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North Providence, RI 02904

STRUCTURAL EXISTING CONDITIONS REPORT

WESTPORT HIGH SCHOOL
WESTPORT, MASSACHUSETTS

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2.0 INTRODUCTION

This structural study of the existing Westport High School building located at 19 Main Road, Westport, Massachusetts, was undertaken at the request of Jonathan Levi Architects of Boston, Massachusetts.

The purpose of this structural study was to assess the adequacy of the existing structure to resist the gravity and lateral loads specified in the current Massachusetts State Building Code ("the Building Code") and to provide recommendations for repairs and retrofitting that may be required as part of a proposed major renovation project.

3.0 STANDARD OF CARE AND USE OF REPORT

Please note that the results of this investigation are limited to visual observations of the accessible areas only. While we have made our best efforts to thoroughly review the areas of concern, many conditions were concealed by architectural finishes or were otherwise inaccessible, and therefore additional damage or other unforeseen conditions may be present. The findings of this report therefore represent our best professional opinion based on the information available to us at this time.

We understand that this report is intended for use by The Town of Westport, the Massachusetts School Building Authority, and Jonathan Levi Architects to establish the existing structural condition of the Weston Field Elementary School and the potential costs for structural repairs and retrofitting. In any budgeting for work, the owner must carry adequate contingency for hidden or unforeseen conditions that are not identified or are worse than described herein.

Please note that all dimensions of the existing structure given herein are approximate and based on measurements of representative members. Dimensions can and will vary, and must be considered as "+/-" in all cases (whether or not the "+/-" symbol is indicated).

4.0 DOCUMENTS AVAILABLE

The following documents were loaned to the design team for use in this study:

- Blueprints of some of the original Westport High School construction drawings, dated May 3, 1950, produced by J. Williams Beal &Sons of Boston, Massachusetts.
- Blueprints of most of the Westport High School Alterations & Additions construction drawings, dated July 14, 1972, produced by Owen F. Hackett, Jr. Associates of New Bedford, Massachusetts.

5.0 ACTIONS TAKEN

Odeh Engineers, Inc. undertook the following actions to complete this structural evaluation:

- Senior Structural Engineer and Project Manager visited the site on Friday, April 22, 2016 and met with Mr. Mike Duarte of Westport Schools to perform visual observations of the existing structure.
- Prepared this written summary of findings and recommendations.

odeh engineers

6.0 DESCRIPTION OF EXISTING STRUCTURE

6.1 KEY PLAN

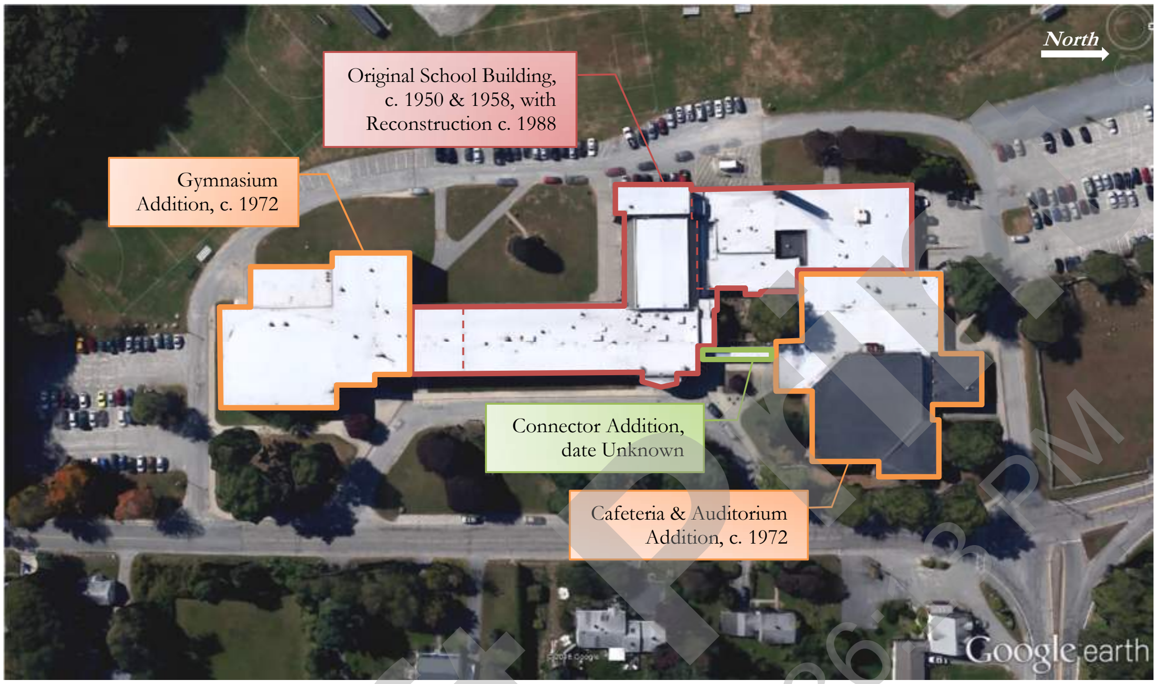

Figure 1 - This is an aerial photo of the existing Westport High School showing the regions of the building referenced in this report.

6.2 EXISTING STRUCTURAL SYSTEMS

The Westport High School is a one- and two-story structure, with a partial basement located at the western central and southern regions of the building. The overall structure measures approximately 700 feet long (north-south) and 60 to 260 feet wide (east-west) depending on the portion of building being referenced. The existing building can be divided into three distinct regions based on their periods of construction – the Original School Building, the Cafeteria & Auditorium Addition, and the Connector Addition. Each region has framing systems that are distinct to those areas. All regions, except for the Connector Addition, for which there is no existing information and existing framing could not be observed, are described herein.

