the outdoor air. A controller will operate the outdoor air, return air, and relief air dampers to maintain proper ventilation.

We propose a demand control ventilation approach to minimize energy use for spaces with a large occupancy as the Sanctuary or Fellowship Hall.

D.2.1 - Cold Water Service:

Keep existing service and distribution if no upgrades are proposed. File and obtain approval for the proposed backflow preventer installation in the domestic water line.

D.2.2 - Hot Water Service:

Replace the existing hot water system with storage tank with high efficiency, 95% condensing type water heaters.

D.2.3 - Gas Service:

Create a separate room for the gas meter. Ventilate as required directly to outdoors. Existing gas service size shall be evaluated based on the proposed revisions/additions or equipment upgrade.

D.3. Electrical Systems

After careful consideration of the current installation and the projected and desired programs, we concluded that the current electrical installation is antiquated and needs updating in the following manner:

1. The main service switch shall be replaced with new 1600 amp service switch fused at 1600 amp
2. The main power distribution panel shall be replaced with the new 1600 amp, 3 phase, 120/208 volt distribution panel. The JP Engineering shall notify the Utility Company that the existing incoming service shall be reinforced in order to accommodate the additional mechanical load proposed in their design drawings dated 3/4/16.
3. All old-fashioned panels from fifties shall be replaced with new circuit breaker type panels. The Electrical Contractor shall match existing circuit breakers quantity and nomenclature and re-connect all existing active loads to the new panels.
4. The electrical Contractor shall field verify existing feeders condition and replace where feeders are damaged or feeders' sizes are inadequate.

Provide all new LED type lights and associated controls corresponding to the latest Energy Conservation requirements.

D.4. Fire Alarm Systems

The fire alarm system shall be upgraded/modified as follows:

1. All pull stations shall be installed at 48" A.F.F as required by Code.
2. All classrooms throughout the building shall be supplied with Carbon monoxide detectors wired back to the main Fire alarm control panel.

3. All restrooms throughout the building shall be provided with strobe lights.
4. Functionality and working condition of all smoke detectors shall be checked in all areas. The contractor shall replace all non-working smoke detectors and properly connect them to the new Fire alarm control panel.
5. After completion of all work, the fire alarm shall be tested and approved by the Fire Department. The Electrical Contractor shall produce the "As Built" set.

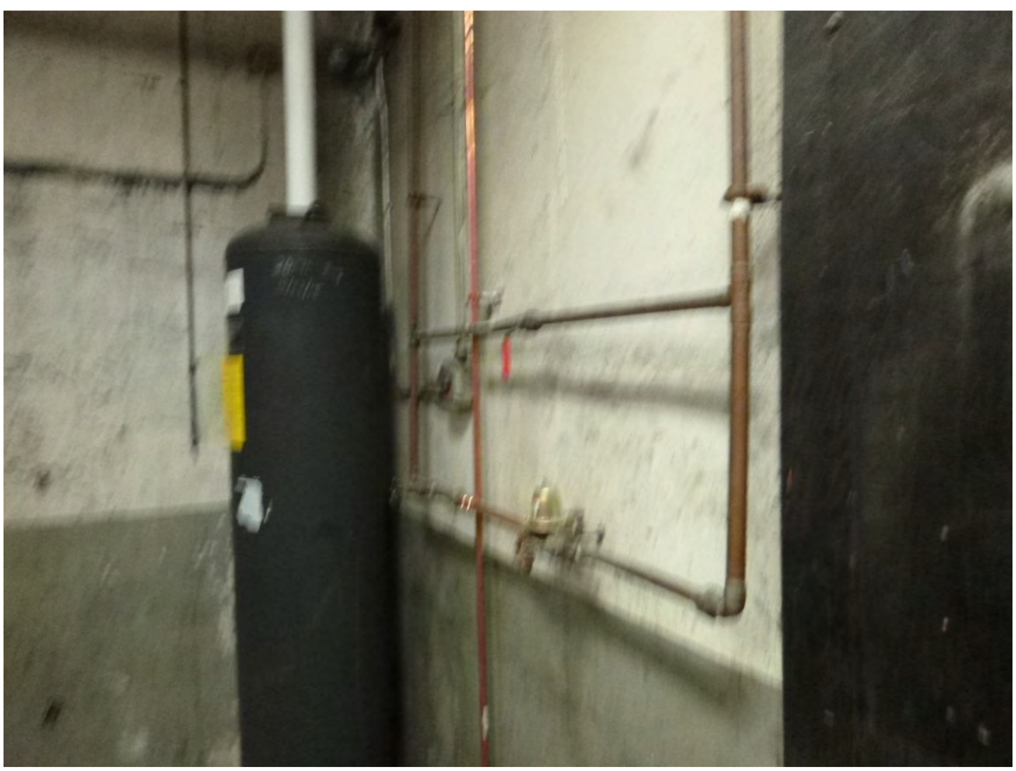
Respectfully submitted by:

