General Information

We have reviewed the four general design options presented for the Doherty Memorial High School feasibility study by Lamoureux Pagano and Associates, and offer the following description of each structural system. Also, we will present the basic structural scope and implications of each design option. The design options are:

1. Code Upgrade
2. Renovation and Addition
3. New Construction on Existing Site (Options A.1, A.2 & A.3)
4. New Construction on Alternate Sites (Options B.1 & C.2)

1. Code Upgrade

The "Code Upgrade" option includes completing regular building maintenance, repairing/replacement of existing building systems that have reached their life expectancy or failed, and addressing pre-existing building code violations. Maintenance and updating building systems will be completed with fixtures that serve the same purpose. The "Code Upgrade" option will need to conform to Level 1 Work of the International Existing Building Code, 2015 Edition, as modified by the Massachusetts State Building Code, Ninth Edition.

Existing Structural Systems:

The two-story buildings consist of:

- Foundations:
  - 16" Concrete frost walls (2-#6 T&B) with continuous 2'-4" wide footing.
  - 12" Concrete retaining walls with continuous 5'-0" wide footing at South walls of buildings to resist stepped soil conditions.
  - Spread footings below columns, designed for soil bearing pressure of 6,000 psf.
  - Interior concrete walls (2-#6 T&B) below CMU partitions 8" and wider.
- Columns:
  - Steel tube columns. TS4x4, TS5x5, TS6x6 and additional rectangular sizes.
  - Wide flange steel columns. W6's, W8's & W10's.
- Floors (at grade):
  - 4" Concrete slab-on-grade at classrooms and common spaces.
  - 6" Concrete slab-on-grade at mechanical room.
- Walls
  - Interior walls are unreinforced concrete masonry units (CMU) at corridors, select interior partitions, and at perimeter of Gymnasium, Auditorium, and Mechanical Rooms.
  - Exterior walls are unreinforced CMU with brick veneer, or insulated wall panels.
  - Select interior partitions are metal studs with plaster.
- Floors (framed):
  - 2 ½" & 3" Concrete slab on metal form deck with 6x6 welded wire fabric at Classrooms.
  - 4" Reinforced structural concrete slabs reinforced with #3's at second floor area surrounding the gymnasium.
  - 6" Reinforced structural concrete slabs reinforced with #3's at connector bridges.
  - Joists: Classroom floors are typically framed with 16J & 18J Joists spaced at 24" o.c.
  - Beams: Non-composite W-beams (Typically W14's and W16's @ 2'-0" o.c. spanning 28 feet). Beams at the floors are typically located on column lines, corridors, or other non-repetitive framing layouts.

  - Girders: Non-composite W-beams (Typically W14's & W16's spanning 16 feet). Girders over Cafeteria are W24's.
- Roof:
  - Steel wide flange beams on column lines, corridors, and at non-typical bays.
  - Steel roof joists at framing infill between column lines (16J joists @ 4'-0" o.c.)
  - Long-span steel roof joists at Auditorium and Cafeteria roofs.
  - Long-span steel beams (W36's) with steel beam infill at Gymnasium roof.
  - Steel roof deck (1 ½" metal roof deck).
  - Insulated plank decking on bulb tees at Gymnasium roof.
  - Flat plate diagonal strapping for lateral forces (Typically 3"x ¼").
- Bracing:
  - Steel bracing towers at several column lines at each building Unit. Bracing towers are constructed with steel plates and steel rods.

Structural Scope:
The structural scope of the Code Upgrade option is fairly limited and will consist of correcting pre-existing Code violations and general repairs. Structural work will include:

- Seismic anchorage of interior CMU partitions built to the underside of floor/roof framing will need to be reviewed. Partitions and other walls built up to the underside, and not around, the steel members will need new anchorage or seismic clips to restrain the walls during a seismic event.
- Replacing deficient mechanical systems will include replacing equipment with similar equipment. The weights should remain unchanged, but should new, or heavier, equipment be required, the structural capacity of existing framing would need to be reviewed.
- Regular maintenance to the structure will include repointing of masonry veneer, re-caulking brick expansion joints, and painting steel lintels. Most of the brick veneer appears sound and stable, so maintenance would be limited to select locations only. Masonry infill will be required at several locations where mechanical openings were abandoned and infilled with wood framing.
- Roofing replacement is not anticipated, but if more than 50% of the roofing is replaced, the roof diaphragm will need to be investigated for resisting wind loads. Generally, most of the school roof consists of steel framing and a metal roof deck diaphragm, which appears to be adequate for resisting winds loads. The Gymnasium roof is framed differently, consisting of steel framing and insulated plank decking on bulb tees. The insulated plank on bulb tees typically do not resist diaphragm loads adequately, and will need to be investigated if the roofing is replaced. A possible solution may include removing the insulated panel system and replacing with metal roof decking and a traditional insulated roof system over the metal decking.