Original School Building

The original portion of the current Westport High School is a one- and two-story structure with a basement in the western central portion of the original footprint. The one-story region is located at the northwestern portion of the original building, with the two-story classroom wing located at the southeastern region of the original building. A double-height media center with a small mezzanine is located at the central region of the existing building. The original portion was constructed circa 1950, with a small extension to the south end of the two-story classroom wing added circa 1958. It is our understanding that the one-story region at the northwestern portion of the building was reconstructed circa 1988 after a fire severely damaged that portion of the building.

The basement and ground floors in all regions appear to be concrete slabs on grade. Foundation and basement walls appear to be cast-in-place concrete. The existing exterior walls appear to be masonry bearing walls comprised of cinder block backup with brick veneer, full-width brick bearing walls, or a combination of the two. Interior corridor walls and demising walls between classrooms appear to be unreinforced cinder block walls in a running bond layup. The ground floor framing above the basement is elevated one-way cast-in-place concrete slab construction, with a 6"± concrete slab spanning between lines of concrete beams and basement walls (span direction varies in different areas above the basement). The beams are supported on cast-in-place concrete columns and the basement walls. Refer to Photographs #1 and #2 for examples of the framing above the basement in this region.

The roof framing over the one-story northwestern region of the building is comprised of two different framing systems. Long-span open web steel joists that bear on masonry bearing walls and support a Tectum Tile roof system are present over the Facilities and Maintenance area. The joists and Tectum roof systems are supported on masonry bearing walls. The remainder of the region appears to be steel wide-flange beams and girders that support 1½" narrow-rib metal roof deck. The beams, girders, and roof deck are supported on masonry bearing walls as well as round steel columns. Refer to Photographs #3 through #6 for examples of the roof framing in this region.

The second floor of the two-story southeastern classroom region of the building is comprised of an elevated cast-in-place concrete pan-joist floor slab system spanning east-west between cast-in-place reinforced concrete beams at two interior lines line of support on either side of the main corridor, and cast-in-place concrete encased steel beams at the two exterior walls. The concrete beams span north-south and are supported on cast-in-place rectangular concrete columns at the two interior lines of bearing and on the existing masonry bearing walls and heavy weight Lally columns at the exterior bearing lines. Refer to Photographs #7 and #8 for examples of the floor framing in this region.

The roof of the two-story southeastern classroom region of the building is comprised of 1½"± narrow-rib metal roof deck spanning north-south between 12-inch deep "BL" steel beams. The beams span east-west and are supported on two lines 12-inch deep "BL" steel girders at two interior lines and at the two exterior lines. The exterior girders bear on the existing masonry bearing walls and heavy weight Lally columns. Refer to Photographs #9 and #10 for examples of the roof framing in this region. The roof framing for the 1958 extension is similar to the adjacent roof systems, however, it consists of open-web steel roof joists in lieu of the "BL" steel roof beams and Tectum Plank roof deck in lieu of metal roof deck. Refer to Photograph #11 for an example of the roof framing in this area.

The current Media center, which is located directly adjacent to the one-story region of the Original Building, is a double-height space with a small mezzanine along the north side. The framing in this area could not be visually verified, however, existing drawings indicate that the roof is comprised of steel trusses spanning north-south between existing columns and the existing masonry bearing walls. The existing drawings also indicate that existing 12-inch deep "BL" roof beams span east-west between the trusses and support wood plank roof deck.

Gymnasium, Cafeteria, and Auditorium Addition

A new gymnasium, cafeteria, and auditorium were added to the original building at Westport High School circa 1972. The gymnasium addition is a two-story addition to the south end of the classroom wing of the original building with a partial basement along the western side of the addition. The cafeteria and auditorium addition, which is directly adjacent to the northwestern one-story region of the original building, is a one-story addition with a double-height space at the auditorium.

The basement and ground floors in both regions of the additions appear to generally be concrete slabs on grade. Foundation and basement walls appear to be cast-in-place concrete. The existing exterior walls appear to be masonry infill walls comprised of CMU block backup in a stack bond layup with brick veneer. Interior corridor walls and demising walls between classrooms appear to CMU block walls in a stack bond layup.

<u>Gymnasium Addition</u>

The ground floor framing above the basement in the Gymnasium Addition was not observed, however, existing structural drawings indicate that it is elevated cast-in-place concrete slab construction, with a 9"± concrete slab spanning between lines of concrete-encased steel beams and basement walls (span direction varies in different areas above the basement). The beams are supported on concrete columns and the basement walls.

The second floor framing appears to be a 4"± thick composite concrete floor slab (2½" topping on 1½" composite metal deck) that spans in the north-south direction between structural steel wide-flange beams. The beams span east-west between structural steel wide-flange girders, which are supported on structural steel columns. Refer to Photograph #12 for an example of the floor framing in this region.

The roof framing over the Gymnasium is comprised of 3-inch metal roof deck spanning east-west between steel beams and long-span open-web steel joists. The beams and joists span north-south and are supported on steel wide-flange girders at the north and south bearing lines and a built-up plate girder at the center line of bearing. The girders are supported on structural steel columns. The existing roof framing over the remainder of the Gymnasium Addition is comprised of steel joists spanning east-west between steel wide-flange girders. 1½" metal roof deck spans between the existing joists. Refer to Photographs #13 and #14 examples of the roof framing in this region.

Infill walls appear to be CMU backup walls in a stack bond layup pattern with brick veneer at the exterior. Interior masonry walls and partitions appear to be CMU of unknown thickness arranged in a stack bond layup pattern.