Lucian Nicolescu, PE, LEED AP $_{BD+C}$

Enc: pictures of the existing equipment

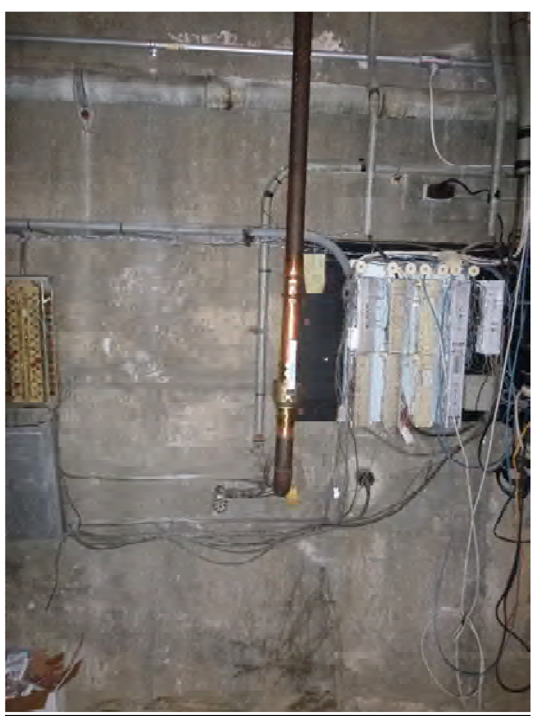
Picture#1-Viessmann boilers

Picture#2-Expansion Tank



Picture#3-HW Pumps

Picture#4-Water Service



Picture#5-AO Smith Hot Water Heater

Picture#6-Main Switch

Picture#7-MDP

Picture#8-Panelboard

Picture#9-Fire Alarm System

Guidelines for Pipe Organ Temperature Control

As energy costs continue to rise, many pipe organ owners will be re-examining how they heat and cool their worship spaces throughout the week. These guidelines are intended as a common-sense approach to climate control that can reduce utility bills while still avoiding the extreme conditions that may damage sensitive organ components. Extremes in temperature and humidity can be avoided without having to constantly run heating or air conditioning systems.

How temperature and humidity affect the organ

Organ pipes are like every other wind instrument: their pitch varies with the temperature. When the air is cool, pipes will sound flat. When the air is warm, pipes will sound sharp. This is because the air inside the pipe is less dense when it is warm and therefore oscillates faster. Expansion and contraction of the pipe metal itself is negligible.

Regardless of how raucous the organ sounds when it is extremely hot or cold, it will quickly come back into tune at the designated temperature used during worship services. Of course, that same temperature needs to be maintained whenever your organ technician is tuning the organ.

While temperature extremes are not a big concern, excessive seasonal variations in humidity can cause problems with certain organ components. Wood expands, contracts, and twists as humidity rises and falls. Good organ design can compensate for most problems with wood movement, but extreme dryness caused by continuous winter heating for several days at a time can lead to serious wood cracking. A humidity gauge placed inside the organ should generally stay above 30% during the winter and below 80% during the summer.

General temperature control procedures

- Bring the worship space to your normal designated temperature only when it will be occupied for public services.
- Turn on the heating/cooling (“HVAC”) system sufficiently far in advance to allow each part of the organ to reach its normal temperature. If your HVAC system was designed with good air circulation patterns in mind, stable temperatures can usually be achieved inside the organ three to six hours after turning on the system. Allow extra time when outside temperatures are extreme or if air does not circulate freely through all parts of the organ.
- If the worship space is unoccupied for most of the week, lowering the winter midweek heat setting to around 40 degrees (or slightly higher in mild climates) will naturally keep the relative humidity high enough that a humidifier may be unnecessary. If no heat is used for the entire week during freezing weather, it is important to slowly raise the temperature incrementally over at least a 24-hour period.

Possible upgrades to your HVAC system for improved temperature stability and energy efficiency

- Ask your organ technician to install extra return-air duct lines or a small, quiet centrifugal blower within the organ to pull air through all parts of the organ. If any organ pipes are near uninsulated roof decks, it is especially important to pull stratified air out of those areas. Increase the size of HVAC grilles and/or

continued on page 2

remove metal grates to quiet the rush of air. Do not add supply registers near organ pipes, since air blowing directly on them can cause wide temperature swings as the system cycles on and off. Remove organ grille cloth wherever feasible to promote better air circulation.

- Develop a page of clear HVAC operating procedures and post it on the wall next to the controls. Consider replacing overly complicated system controls. Relocate any thermostat that is exposed to sunlight or too close to exterior doors and windows. Thermostats need to be fairly close to the large return-air grilles within the worship space.

- HEATING: If the heat must be on for more than an entire day and there are prolonged humidity readings below 30% inside the organ, install a humidifier. Humidifiers should ideally be a part of the main HVAC system; if a separate unit must be placed in the organ chamber, great care must be taken to ensure that water cannot drip on any organ parts. Malfunctioning humidifiers and overflowing dehumidifiers can severely damage organ pipes and windchests. Never place a humidifier near the blower intake area of the organ.

- COOLING: If summer humidity readings are often above 80%, a dehumidifier in the duct line may be needed to help the primary compressor remove enough moisture from the air. If the primary compressor is severely oversized and therefore not able to run long enough during off-peak times to lower humidity, consider adding a smaller secondary compressor. Running only the secondary compressor for a few hours during the week may be all that is needed to maintain summer humidity levels below 80%. As long as humidity remains generally below 80%, organ components should be fine even though temperatures during the week may be around 100 degrees during the hottest weather.

Since these guidelines cannot anticipate every situation, it would be wise to talk with your pipe organ technician about the specific conditions in your worship space that may require unique climate control procedures and remedies. Pipe organ technicians are often the best source of information regarding HVAC controls because they have seen what does and doesn't work in a wide variety of buildings throughout your region.

About the AIO

The American Institute of Organbuilders is an educational organization dedicated to advancing the art of organbuilding "by discussion, inquiry, research, experiment and other means." Among the Institute's 385 members are professional organ builders, service technicians and suppliers who subscribe to AIO objectives and its code of ethics. Conventions are held each year in cities throughout the United States and Canada. These meetings are structured around a full schedule of technical lectures, visits to local organ shops and instruments, product exhibits and business meetings. AIO small-group seminars provide another valuable opportunity for professional growth. Held in organ shops throughout the country, these sessions offer hands-on training in specific organ building skills. Further information and online resources are available at www.pipeorgan.org