CITY OF HALLOWELL

ENGINEERING/ENVIRONMENTAL SERVICES FOR FIRE STATION STRUCTURE

OCTOBER 6, 2009

Prepared by:

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October 6, 2009

Todd J. Shea
Interim City Manager
City of Hallowell
One Winthrop Street
Hallowell, Maine 04347

Subject: Visual Structural Observation
City of Hallowell Fire Station
124 Second Street
Hallowell, Maine

Dear Mr. Shea:

Thank for choosing E.S. Coffin Engineering & Surveying, Inc. to perform a visual structural observation of the City of Hallowell Fire Station located at 124 Second Street. The following report is the structural engineering portion of the Engineering/Environmental Services contract.

As part of our observation, no destructive or invasive testing or observations were performed. A visual observation does not constitute the entire structure being analyzed. Observations and subsequent assessments are limited as such to those limitations. The evaluation and report is not to be considered as a guarantee of condition and no warranty is implied. The work conducted does not constitute a building inspection.

Observations

We have separated our structural observation of the fire station into three separate areas including the original fire station, the wood addition and the fire tower. As part of our structural observation, we have generated as-built structural plans, floor plans and elevations that have been attached. The structural plans include approximate locations, sizes and spacings of existing framing limited to what could be seen through existing openings in the corresponding sheathing. Based on our observation and referencing the attached drawings, the following is a description of what was observed.

Original Fire Station

The original fire station is a wood framed three-story structure with multi-wythe solid brick exterior walls that was constructed in approximately 1828. The history of the usage of the building includes various uses ranging from Town Hall to a jail but has been primarily used to house fire-fighting vehicles as well as serve as sleeping quarters since 1898. The usage of the three levels of the station currently includes vehicle storage on the first level, a meeting room and abandoned apartment on the second level, and a mechanical space and the City of Hallowell Food Pantry on the basement level.

We conducted an observation of the roof framing within the attic space of the original fire station. Mobility within the space is limited to walking along the bottom chord of trusses due to the lack of a floor. We were able to observe the framing on the south side of the ridge but were not able to closely observe the framing on the north side due to inaccessibility. The roof framing for the original station

consists of five timber framed roof trusses evenly spaced along the length that span the width of the building. The timber frame trusses consist of 7 ½" wide by 9" tall top and bottom chord wood members that span from the exterior walls to the ridge. A 9" square king post at the center as well as 6" square diagonal members comprise the webbing of the truss (see Photo #1). Purlins consisting of the same 7-½" wide by 9" tall members frame into the top chords of the trusses at the ridge and at two evenly spaced locations along the slope. The connections of the truss members consist of dowel connections throughout. Framing into the purlins are (2) 4" square roof joists in each bay with an overall horizontal span of approximately 8'-0". The trusses are diagonally braced at both the bottom and top chords with inline bracing from the trusses back to the purlins. We also observed diagonal bracing along the length of the building between the trusses.

We observed that the trusses appear to be good condition with some minor longitudinal checking of the top chords with the connections appearing solid and intact. The roof joists and purlins appeared to be sagging in some locations but are in good condition. We observed that one of the original purlins has been replaced with a 4" wide by 6" deep wood member on the south side of the ridge. The replacement member was not connected with dowels similar to the original member but instead was connected using steel spikes. During the replacement, the diagonal bracing between the purlin and the top chord was removed and never replaced. The roof sheathing consists of wood planking spanning over the trusses and joists. Several locations of the planking have been replaced over the years with new planking in order to replace planking that was rotten or otherwise damaged. A majority of the planking on the east side has smoke damage from a previous fire in the wood addition. We also observed some minor charring of the planking at the east wall. During our limited observation of the planking, we did not observe signs of rot. We did not conduct an observation of the existing roof covering.

The second floor framing consists of 4" wide by 12" deep wood joists spaced at approximately 24" on center. The beams span in the north-south direction from a brick shelf on the exterior wall to an interior support beam which size and material could not be confirmed due to access limitations. Support for the middle support beam consists of (2) interior 8" square wood columns in the vehicle storage area and the east and west exterior brick walls. From the two locations where the framing could be observed, the joists appeared to be in good condition with no observed rotting. We were not able to observe the framing at the exterior bearing wall. The floor framing is covered with a metal ceiling, which is experiencing oxidation in several locations causing it to deteriorate and flake (see Photo #2).