<u>Comments</u>: As part of the "Code Upgrade" option, the building will <u>not</u> be re-roofed, except at select locations where roof deck repair is required. Existing mechanical/electrical equipment will be repaired, or replaced with similar equipment. The structural scope of work will be fairly limited through most of the building and will likely need to comply with Level 1 Work, per the Building Code. As part of Level 1 Work, masonry parapets and masonry wall anchorage need to conform to the International Existing Building Code. Based on our review, there are no masonry parapets that need to be corrected, and the roof diaphragm appears to be connected to the exterior framing. Interior masonry partitions will need to be secured to the floor/roof framing to conform to the seismic code.

The building will continue to perform as currently used, but due to lack of renovation, addition, or additional structural improvement, the "Code Upgrade" option will limit future flexibility, such as, modifying room sizes. Also, since the building will be undergoing regular maintenance as part of the

"Code Upgrade" option, we recommend general repair of exterior masonry joints and repointing the brick at deteriorated locations.

2. Renovation and Addition

The "Renovation and Addition" option includes partial demolition of the existing building (77,500 ft^2), renovation of the existing building (98,00 ft^2), and a structurally isolated addition (322,000 ft^2) for a finished building of 420,000 ft^2. Due to the substantial renovation work involved within the existing building, the renovation portion of the "Renovation and Addition" options will need to conform to the International Existing Building Code for Level 3 Work, as modified by Chapter 34 of the Massachusetts State Building Code. The new construction portion of the project will need to conform to the current International Building Code, as modified by the Massachusetts State Building Code.

Existing Structural Systems:

- Structural systems of the existing building are similar to "Code Upgrade" option

New Addition Structural Systems:

- Additions will be seismically isolated from the existing building by installing building expansion joints.
- Foundations:
  - Interior concrete spread footings
  - Continuous reinforced concrete frost wall and footing at exterior walls at level site areas.
  - Concrete retaining walls and possibly concrete buttress walls at sloped site conditions.
- Columns:
  - Wide flange steel columns (W8 & W10)
- Framed Floors:
  - Wide flange composite steel beams.
  - Composite metal deck.
  - Concrete fill (light-weight concrete at fire-rated slabs).
- Roof:
  - Wide flange steel beams.
  - Long-span steel trusses and joists at open areas.
  - Metal roof deck
- Lateral Force Resisting System:
  - Concentrically braced steel frames.

Structural Scope at Existing Buildings:

- Seismic anchorage of interior CMU partitions must be reviewed similar to the "Code Upgrade" option.
- Support of new or replaced rooftop mechanical equipment will be similar to the "Code Upgrade" option.
- Complete regular maintenance at exterior envelope, including: re-pointing veneer, painting lintels, and caulking brick expansion joints.
- The proposed scope of demolition includes the existing Cafeteria/Kitchen, the west end of the upper Classroom Building, and the Gymnasium/Engineering Building. Due to the significant changes to the existing building, the remaining portions of the building will need to be fully reviewed for seismic load resistance in accordance with the Building Codes. We anticipate adding new seismic force-resisting elements throughout the existing building to

comply with the current Building Code requirements. New elements may include steel bracing towers, or reinforced concrete masonry unit (CMU) shear walls. Typically, the bracing would be HSS tubes located at corridor walls and demising walls between classrooms. The installation will require attaching new plates to existing columns, beams, and foundations for the tube bracing.

Comments: From a structural point of view, the “Renovation and Addition” option is the most involved due to the significant renovation of the existing building, phasing of construction, and the integration of the new construction. At a minimum, the existing building will need to be brought into compliance with the International Existing Building Code, as modified by Chapter 34 of the MSBC to increase basic life safety to the minimum requirements of the Code. We anticipate structural modifications to the existing building will be required due to the proposed renovation. Structural modifications will likely include redesigning the seismic bracing systems to resist current seismic loads, providing support for new mechanical systems, and laterally supporting existing masonry partitions.