<u>Cafeteria and Auditorium Addition</u>

The Cafeteria and Auditorium Addition is a one-story addition located to the east side of the one-story portion of the Original School Building. The existing roof framing over the cafeteria portion is comprised of open-web steel joists spanning east-west between steel wide-flange girders, which are supported on structural steel columns. 1½" metal roof deck spans between the existing joists. A 2"± expansion joint runs north-south through the cafeteria portion of the addition. Refer to Photograph #15 for an example s of the roof framing in this region.

The auditorium is a double-height space with a sloped floor for fixed seating. 3"± metal roof deck spans between roof beams the beams, which are supported on three built-up steel plate girders arranged in a radial (fan) pattern centered on the proscenium. The girders are supported on steel columns and a built-up plate girder at the proscenium. A steel-framed mechanical room and catwalk are located at the rear of the auditorium space. Refer to Photographs #16 through #18 for examples of the roof framing in this region.

Infill walls appear to be CMU backup walls in a stack bond layup pattern with brick veneer at the exterior. Interior masonry walls and partitions appear to be CMU of unknown thickness arranged in a stack bond layup pattern.

7.0 STRUCTURAL DEFICIENCIES, POTENTIAL PROBLEM AREAS, AND COMMENTS

The following structural deficiencies and potential problem areas were observed by Odeh Engineers, Inc. during our investigation of the existing building and during our review of the existing structural drawings. Each observation is accompanied by comments on the cause and impact of the deficiency. Please refer to the photographs in Appendix A for additional information.

7.1 DEFICIENCIES AND PROBLEM AREAS FROM VISUAL OBSERVATIONS OF THE EXISTING STRUCTURE

- **Minor cracking of the brick veneer at varied locations around the building perimeter (Photos #19 and #20):**
  - **COMMENT:** Cracking of brick veneer can by caused by a number of reasons, including thermal or moisture expansion of the brick, localized overstress (e.g. lintel bearing), differential stiffness of supports, and settlement. It is unknown whether the cracks propagate through the entire thickness of the wall, however, they appear to be minor in nature. The root cause of the cracking should be thoroughly investigated and repair details (e.g. crack sealing and repointing ant nonmoving, nonstructural cracks or crack stitching at moving or structural cracks) should be developed accordingly.
- **Minor deterioration of masonry and spalling of the brick veneer at varied**

locations around the building perimeter and at the chimney (Photos #21 and #22):
  - **COMMENT:** Brick deterioration and spalling is typically caused by repeated exposure to freeze-thaw cycles or poor manufacturing of the brick. Deteriorated masonry should be cleaned and repointed, and spalled bricks should be replaced in kind.
- **Minor to moderate rusted steel veneer lintels (Photos #23):**
  - **COMMENT:** Rusted steel veneer lintels is caused by exposure to the elements. Steel veneer lintels that exhibit minor rust can typically be cleaned and painted to increase their longevity. Steel veneer lintels that exhibit moderate to severe rust (i.e. delamination and loss of section) should be replaced with new galvanized lintels.
- **Interior nonbearing masonry partitions appear to be laterally unbraced at the tops of walls and are likely lacking restraint at the base of wall as well. Additionally, the existing partitions do not meet the minimum height-to-thickness or length-to-thickness ratios for nonbearing masonry walls prescribed by the current Building Code for existing structures (Photos #24 & #25):**
  - **COMMENT:** Unbraced or inadequately braced unreinforced reinforced masonry partitions represent a significant seismic hazard due to their inability to resist lateral loads imparted upon them during a seismic event. All nonbearing masonry partitions will require lateral bracing at the top and bottom of the walls and additional wall bracing will be required at approximately 4'-6"" on center vertically and horizontally to conform to the Code requirements for height- and length-to-thickness ratios. Alternatively, nonbearing masonry partitions could be removed and replaced with code-compliant nonbearing partition assemblies.
- **The existing chimney, which is free-standing for approximately 40 feet above the existing roof, represents a seismic hazard (Photo #26):**
  - **COMMENT:** The existing chimney will require bracing to resist the code-prescribed seismic loads. As an alternative to bracing, the chimney may be substantially reduced in height such that its height-to-thickness ratio does not exceed the code-prescribed maximum of 2.5. The chimney may also be taken down in its entirety.
- **Several existing structural elements that may be acting as lateral force-resisting elements (though not necessarily designed as such) appear inadequate to resist the lateral forces that would be exerted on the structure during a seismic event. There appear to be inadequate or nonexistent connections between the lateral force-resisting elements and foundations and floor/roof diaphragms to transfer lateral forces to the foundations.**
  - **COMMENT:** Existing structural elements may be upgraded and new structural elements added to increase the load-carrying capacity of the existing elements and reduce the load on the existing elements, respectively. Additional connections would also be required to provide adequate attachment of the lateral force-resisting elements to the roof and floor diaphragms as well as anchorage to the foundation elements.

- **The existing steel roof joists at the 1958 extension to the classroom wing may have inadequate capacity to resist the code minimum roof snow loads.**
    - **COMMENT:** Assuming the minimum size for the existing joists at the measured depth, the joists are inadequate to resist the code minimum roof snow load. Detailed measurements of the existing joists should be performed to determine their actual size and capacity.

7.2 DEFICIENCIES AND PROBLEM AREAS FROM EXISTING DRAWING REVIEW

- **The structure appears to lack a clearly defined lateral force resisting system required to resist the wind and seismic loads prescribed by the new Building Code.**
    - **COMMENT:** Both the 1950 original structural drawings and the 1972 additions and renovation drawings do not indicate a designated lateral force resisting system for the building. Existing structural elements will need to be upgraded or replaced and new structural elements added to ensure an adequate lateral force resisting system is present to resist the required design forces. We recommend that the following two options or a combination thereof be considered:
        - Introduce a new system of steel braced frames with new foundations, located within the building footprint so as to create a symmetric bracing scheme in each plan direction. New braces must be attached to the existing floor and roof levels to transfer lateral loads.
        - Reinforce or replace the existing masonry walls, and also selectively introduce new reinforced CMU shear walls. Existing walls may be reinforced by introducing new spray applied reinforced shotcrete to the surfaces, and introducing new reinforcing dowels to properly anchor the walls. Existing foundations will also require reinforcement and enhancement at these masonry walls.