The first floor framing for the fire station typically consists of 4" wide by 5 ½" tall wood joists spaced at approximately 26" on center that span in the east-west direction. However there are several areas where the floor framing size and spacing differs or additional members have been added. These areas include but are not limited to along the east wall where additional 2" wide by 12" deep floor joists are used in the first two bays off from the wall. The framing also is reinforced with 4" tall steel beams in the first bay along the west wall directly below the vehicle entry point (see Photo #3). The joists typically span approximately 9'-0" and are connected to original 8 1/2" wide by 8" tall wood beams that span in the north-south direction. At some point in the history of the building, the floor framing was reinforced by adding additional 8" wide by 10" tall beams under the joist framing to cut the joist span in half to 4'-6" (see Photo #4). We did observe that some of the reinforcing support beams have developed longitudinal checks along their lengths due to the drying of the wood. The checking in some of the beams must have raised concerns in the past due to observed additional steel and wood reinforcing that has been installed under the checked beams (see Photo #5). On the south side of the basement, a section of the reinforcing beams were installed over a compressed air storage tank, which required the removal of one of the post supports. In order to remove the post support, a 10" square beam was installed in between the adjoining post supports in the east/west direction. At the west support post, we observed a void between the top of the beam and the post support of the floor beam, which allows the floor beam to span farther than required (see Photo #6). On the north side of the basement, we observed that two of the reinforcing beams located near the entry into the Food Pantry are cantilevered. The length of the cantilever is causing

the beams to deflect which has created a void between the top of the beam and the floor joists. We also observed that the reinforcing beam located next to the west wall has a large area of dry rot along the bottom of the beam. The dry rot has progressed to the point where it allows considerable knife penetration but no actual damage in the form of cracking or crushing was observed.

Both the original and reinforcing support beams are supported by multiple post supports consisting of 8" square wood, irregular sized granite, and 12" square brick supports. It appears that all of the wood post supports were replaced at the same time the wood beam reinforcing was installed. We observed that a majority of both the joists and the beams appear to be solid and in good physical condition based on our observation and knife penetration. At the chimney, we observed that the floor framing is twisted and the framing stops abruptly at the opening without a support header (see Photo #7). A majority of the flooring and underside of the wood planking on the south side of the basement has smoke damage from the previous fire in the wood addition. We also did observe areas that show signs of water and salt damage to the floor sheathing and joists. Some of the joists in these areas are moist and had minimal knife penetration. These areas are localized and are discussed further in upcoming sections of the report.

Over the joist framing, the floor consists of multiple layers of wood planking and a concrete slab. From the top of the floor to the top of the framing, the assembly consists of a 7" thick slab over 1 ¾" thick wood planking over (2) layers of 1" thick wood planking (see Photo #8). The wood planking is most likely original to the building with the concrete slab being added at some point in order to better distribute the weight of the heavier vehicles and protect the floor framing and sheathing from water. The concrete slab may have been installed at the same time the reinforcing supports were added to the floor framing. Also at perhaps the same time, a large section of the floor joists had additional members installed on each side consisting of 2" wide by 2 ¾" tall wood joists (see Photo #9). The additional members are only located in the middle section of the first floor framing and looks to have been installed in order to install an additional layer of wood planking to the underside of the floor in between the original floor joists. The exact reason for the additional layer is not known but it may have been installed to reinforce a defected or rotten layer of wood planking.

The majority of the planking appears to be solid, dry and in good condition. However, we did observe sections of rot and/or decomposed planking. The areas of the damaged planking appear to be both along the west wall (see Photo #10) as well as a large area in the third and fourth bays off from the south overhead door at the west wall (see Photo #11). The planking in these areas has been rotten for some time causing the planking to decompose and flake off exposing the concrete slab above. An observation of the concrete slab at the overhead doors from above revealed that the doors are set back the width of the wall or approximately 18". The concrete slab at the doors extends over the top of the foundation wall with a slight pitch to drain rainwater away from the interior of the building. However, the concrete in this location has cracked which allows water and salt to drain down into the planking (see Photo #12). This is the most likely reason for the rotting of the planking. We observed cracking in the slab at both of the overhead doors with the south door having a larger degree of cracking. The planking damage observed in the basement mimicked the degree and location of the slab cracking with the planking below the north door having far less damage. The planking damage that was observed in the third and fourth bay out from the south overhead door is also most likely due to a crack in the concrete slab which is allowing water to penetrate the planking. Due to the bay having a fire truck at this location at the time of our observation, we were unable to confirm the presence of a crack in the slab that would appear to be sole reason for the leak.