It should be noted that the renovation will increase the life safety of the existing building, but it will not fully bring the existing building up to standards of the current Building Code due to lesser quality materials and design practices used at the time of original construction. Also, even though the renovation will extend the life of the existing building, the building should not be expected to last as long or perform as well as the newly constructed additions or a new building. Similar to the “Code Upgrade” option, the brick veneer will need to be repointed at deteriorated locations. Other water damage or deteriorated conditions may be discovered after finishes are removed for renovation and will need to be corrected at that time.

3. New Construction on Existing Site (Options A.1, A.2 & A.3)

The “New Construction on Existing Site” options consist of building an entirely new 420,000 ft^2 school on the same site as the existing school. The construction will take place while the existing school remains in use. The school will consist of a multi-story core area and multi-story classroom wings. The building will use standard construction methods and materials.

Structural Systems:

- Options A.1 & A.3 provide standard building layout with the large open floor plans (Auditorium & Gymnasium) located at grade.
- Option A.2 provides parking at the lowest level of the building with the Auditorium located above the parking area.
- Foundations:
  - Interior concrete spread footings
  - Continuous reinforced concrete frost wall and footing at exterior walls at level site areas.
  - Concrete retaining walls and possibly concrete buttress walls at sloped site conditions.
  - Foundation systems are assumed based on existing conditions and must be verified by a qualified Geotechnical Engineer.
- Columns:
  - Steel tube columns (HSS6x6 & HSS7x7) at 1 & 2-story portions of the building.
  - Wide flange steel columns (W8 & W10) at 3 & 4-story portions of the building.
- Framed Floors:
  - Wide flange composite steel beams
  - Composite metal deck

- Concrete fill
- Walls:
  - Light gauge framing will be used at interior partitions and exterior walls.
  - Reinforced CMU will be used at elevator shafts, locker rooms, gymnasium, and other high-abuse areas.
- Roof:
  - Wide flange steel beams
  - Metal roof deck
  - Designed to support photovoltaic panels.
- Lateral Force Resisting System:
  - Concentrically braced steel frames.

Comments: The "New Construction on Existing Site" Options A.1 & A.3 are flexible options, from a structural point of view. Option A.2 provides flexibility since it is new construction, but the parking located below the proposed Auditorium will require compromises with either the Auditorium column layout or the parking layout around the columns. All three options will also allow for increased life safety and more flexibility for sustainable design, relative to the "Code Upgrade" or "Renovation and Addition" options. Construction materials and systems will be designed in compliance with the current Massachusetts State Building Code.

4. New Construction on Alternate Site (Options B.1 & C.2)

The "New Construction on Alternate Site" options consist of building an entirely new 420,000 ft^2 school on either the Foley Stadium Site (B.1) or the Chandler Magnet Site (C.2). The construction will take place at an alternate site and will not affect the use of the existing school. Similar to the "New Construction on Existing Site" Options, the new school will consist of a multi-story core area and multi-story classroom wings. The building will use standard construction methods and materials.

Structural Systems:

- Foundations (Option B.1- Foley Stadium Site):
  - Existing test pits indicate up to 12 feet of coal ash and urban fill over peat.
  - Deep foundation system using piles.
  - Reinforced concrete grade beams at exterior walls and throughout building.
  - Structural concrete slab at grade level supported on grade beams and piles.
  - Foundation systems are assumed based on existing test pit information and must be verified by a qualified Geotechnical Engineer.
- Foundations (Option C.2- Chandler Magnet Site):
  - Interior concrete spread footings
  - Continuous reinforced concrete frost wall and footing at exterior walls at level site areas.
  - Concrete retaining walls and possibly concrete buttress walls at sloped site conditions.
  - Foundation systems are assumed based on existing conditions and must be verified by a qualified Geotechnical Engineer.
- Columns:
  - Steel tube columns (HSS6x6 & HSS7x7) at 1 & 2-story portions of the building.
  - Wide flange steel columns (W8 & W10) at 3 & 4-story portions of the building.
- Framed Floors:
  - Wide flange composite steel beams
  - Composite metal deck
  - Concrete fill

- Walls:
  - Light gauge framing will be used at interior partitions and exterior walls.
  - Reinforced CMU will be used at elevator shafts, locker rooms, gymnasium, and other high-abuse areas.
- Roof:
  - Wide flange steel beams
  - Metal roof deck
  - Designed to support photovoltaic panels.
- Lateral Force Resisting System:
  - Concentrically braced steel frames.

Comments: The “New Construction on Alternate Site” options offer a flexible option, from a structural point of view. These options will also allow for increased life safety and more flexibility for sustainable design, relative to the “Code Upgrade” or “Renovation and Addition” options. Construction materials and systems will be designed in compliance with the current Massachusetts State Building Code.