      Regardless of the system chosen, all lateral force-resisting elements will require adequate attachment to the roof and floor diaphragms as well as anchorage to the foundation elements. Existing connections to enhanced framing would require enhancement as well to adequately transfer lateral loads to the new lateral force resisting elements. Additionally, based on our review of the existing structure, the entire roof diaphragm would require additional fastening at support and sidelaps in order to adequately transfer the lateral forces in the diaphragm to the lateral force resisting elements.
- **Existing unreinforced masonry load-bearing walls do not conform to the minimum strength requirements and prescriptive requirements of the current Building Code for existing structures.**
    - **COMMENT:** The material strengths for the existing cinder block bearing walls are likely below the code-required minimum, and higher material strength requirements are required to resist the code-prescribed lateral forces. At a minimum, all existing masonry bearing and shear walls will require enhancement in place or application of a reinforced spray-applied shotcrete

wall against the existing. Enhancement of the existing bearing and shear walls in place would include, but not be limited to, addition of reinforcing steel at boundary elements, solid grouting of all cores, and repointing of all masonry beds. Once these upgrades have been conducted, additional testing of the upgraded materials is required by Code to ensure required design strengths are achieved. Nonbearing masonry partitions will require that all cores be grouted solid and mortar beds repointed to meet the minimum strength requirements. Nonbearing partitions that are to be incorporated into the lateral force-resisting system will require the addition of reinforcement or a spray-applied reinforced shotcrete wall, or will require replacement as previously described (for those placed in a running bond pattern). Those in a stack bond pattern will require an application of reinforced shotcrete or replacement in their entirety. Additional connections to the floor diaphragms will be required, as will enhanced or new foundations at the lowest level.

All existing masonry load-bearing and shear walls will also require adequate anchorage to the roof and floor diaphragms to transfer the diaphragm forces to the walls, as well as to support the out-of-plane wall forces. The walls will, in turn, require anchorage to the existing foundations by installation of masonry dowels in grouted cores, shear transfer plates, doweling of the new spray-applied reinforced shotcrete wall, or other system as determined by analysis. Alternatively, the masonry may be removed and replaced with new CMU that conforms to the current Building Code and is adequately attached to the foundations and floor diaphragms.

- **The Code prohibits the use of tensile stress capacity parallel to bed joints in stack bond masonry. The existing masonry backup walls at the 1972 additions are therefore inadequate to resist the tensile forces created by out-of-plane bending due to the wind loads on the structure.**
  - **COMMENT:** Existing unreinforced masonry stack bond walls will require enhancement to resist the out-of-plane wind loads loads, most likely by adding a reinforced shotcrete wall at the interior or replacing the wall with new reinforced masonry. These enhanced walls will require adequate attachment to their supports at the top and bottom to ensure adequate support against the out-of-plane loads.

8.0 STRUCTURAL BUILDING CODE REVIEW

Based on our review of the possible project scope of work provided by the Architect, we understand that the potential renovations to the building may include one or more of the following scope items:

- Renovations to the existing building including reconfiguration of the existing spaces to conform to current classroom requirements.
- Horizontal additions that area structurally attached to the structure to increase the building footprint, specifically along the sides of the classroom wing.
- Replacement or upgrade of building mechanical, electrical, and plumbing systems.

- New egress stair and elevator shafts.
- Enlarging existing openings or providing new openings in existing masonry walls.

No preliminary plans were provided for use in developing this report, so all findings are preliminary and subject to revision based on the final architectural program.

8.1 BUILDING CODE REQUIREMENTS

The structural requirements for work on existing buildings are governed by the current Massachusetts Building Code, 8th Edition. Chapter 34 of this Code, "Existing Structures", references the International Existing Building Code 2009 (IEBC 2009 or "the IEBC") with Massachusetts amendments (dated June 20, 2014). The following review is based on these versions of the IEBC and Massachusetts amendments.

PLEASE NOTE: As of the writing of this report, Massachusetts has announced that a new version of the building code – the ninth edition – is planned for adoption in 2016. Therefore, the provisions of the new code must be investigated as they may apply to the design of any alterations to this building. Additional requirements of the ninth edition code, based on our review of a public draft copy of the proposed amendments, are included in the sections below. Because the requirements are based on a draft version of the proposed ninth edition code, they be subject to change, addition, or deletion in the final adopted version.

The IEBC allows three different methods of compliance – the Work Area Method, the Prescriptive Method, and the Performance Method. We describe our professional opinion of the requirements for the first two methods (the most commonly used for this type of work).

Note that it is our understanding that the project may include significant horizontal additions that are structurally attached to the existing building. Additional requirements for upgrade of the lateral force and gravity force resisting systems will be triggered by such additions. All new additions and members must be constructed in accordance with the International Building Code provisions for new construction.

Structural Requirements for Renovations and Repairs – Work Area Method

For projects using the work area method, the IEBC classifies alterations as Level 1, Level 2, or Level 3, depending on the amount of work to be performed, as well as the occupancy of the building and the proposed scope of structural modifications. Based on our current understanding of the project, the proposed renovations to this building would be classified as "Level 3" per Section 405 of the IEBC, which states, "Level 3 alterations apply where the work area exceeds 50 percent of the aggregate area of the building."