The concrete slab itself appears to be in overall good condition with minimal cracking throughout in addition to the cracking described above. The lack of original crack control joints has caused the slab to crack erratically due to the drying and shrinkage of the concrete. We observed that the floor has minimal floor drainage to drain water and melting snow off from the trucks. There appears to be two original cast-in steel openings in the slab, which may have originally been drains. One appears to be operational while

the other is plugged in the basement and has standing water in it (see Photo #13). The station does have what appears to be a ventilation system that is ducted in the basement to four vents set in the concrete floor. The system can supply outside air to the inside of the station when the vehicles are started. The system has an intake blower in the basement that is connected to an outside louver. Activation of the system brings fresh air into the station through a series of ductwork and the floor vents. Our observation of the penetration through the floor at the vents from the basement showed a concentration of water and salt stains on the planking and joists (see Photo #14). This is most likely happening because water, melting snow and salt is being allowed to drain to these vents. The seal between the vent and the concrete has not been designed to drain water so the water is most likely getting behind the vent and into the wood planking. This would allow the damage that has been seen.

The foundation for the original fire station consists of a perimeter granite foundation wall with an approximately thickness of 22". The granite stones are vertically stacked on top of one another with a mortar connection. Both the granite and the mortar appear to be solid and in good condition. The south section of the foundation has an original concrete slab that is in good condition with minimal cracking and unevenness with minimal signs of water infiltration. The north section of the foundation has had a newer concrete slab placed over the existing slab most likely to gain elevation and have a cleaner surface for the Food Pantry. The slab appears to be in good to excellent condition. Each of the wood support posts set directly on a concrete pier that appears not be original. At the north side of the station, the grade drops along the length of the building in order to create a daylighted basement at the northeast corner. At this corner, a double exterior door accesses the Food Pantry in the basement (see Photo #15). We observed that the site grading along the north wall allows water to enter the basement at the exterior door. Recent steps have been taken in order to reduce the amount of water entering the basement including the installation of a trench drain in front of the door and the regrading and replacement of asphalt along the north side. Even with these measures in place, water is still entering the basement. We observed that the water is collecting around the base of several wood support columns causing the bottom of the columns to be constantly wet (see Photo #16).

The wall framing for the entire original building consists of a solid brick multi-wythe wall. The wall has an overall thickness of approximately 18" on the first floor and approximately 12" on the second floor and attic with it stepping at the second floor to support the floor framing. The interior face of the brick is covered in nearly every location but an observation of the exterior revealed that the brick is in good condition with minimal surface cracking and no signs of movement. We observed several locations of where the brick has been repointed over the years in sporadic fashion with several other areas requiring repointing (see Photo #17). The three visible exterior walls appear to be plumb from the exterior with no signs of bowing or movement. While observing the roof framing for the wood addition, it was revealed that a portion of the exterior brick on the east wall above a door between the stair and the living room is damaged. The damage includes the movement of the brick and missing bricks.

The original building had two brick chimneys at the east and west walls with a total of four. Currently the two chimneys on the north side of the ridge have been discontinued consisting of a cap above the roof covering. The southeast chimney is currently being used as a chase for a metalbestos chimney for the existing boiler in the basement while the southwest chimney is no longer used. All of the chimneys within the attic show damage consisting of removed bricks. In the attic and the meeting room on the second floor, there is significant past water and creosote damage on the floor and walls at the southeast chimney (see Photo #18). The damage continues and intensifies into the basement with a majority of the brick chimney and floor next to the chimney covered with creosote (see Photo #7). The most likely reason for the water and creosote damage is rainwater leakage through the chimney wall. It is difficult to determine if the damage was before or after the installation of the metalbestos chimney.