The most significant difference between the two site appears to be the existing sub-grade soil conditions. The Chandler Magnet Site appears to be located on dense sand/clay/gravel, likely allowing the use of typical shallow foundations, similar to the existing site. The Foley Stadium site appears to be located on coal ash, urban fill, and peat and will require deep foundations with structural concrete framing at the first floor due to the poor existing site conditions. Assumptions will need to be confirmed by a qualified Geotechnical Engineer, who will also need to provide design recommendations and site preparation requirements.

Conclusions:
We have reviewed the four design options and it our professional opinion that all four options are structurally feasible. The “Code Upgrade” option requires very few structural modifications due to the limited nature of the work. Minor structural work will be required to address the interior partitions and general deterioration of the building. The “Renovation and Addition” option will require demolishing a portion of the building and building a significant addition. Completing this work will require structural modifications to install building expansion joints and installing new seismic bracing within the remaining portion of the building. The addition will be structurally isolated to avoid impacting the existing building. The “New Construction” options are fairly straight forward; a new 420,000 ft^2 school will be constructed on either the same site adjacent to the existing school, or a new site at Chandler Magnet School or Foley Stadium. The Foley Stadium site is located on poor quality soil and will likely require deep foundations, structural concrete framing at the lowest level, and significant site maintenance to deal with poor soil during construction. The “New Construction” options provide the most flexibility, from a structural point of view, allowing the school construction to conform to the full extent of the current Building Code, but may not be as cost effective as the “Renovation and Addition” option.

Prepared by: Christopher Tutlis, President

3.3.3 D 1. d.
Doherty High School - Worcester, Ma.
Fire Protection - Final Evaluation of Alternatives
12-11-19

EXECUTIVE SUMMARY

The purpose of this study is to evaluate the need, feasibility and cost-impacts of adding a fire-protection (FP) sprinkler system to either the existing (renovated) building, or to a newly constructed building on one of 3 possible sites (existing site, Foley Stadium site, or Chandler Magnet School site).

The existing building structure, layout, and various hazard levels were summarized in the FP existing conditions report (dated 6-25-19). The FP PDP report (dated 8-28-19) noted available street water flow and pressure at the existing Doherty site as “good” (80 psi static, 75 psi residual, 1690 gpm flowing), but in need of current confirmation – since it was 12 years old.

We have since received flow test data near the 2, alternate, Chandler St sites. This data also needs to be confirmed, due to the age of the tests. As would be expected from a 24” street main, flow is very good at both sites - around 1,500 gpm.

Available pressure at the Foley site is even better than at the existing High School 93 psi static, 89 psi lower residual. The Chandler Magnet school site has the lowest available pressure of the 3 sites – roughly 60 psi static, 55 psi residual – explained by it’s much higher elevation compared to the other 2 sites.

It is important to note that all 3 sites have steep terrain, and will require a 4 (or more)-story academic wing because of the relatively small buildable area at each site. Under these conditions, a significant portion of the available pressure is “used up” just raising the water to the highest-level sprinklers. This is summarized in Table 1 below.

TABLE !

Location	New Construction Option	Available Static PSI	Available Static at Highest Sprinklers - PSI	Fire Pump Required for Spr.?	Fire Pump Required for Standpipe?
Existing Site	A.1 A.2 A.3	80 80 80	39.7 39.7 39.7	Can be avoided with larger than normal piping.	Yes, Due to "high-rise" building
Existing Site	Add-Reno	80	80.0	No	No - manual-wet standpipe
Foley Site	B.1	93	60.1	No	No - manual-wet standpipe

Magnet School.	C.2	60	33.2	Likely	No - manual-wet standpipe

All of the base-repair / renovation-addition / new construction options considered in the preliminary evaluation of alternatives would require a new, NFPA 13 sprinkler system, with sprinkler coverage “through-out”.

In addition, all but the base-repair option would require stairwell standpipes.

5 new construction and 1 addition-renovation options are considered in this report. Key fire protection characteristics are summarized in Table 2 below.

TABLE 2

Location	New Construction Option	FP Gross Area Sq. Ft.	No. of Standpipes / Hose Valves	No. of Roof Hydrants	Fire Pump Required ?
Existing Site	A.1	418,610	7 / 29	7	Yes, Due to "high-rise" building
	A.2	416,786	5 / 20	5	
	A.3	426,172	4 / 15	4	
Existing Site	Base-Repair	169,000	None	None	No
Existing Site	Add-Reno	378,000	3 / 14 est	3	No - manual-wet standpipe
Foley Site	B.1	397,078	7 / 28	7	No - manual-wet standpipe
Magnet School.	C.2	418,564	4 / 12	4	Likely

Based on this study, the following work is recommended.