Requirements Triggered by Alterations:
For a Level 3 alteration project, the Code requires that the building, as altered, conform to the minimum requirements established for Levels 1 and 2 work as well as additional requirements for Level 3 work.

Key structural requirements for "Level 1" work include:

- Where roofing or equipment is replaced or modified such that additional dead load is applied, the existing structure must be evaluated for the new loading conditions per requirements of the International Building Code.

Key structural requirements for "Level 2" work include:

- New structural members and their connections and anchorage must conform to the Code requirements for new buildings.
- Where existing structural elements carrying gravity loads are altered (or loads increased due to the renovations, including the effects of snow drifting), such members must be reinforced to meet the requirements of the Code for new structures.
- The demand/capacity ratio for existing structural elements carrying lateral loads may not be increased by more than 10% without triggering the requirements for Level 3 work (see below). Furthermore, any building alteration that results in the creation of a seismic irregularity (such as a torsional irregularity, soft story, or weak story) will trigger the requirements of Level 3 work.
- *Per the proposed ninth edition of the Building Code, all roof framing components that have sustained any level of structural damage caused by or related to snow load effects shall be rehabilitated to comply with the applicable provisions for dead and snow load requirements of the International Building Code. Undamaged roof framing components that receive dead or snow loads from rehabilitated components shall also be rehabilitated to comply with the design loads of the rehabilitated design.*

The key structural requirements for "Level 3" work include:

- For major alterations ("Substantial Structural Alterations" are defined as those alterations that involve structural work exceeding 30% of the total floor and roof areas of the building), the structure as altered must comply with the minimum wind loading prescribed for new buildings, as well as a reduced percentage of the seismic loading prescribed for new buildings.
  - *COMMENT: We anticipate that horizontal additions attached to the building in conjunction with other structural modifications to and reinforcement of the existing structure and new rooftop equipment will trigger the requirements of a Substantial Structural Alteration.*
- Alteration work shall include installation of wall anchors at the roof and floor levels to resist the reduced IBC-level seismic forces, unless an evaluation demonstrates compliance of existing wall anchorage.
- Parapets constructed of unreinforced masonry must have bracing installed to resist the reduced IBC-level seismic forces where a height-to-thickness ratio exceeds 2.5.

Structural Requirements for Renovations and Repairs – Prescriptive Method

Alternatively, the project could be executed using the Prescriptive Method as described in the IEBC 2009. The structural requirements of the prescriptive method are included in Chapter 3 of the IEBC, and are summarized below for the likely scope of work for this project.

<u>Requirements Triggered by Alterations:</u>
Structural requirements for alterations are covered under IEBC Section 303. All new

structural elements will be required to conform to the Code requirements for new buildings.

- Where existing structural elements carrying gravity loads are altered (or loads increased due to the renovations, including the effects of snow drifting), such members must be reinforced to meet the requirements of the Code for new structures.
- The demand/capacity ratio for existing structural elements carrying lateral loads may not be increased by more than 10% without triggering an upgrade to the wind and seismic requirements for new construction. Furthermore, any building alteration that results in the creation of a seismic irregularity (such as a torsional irregularity, soft story, or weak story) will trigger a wind and seismic upgrade to the requirements for new construction.
- Alteration work shall include installation of wall anchors at the roof and floor levels to resist the reduced IBC-level seismic forces, unless an evaluation demonstrates compliance of existing wall anchorage.
- Parapets constructed of unreinforced masonry must have bracing installed to resist the reduced IBC-level seismic forces where a height-to-thickness ratio exceeds 2.5.
- *Per the proposed ninth edition of the Building Code, all roof framing components that have sustained any level of structural damage caused by or related to snow load effects shall be rehabilitated to comply with the applicable provisions for dead and snow loads requirements of the International Building Code. Undamaged roof framing components that receive dead or snow loads from rehabilitated components shall also be rehabilitated to comply with the design loads of the rehabilitated design.*

Structural Requirements for Renovations and Repairs – ALL METHODS

All existing structural members in the buildings will be required to be analyzed for compliance with the Code. This includes all gravity load-bearing elements, as well as the seismic and wind load resisting systems. In addition, certain existing conditions may need to be corrected, such as upgrading existing structural assemblies, adding seismic bracing to existing walls, as well as providing additional lateral force-resisting elements.

It may be necessary to conduct additional tests of the existing structure to determine the design strengths of the materials present if the information cannot be determined otherwise. Additionally, the Code requires testing of certain elements in their upgraded state (e.g. strengthened masonry shear walls) to verify that adequate design strengths have been achieved.

Note that the above only applies to the existing structural elements. All new work is required to conform to the requirements of the current building Code for new structures.

8.2 STRUCTURAL REQUIREMENTS FOR FM GLOBAL INSURANCE

It is currently unknown if the High School building will be insuring the renovated complex using FM Global as their insurer. If FM Global is selected as the insurer, the following will likely apply.

FM Global requires that their own proprietary set of guidelines for wind uplift loading be utilized for roofing component design and roof uplift structural analysis. These guidelines typically exceed the base wind loading requirements prescribed by the Building Code and result in additional structural anchorage of the roof framing. Typically, these additional anchorage requirements include, but are not limited to, the following:

- Adequately fastening the roof deck to structural supports.
- Adequately anchoring the framing to the exterior walls and interior columns.
- Adequately anchoring the interior roof columns to the floor structure below.

All existing connections will need to be evaluated to determine their adequacy to resist the FM Global prescribed wind uplift loads. If found to be inadequate, additional structural anchorage will be required. The structural anchorage at the exterior walls typically consists of steel plate straps that are fastened to existing beams and anchored to masonry walls with a post-installed epoxy anchor system such as Hilti's HIT-HY 70 Hybrid Injection Adhesive. At interior column locations, the structural anchorage typically consists of additional bolting or welding of the framing members to the columns. The bases of these columns are typically anchored to the foundations below and likely will not need any modifications.