- Provide a new, NFPA 13 system through-out.
- Provide stairwell stand-pipes where the top floor level is 30 ft. or more above adjacent grade. *This applies to all options except base-repair.*

- Confirm with the Worcester Fire Dept. (WFD) if they would accept a manual-wet-fire-dept.-connection to serve the standpipe system. This was accepted for South High School – so we expect the same approval for this school – ***except for existing site, new-construction options, which are all "high-rise" – manual-wet standpipe not permitted by code.***

- Provide a new, ***schematic-design*** phase flow test at the city-selected preferred site.

- Keep all storage heights less than 12', and keep storage confined to designated storage rooms, with appropriate FP coverage.

- Connect new FP system alarms to a new central Fire Alarm Control Panel (FACP).

- Provide new Kitchen Exhaust Hood and Hood FP system under Kitchen Equipment

- With the addition of a fire sprinkler system "though-out" the building, many of the existing portable fire extinguishers will no longer be required. These should be removed, to minimize maintenance costs.

Maintenance:

- Train in-house personnel, and provide required, regular, sprinkler system and fire extinguisher inspections using in-house inspectors

- Provide additional required maintenance and testing of FP and fire extinguisher systems, alarms and flow via maintenance contract.

BUILDING DESCRIPTION

General: The existing Doherty High School (DoHS) was constructed in the mid 1960s, and has 2, long narrow wings parallel to Highland St. Because the site is on a hill, the 2nd floor of the front wing is level with the 1st floor of the rear wing.

For additional comments on the existing layout, hazards, school flammability standards, and storage issues, see the Existing Conditions – Preliminary Design Program report, dated 6-25-19

CONSTRUCTION OPTIONS:

3.3.3 D 1. d.
Doherty High School - Worcester, Ma.
Fire Protection - Final Evaluation of Alternatives
12-11-19

Based on the preliminary design program (PDP) submission, the City and MSBA have concurred that the following options should be evaluated in more detail. These are:

1. Base Repair of the existing high school

2. Complete Renovation of the existing high school with a large addition

3. A.1 – New construction on existing site - "Pods on Park"

4. A.2 – New construction on existing site - "Olmstead Homage"

5. A.3 - New construction on existing site - "Highland Proud"

6. B.1 – New construction at the Foley Stadium site.

7. C.2 - New construction at the Chandler Magnet School site.

FIRE PROTECTION RECOMMENDATIONS AND COST ISSUES

Base Repair

1. New FP: Provide a new, NFPA 13, wet, fire protection system thru-out the building.

2. *Standpipes:* Not Required, except for 2 stage hose-stations.

3. *Fire Dept. Connection:* We understand the Worcester Fire Department has recently become compatible with both 4" Storz and 2-1/2" Siamese" FDCs. We will re-review with WFD, which type to install for this project. 2 FDCs will be required if the addition is ***not high-rise***. 3 FDCs would be required for any high-rise options.

4. *Fire Pump:* Not Required

5. *Phasing:* As the building will be occupied during the construction period, work will have to be done in phases. Phasing will increase FP contractor costs as follow:

   . mobilizing and de-mobilizing for each phase,
   . testing new piping by phase,
   . purchasing materials by phase,
   . obtaining inspections by phase,
   . addressing punch items by phase.
   draining down existing piping to connect new piping, and re-filling.

Full Renovation with Additions to the Building

This level of work would require that all current FP code requirements be met by the existing building as well as any addition. Fire Protection work includes:

1. *New FP:* Provide a new, NFPA 13, wet, fire protection system thru-out the original building and new addition.

2. *Standpipes:* The top floor level of the proposed addition will be more than 30 ft above the lowest fire department access. Thus, stairwell standpipes will be required through-out the new addition. The existing 2-story building would not require standpipes. Each stairwell (having a standpipe) that does ***not*** extend to the roof will also require a roof hydrant at the top of it's standpipe.

   Standpipes require a much higher water-pressure and flow than a sprinkler system. NFPA 14 (which governs the installation of standpipes) specifically states it it ***not*** their intent to require fire pumps for standpipes if the city pressure is sufficient for the sprinkler systems. Thus, NFPA 14 permits the use of a manual-wet Fire Department Connection (i.e. fire dept. pumper will provide the required pressures) for feeding the standpipes. NFPA 14 requires (in a fully sprinkled building) that 1000 gpm stand-pipe water flow rate be calculated, with 100 psi outlet pressure at the most remote hose.