9.0 SUMMARY AND RECOMMENDATIONS

In order to bring the existing Westport High School into conformance with the current Massachusetts State Building Code, a significant amount of structural work will be required. The lateral force resisting system of the structure is seriously deficient and will require major retrofitting to meet the requirements of the Massachusetts State Building Code for existing building renovations. Existing unreinforced masonry walls will either need to be removed (where possible) or reinforced to meet the Code minimum strength requirements.

At a minimum, we believe that the following structural scope of work will be required as part of the renovation to the building:

- Introduction of new steel braced frames and shear walls throughout the building. These new braced frames will extend from the ground floor level up to the underside of roof and must be tied to the floor and roof diaphragm using appropriate anchors. Braces will be designed to carry the Code prescribed seismic and wind loads discussed in the body of this report. New footings for the braced frames will be required where none are present, and the existing concrete piers, foundation wall, and footings supporting new lateral force resisting elements will likely require enhancement to adequately transfer the seismic and wind loads.
- Reinforcement of existing load-bearing masonry walls to remain in place. Several methods of reinforcement may be considered, however we recommend the use of spray-applied shotcrete (approximately four to six inches thick with vertical and horizontal steel reinforcement), bonded directly to the existing masonry and attached to the foundation elements and floor diaphragms. In selected areas, additional reinforcement of the foundations may also be required to accommodate the reinforced wall system.
- Reinforcement of existing exterior masonry infill walls to resist wind loads. The walls may be reinforced in place, but due to their assumed thickness (6"±), spray-applied shotcrete (approximately four to six inches thick with vertical and horizontal steel reinforcement) bonded directly to the existing masonry and attached to the foundation elements and floor diaphragms would be the preferred structural solution.
- Enhancement of the metal roof deck fastening to meet the minimum diaphragm strength requirements of the Code. The reinforcement will likely consist of additional fasteners at supports, additional sidelap fastening, as well as additional fastening at the perimeter of the structure and new and existing lateral force resisting element locations.
- All deteriorated steel lintels will need to be replaced. The lintels will require temporary shoring of the supported masonry, replacement with new galvanized steel angle members, and installation of new flashing.
- Reinforcement of the roof framing to accommodate the additional weight of any new required insulation and mechanical equipment as well as related snow drift loads. Reinforcement would consist of steel WT sections to the underside of existing steel beams and girders, as well as additional steel beams to reduce deck spans. All existing connections at reinforced members would require enhancement as well.

- Bracing of the unreinforced masonry chimney structure to resist Code prescribed seismic loads, likely in the form of a steel collar anchored near the top of the chimney and braced with diagonal steel members attached to the roof structure (which will be reinforced to account for the brace loads).
- Construction of new floors and roofs to expand the classroom spaces along the classroom wing of the building. If the new additions are structurally attached, the existing perimeter framing, columns, and foundations will require analysis and reinforcement to support the new addition as well as the original construction. Additionally, the existing lateral force resisting system will be required to upgraded to resist the added load from the expansion in conjunction with the loads from the original building. If the additions are structurally independent from the existing building, a new line of framing, which includes beams, columns, and foundations, will be installed directly adjacent to the existing exterior line of framing and a seismic joint will be required between the new and existing structures. The new structure would be designed to resist its own seismic and wind loads. In both situations, columns would be located in the middle of the enlarged classrooms, and in the latter, a joint through the classroom spaces would be present as well. Neither of these items is desirable for current classroom layout standards.

A more detailed investigation of the entire structural framing system and exterior wall elevations should be performed to document the exact location and extent of each of the structural deficiencies identified above, as well as to discover additional deficiencies that were not previously visible due to the existing finishes being in place. As part of the renovation project, structural repairs must be performed for each of the structural deficiencies identified in the detailed investigation.

We trust that this report meets your needs at this time. If you require anything further, please do not hesitate to contact this office.

APPENDIX A: PHOTOGRAPHS

PHOTO #1

This photo shows the elevated cast-in-place concrete slab construction above the basement in the Original School Building region.

PHOTO #2

This photo shows the elevated cast-in-place concrete slab construction above the basement in the Original School Building region.

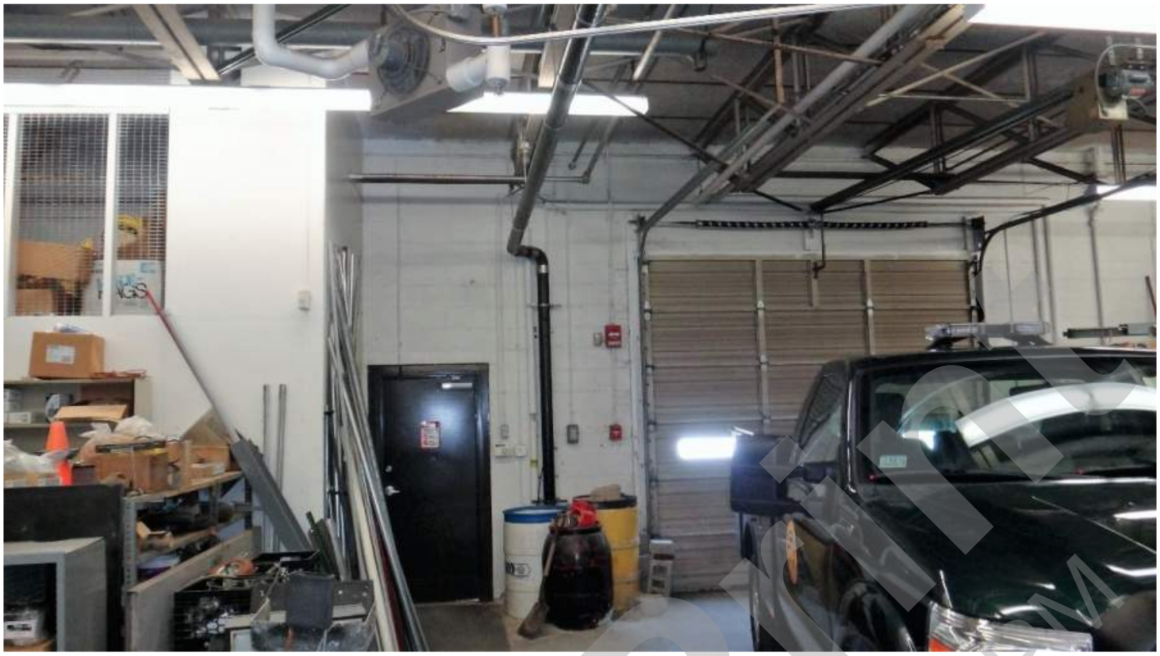

PHOTO #3

This photo shows the existing long-span open-web steel joists and masonry bearing walls that comprise the roof framing in the Facilities and Maintenance area in the Original School Building region.

PHOTO #4

This photo shows the Tectum Tile with bulb-tee roof system spanning between open-web steel joists above the Facilities and Maintenance area in the Original School Building region.

PHOTO #5

This photo shows the existing metal roof deck on steel beams and girders that comprises a portion of the roof framing in the one-story portion of the Original School Building region.

PHOTO #6

This photo shows the existing metal roof deck on steel beams and girders that comprises a portion of the roof framing in the one-story portion of the Original School Building region.

PHOTO #7

This photo shows the existing concrete pan joist floor system with interior cast-in-place beam at the second floor of the two-story portion of the Original School Building region.

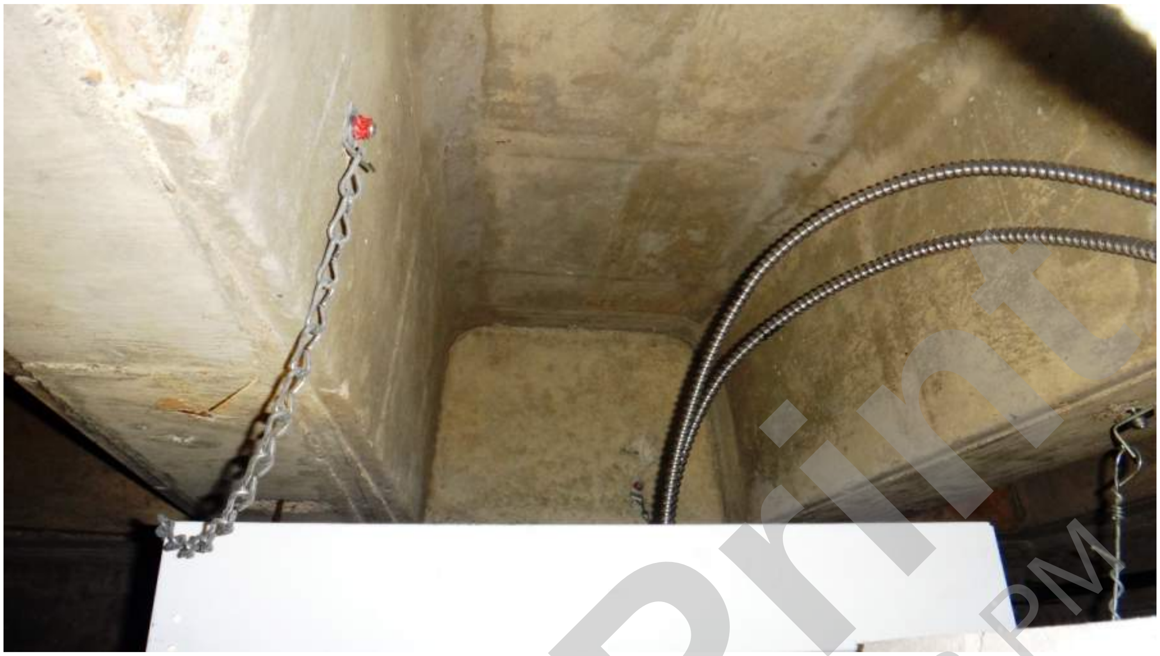

PHOTO #8

This photo shows the existing concrete pan joist floor system with distribution rib at the second floor of the two-story portion of the Original School Building region.

PHOTO #9

This photo shows the existing roof beams and metal deck at the two-story portion of the Original School Building region.

PHOTO #10

This photo shows the existing roof beams and metal deck at the two-story portion of the Original School Building region.

PHOTO #11

This photo shows the existing roof joists and metal deck at the 1958 extension to the two-story portion of the Original School Building region.

PHOTO #12

This photo shows the second floor framing in the Gymnasium Addition region.