   The proposed stage is over 1,000 square feet, so will have 2 stage hose-stations.

3. *Fire Dept. Connection:* We understand the Worcester Fire Department has recently become compatible with both 4" Storz and 2-1/2" Siamese" FDCs. We will re-review with WFD, which type to install for this project. 2 FDCs are required for this ***non-***high-rise-building option.

4. *Fire Pump:* The most recent flow test available near this site is from 2007, however it showed good pressure and very good flow: 80 psi static, 75 psi residual, with 1,690 gpm flowing.

   This flow and pressure are adequate for the sprinkler system, but not for standpipes.

   A manual-wet-FDC could provide sufficient pressure for the standpipes, and this is the expected design for this option. Thus no fire-pump would be required.

5. *Phasing:* As the building will be occupied during the construction period, work will have to be done in phases. Phasing will increase FP contractor costs as follow:

   . mobilizing and de-mobilizing for each phase,
   . testing new piping by phase,
   . purchasing materials by phase,

. obtaining inspections by phase,
. addressing punch items by phase.
draining down existing piping to connect new piping, and re-filling.

New Construction – existing site

All new-construction options at the existing site (A.1 to A.3) will be "high-rise" buildings. High-rise buildings have additional fire-protection requirements as follows:

- Standpipes must have an automatic water supply – this means a fire pump for these 3 options.

- A secondary water supply is required in seismic catergories C, D, E, and F. This site is seismic catergory B, so this does ***not apply.***

- 2-hour rated fire-pump room, and 2-hour rated access to same.

- A fully automatic back-up fire pump system is required if any portion of the high-rise standpipes cannot be served by the fire dept. pumper. This will have to be calculated for the preferred option.

All new Educational use buildings over 12,000 sqft must meet all current FP code requirements, including a new NFPA 13 fire protection system through-out the building. Fire Protection work for this option includes:

1. *New FP:* Provide a new, NFPA 13, wet, fire protection system thru-out the new school building. All 3 options also include an underground parking garage (under the building for A.1 and A.2 and under the adjoining fields for A.3). A "dry system" with dedicated piping, air-compressors, and risers will be required:

   A. for Options A.1 and A.2 if the parking garage exceeds 5,000 sqft.

   B. For Option A.3 if the parking garage exceeds 12,000 sqft.

2. *Standpipes:* The highest floor level for all A-options is well over 30 ft. above the lowest fire dept. access, thus stairwell standpipes are required in all 3 A options. Also for all A options, an interior hose station will be required on each floor level as the building is built. See table 2 for a summary count of standpipes, hose stations, and roof-hydrants.

   The stage planned is over 1,000 square feet, so 2 stage hose-stations ***will*** be required.

3. *Fire Dept. Connection:* We understand the Worcester Fire Department has recently become compatible with both 4" Storz and 2-1/2" Siamese" FDCs. We will re-

review with WFD, which type to install for this project. 3 FDCs are required for all A-options, which are all high-rise buildings.

4. *Fire Pump:* The most recent flow test available near this site is from 2007, however it showed good pressure and very good flow: 80 psi static, 75 psi residual, with 1,690 gpm flowing.

   This flow and pressure are adequate for the sprinkler system, but not for standpipes.

   As a manual-wet-FDCs is not permitted in high-rise buildings, these 3 options will all require a fire-pump.

5. *Phasing:* As the newly constructed building will be completed and occupied prior to any work in the existing building, there will be no additional FP costs for "phasing".

New Construction – Foley Stadium Site

All new Educational use buildings over 12,000 sqft must meet all current FP code requirements, including a new NFPA 13 fire protection system through-out the building. Fire Protection work for this option includes:

1. *New FP:* Provide a new, NFPA 13 fire protection system thru-out the new construction.

2. *Standpipes:* The highest floor level is well over 30 ft. above the lowest fire dept. access, thus stairwell standpipes will be required. Also, interior hose station will be required on each floor level as the building is built. See table 2 for a summary count of standpipes, hose stations, roof-hydrants, etc.

   The stage planned is over 1,000 square feet, so 2 stage hose-stations ***will*** be required.

3. *Fire Dept. Connection:* We understand the Worcester Fire Department has recently become compatible with both 4" Storz and 2-1/2" Siamese" FDCs. We will re-review with WFD, which type to install for this project. 2 FDCs will be required for this ***non-***high-rise-building site.

4. *Fire Pump:* The most recent flow test available near this site is from 2015, however it showed very good pressure and flow: 93 psi static, 89 psi residual, with 1,500 gpm flowing.

   This flow and pressure are adequate for the sprinkler system, but not for standpipes. A manual-wet-FDC could provide sufficient pressure for the standpipes, and this is the expected design for this ***non***-high-rise-building site.

5. *Phasing:* As the newly constructed building will be completed and occupied prior to any work in the existing building, there will be no additional FP costs for “phasing”.

New Construction – Chandler Magnet School Site

All new Educational use buildings over 12,000 sqft must meet all current FP code requirements, including a new NFPA 13 fire protection system through-out the building. Fire Protection work for this option includes:

4. *New FP:* Provide a new, NFPA 13 fire protection system thru-out the new construction.

5. *Standpipes:* The highest floor level is well over 30 ft. above the lowest fire dept. access, thus stairwell standpipes will be required. Also, interior hose station will be required on each floor level as the building is built. See table 2 for a summary count of standpipes, hose stations, roof-hydrants, etc.

   The stage planned is over 1,000 square feet, so 2 stage hose-stations ***will*** be required.

6. *Fire Dept. Connection:* We understand the Worcester Fire Department has recently become compatible with both 4” Storz and 2-1/2” Siamese” FDCs. We will re-review with WFD, which type to install for this project. 2 FDCs will be required for this ***non-***high-rise-building site.

4. *Fire Pump:* The most recent flow test available near this site is from 2001. It showed moderate pressure and very good flow: 60 psi static, 55 psi residual, with 1,500 gpm flowing.

   This flow and pressure may or may not be adequate for the sprinkler system. This site is the most likely to require a fire pump for the sprinkler system.

   A manual-wet-FDC could provide sufficient pressure for the standpipes, and this is the expected design for this ***non*** “high-rise-building” site.

5. *Phasing:* As the newly constructed building will be completed and occupied prior to any work in the existing building, there will be no additional FP costs for “phasing”.

GENERAL RECOMMENDATIONS IMPACTING FP COSTS

The following general recommendations apply to all renovation and new construction options being considered:

Storage:

The following storage recommendations apply to ***all options*** being considered:

- base-repair renovation,
- renovation-addition,
- new-construction-existing site

With attentive planning and design, the "hazard level" of storage can be minimized, to reduce FP cost and complexity.

1. **Miscellaneous Storage** has separate, and generally less stringent requirements for FP protection than regular storage. Thus, it is advantageous to adjust storage room design to ensure anything stored within would be considered "miscellaneous storage". NFPA requirements for "miscellaneous storage" are in plain text below, comments re school design are in **bold.**

    a. Storage must be incidental to the building's main use. **All storage rooms in E-use buildings qualify.**

    b. Height from the floor to the top of storage must not exceed 12'. **This can be best assured if the ceiling height is less than 12'.**

    c. Storage areas cannot exceed 10% of the total building area, or 4,000 sqft, whichever is less. **Make total sqft of storage rooms less than 4,000 sqft, and less than 10% of building's area..**

    d. Each individual storage area / pile cannot exceed 1000 sqft. **Make all storage rooms under 1,000 sqft.**

    e. If there are several "piles" of storage in a large open room, each 1,000 sqft pile must be 25' or more from the next pile. **In storage rooms over 1,000 sqft do not use any "caged" sub-rooms. Provide walls for any sub-rooms.**

2. **Miscellaneous Storage Hazard Levels:** The sizing of FP pipe is based on how large an area of sprinklers is assumed would activate in a fire, and how many gallons-per-minute (gpm) of water flow is required per sqft of operating area.

    As the "hazard level" increases, both the design operating area, and the required gpm/sqft also increase. Thus "extra-hazard" (EH1 and EH2) areas have a much, much higher total water flow (minimum 1250 to 1500) than "ordinary hazard" (OH1 or OH2) areas (minimum 475 to 550 gpm). This results in larger FP piping including the riser, backflow, and underground service.