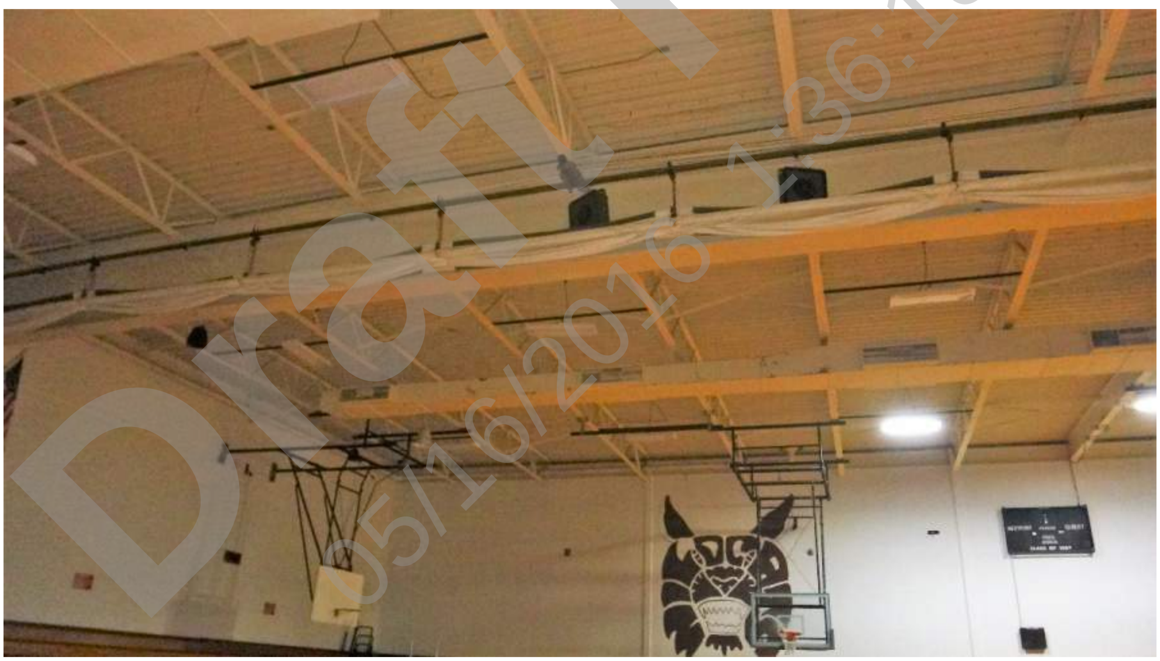

PHOTO #13

This photo shows the existing roof framing over the Gymnasium.

PHOTO #14

This photo shows the typical roof framing in the Gymnasium Addition region.

PHOTO #15

This photo shows the existing roof framing over the Cafeteria. Note the double beams on either side of the expansion joint.

Photo #16
This photo shows the typical radial roof framing in the Auditorium.

Photo #17
This photo shows another example of the typical radial roof framing in the Auditorium.

PHOTO #18

This photo shows the typical radial roof framing in the Auditorium above the stage.

PHOTO #19

This photo shows a previously repaired crack (and displaced brick) in the exterior brick veneer. Note the additional cracking to the left and displacement along a portion of the previous repair.

PHOTO #20

This photo shows an example of a crack in the exterior brick veneer. Note the displaced brick in the center of the image.

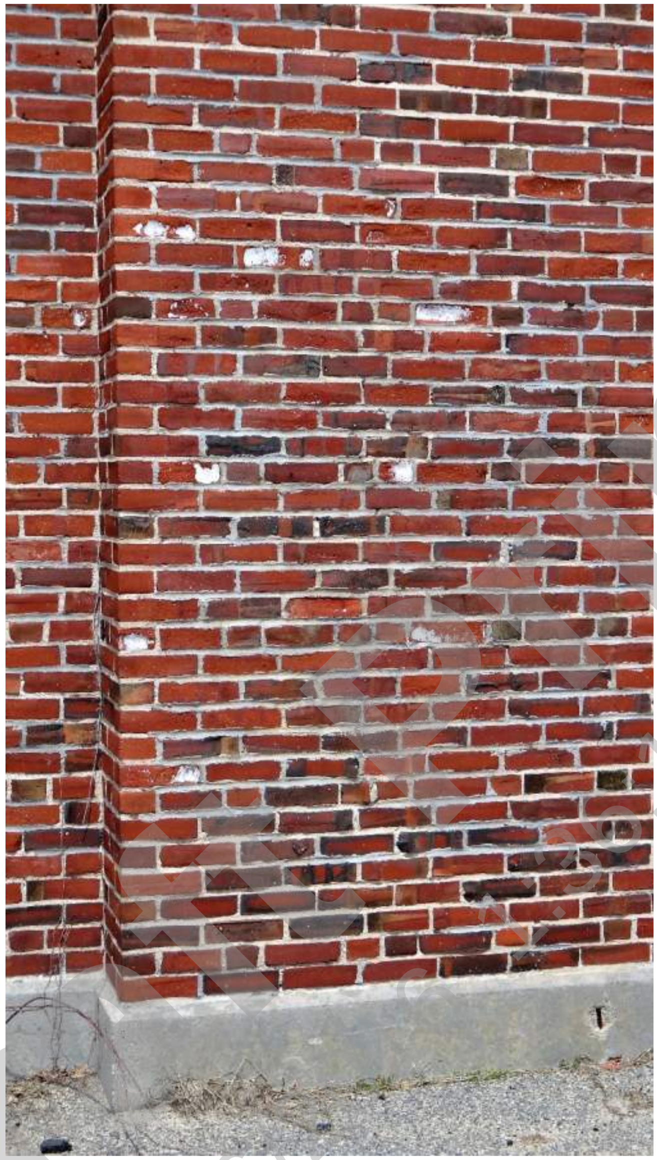

PHOTO #21

This photo shows an example of deteriorated and spalling exterior brick veneer.

PHOTO #22

This photo shows an example of the deteriorated brick at the existing chimney.

PHOTO #23
This photo shows an example of a rusted veneer lintel.

PHOTO #24
This photo shows an example of the inadequately nonbearing masonry partitions. The piers that extend to the framing above are inadequate to brace the wall during a seismic event.

PHOTO #25

This photo shows an example of the unbraced nonbearing masonry partitions. The partitions are built to the underside of the existing structure, but do not appear to have any positive anchorage or attachment at the top of wall.

PHOTO #26

This photo shows the existing chimney, which extends approximately 40 feet above the existing roof.