EH areas also require a larger number of (more closely spaced) sprinklers to be installed, further increasing costs. The recommendations a thru d in **bold** below would keep the storage areas “ordinary hazard”.

a. Schools very often store materials in large plastic bins, which are virtually always Group A plastics. Group A plastics are the highest hazard of all “solid” materials typically found in a school. If a plastic bin contains ordinary hazards such as paper, wood, clothing, etc, (so the “bin” is less than 25% of the total volume), the “package” is considered an ordinary hazard. .**Use plastic bins primarily for storing ordinary hazard materials such as metals, paper, cardboard, foods, wood, leather, natural fibers, etc.**

b. Wherever possible, use sturdy cardboard cartons to store Group A plastic materials, and keep the top of plastic storage under 10’ AFF.

c. If plastic materials must be stored “exposed” or in plastic bins, keep the top of storage under 5’ AFF thru-out the entire plastic-storage area.

d. Storage that contains more than 25% (by volume) Group A plastics should be stored in a separate EH storage room (see adjacent hazards below)

3. **Flammable Liquids Storage Issues:** Provide listed flammable storage cabinets for the storage of all flammable or combustible liquids or chemicals.

4. **Adjacent hazards**: Sometimes there is a small area of high hazard storage located within a room that is mostly a lower hazard. An example is a “wire-cage” for off-season sports equipment, located within a receiving room. A fairly large percentage of sports equipment these days is made of plastic – most frequently Group A plastics.

   If the higher hazard is not separated from the surrounding, lower hazard area by a solid wall and ceiling, then the higher hazard determines the design area and gpm/sqft for both the high hazard area plus a 15’-on-all-sides buffer area.

   If the small high-hazard area is separated by a solid wall and ceiling, the design operating area is determined by the larger, surrounding (lower-hazard) room, and there is no 15’ extension of the higher hazard gpm/sqft.

   Where an area containing more-than-25%-by-volume-plastic storage occurs within a larger room containing paper, wood, foods, natural fibers, or metal

stored materials, provide a solid wall and ceiling around the plastic storage area.

5. **How Materials are Stored:** FP requirements vary depending on how materials are store: Different methods are listed below, from ***less*** hazardous, to ***more*** hazardous.

    a. Solid piled, palletized, bin-box, and shelf storage are lower hazard ways of storing.

        i. Solid piled means materials stacked on top of each other, directly on the floor.

        ii. Palletized means materials stored on top of pallets, often in solid-piled stacks.

        iii. Bin-box means materials stored in 5-sided wood, metal, or cardboard boxes, with the open side facing the aisle, and little or no horizontal or vertical space around individual boxes.

        iv. Shelf storage means stored on shelves 30" or less in depth, with minimum 30" aisles between shelves.

        v. **Store materials in solid piles, or on shelving less than 30" deep wherever possible. Metal shelves preferred. Wood acceptable. NO plastic shelving.**

    b. For all ***exposed (uncartoned)*** plastic materials, and for ordinary materials ***over 10' high,*** Back-to-back shelving and rack-storage are higher hazard ways of storing.

        i. **Try to avoid back-to-back shelving and rack storage where-ever top of storage is over 10' high, and avoid it for any exposed-plastic storage. To avoid them, use solid piled storage, or shelf storage under 30" deep (aisle to aisle).**

6. **Ceiling Height:** NFPA allows a ceiling height modifier to the basic design area, if quick response sprinklers are used. It only applies to light and ordinary hazard spaces, under 20' high, wet systems, with no unprotected ceiling pockets.

    a. If ceiling height is less than 10' for an "ordinary hazard (OH)" storage room, the design area can be reduced by 40%. This reduces total design flow by 40%, allowing smaller pipe to be used. **In an OH storage situation, a ceiling height 10' or under is very helpful.**

b. As the ceiling height increases up to 20', the design area reduction decreases in proportion, down to a low of 25%. **Still helpful, though with any ceiling over 12', we would be at greater risk of losing "miscellaneous storage" status.**

7. NFPA has a ceiling slope modifier to the basic design area:

    a. For ceiling slopes over 2:12, the design area must be ***increased*** by 30%. **Use only flat ceilings in storage areas.**

- **General Storage issues:** Plan for all storage heights to be less than 12'. Review available storage areas and storage needs. Organize storage to keep it confined to designated storage rooms, with appropriate FP coverage.

- **Special Storage Issues:** Provide listed flammable storage cabinets for the storage of all flammable or combustible liquids or chemicals. Do not permit any plastic shelving. Metal shelving has the best fire resistance, wood shelving is acceptable.

- **Flammability Standards:** Ensure that all (existing and) new furniture and window coverings meet 527 CMR flammability standards.

- **Fire Signaling:** Connect all new FP system alarms to a new central Fire Alarm Control Panel (FACP - provided under electrical).

Maintenance:

- **Training and inspections:** Train in-house personnel, and provide required monthly inspections using in-house inspectors

- **FP Maintenance Contract:** Provide additional code-required maintenance and testing of FP systems alarms and flow via maintenance contract.