Wood Addition

The wood framed addition to the rear of the original fire station was added to the building at an unknown date. The addition served as storage and office space on the first floor, office and living space on the second floor, and storage space on the basement level. Currently all the floors are abandoned and used for storage except for one office on the first floor. The framing for each level is in varying degrees of disrepair due to damage suffered from a fire at some point in its history.

The roof framing for the addition consists of 2" wide by 7 ½" deep wood rafters with 2" wide by 5" deep collar ties both spaced between 16" and 24" on center. The rafters and collar ties span from the east exterior wall to the east exterior brick wall of the original fire station with a support at mid-span. The support at mid-span consists of an interior 2x4 bearing wall at the hallway with a triple 2x12 support beam above the living room. We could not confirm the presences of a similar beam above the kitchen area. The roof framing appears to be good condition with minimal damage received from the past fire. From the areas opened for observation, it appears the framing suffered only heavy smoke damaged and the members were not charred (see Photo #19). In several sections, the ceiling and interior wall sheathing have signs of water damage suffered during the extinguishing of the fire (see Photo #20).

On the second floor, we observed extensive cracking of the wall sheathing at the northwest corner where the addition abuts the original fire station (see Photo #21). We also observed cracking over windows along the north and east walls suggesting movement of the wall and/or floor framing. The floor framing in the kitchen has a pronounce dip in the middle with a differential floor to ceiling measurement from the exterior walls of over 1". The floor framing for the second floor consists of 2" wide by 9 ½" deep floor joists spaced between 16" and 24". The rafters are supported by the east wall consisting a ledger attached to a ballooned framed 2x4 studs spaced at 16" on center. The joists span from the ledger to the east brick wall of the original building with a support at mid-span. The support at mid-span consists of an interior 2x4 bearing wall or a 5" wide by 8" deep support beam which both align with the roof bearing wall above. The support beam is supported by a 4x4 post at its mid-span but we observed evidence of two other past support posts that appear to have been removed at some point (see Photo #22). An observation of the floor framing revealed that much of the floor framing has damage from the past fire including the charring of the joists causing a reduction in the size of the joists and heavy smoke damaged (see Photo #23). The damage has also caused the removal of a section of the support ledger along the west wall.

On the north side of the middle support wall, we observed gaps between the bottom of the second floor joists and the top of the supporting wall suggesting that the support wall has settled or the floor framing has risen (see Photo #24). Shims that were originally installed to make a tight connection between the two are setting on top of the wall with no connection to the floor framing. The lack of a support at the wall is causing the joists to span the entire width of the structure. In the same location, we observed that one of the floor joists has cracked severely at a location west of the support wall (see Photo #25). At the south side of the addition, the joists are in full contact with the support wall but the shims between the joists and wall are not charred suggesting that they were added after the fire (see Photo #26).

The first floor framing for the wood addition runs from the east wall westerly to a mid-span support beam to a ledger attached to the east wall of the original fire station. On the east side of the support beam, the joist framing is consistent with 2" wide by 10" deep joists spaced at approximately 18" on center with a single span from the support beam to the wall framing. A majority of the floor joists and floor planking have suffered heavy smoke and fire damage including the charring of the joists (see Photo #27). We observed that some of the fire-damaged joists have been reinforced by sistering new members to the sides of the joists (see Photo #28). At the north end of the framing, approximately five of the joists have been cut along their lengths and reinforced in order to increase the floor to ceiling height (see Photo #29). This was most likely done in order to store vehicles in the space through an entry door on the north side. The floor framing on the west side of the support beam varies in size but typically consists of the same 2" by

10" joists at 18" on center. All the framing spans from the middle support beam to a ledger attached to the east wall of the original fire station. The joists and planking have similar smoke and fire damage as the east side. Additional short span beams have been erratically added to the west section to reinforce the floor in particular locations. At the northwest corner, the floor framing changes to triple 2" wide by 6" deep joists spaced at 18" on center however the bottom elevation of the joists remain the same. This is to allow for the installation of a 4" concrete slab has been installed over the floor framing in this area. An observation of the entire floor framing revealed that the floor is considerably deflecting at the mid-support beam. Joists on both sides of the beam are inset into the beam with mortise and tendon connections. We observed that the deflection of the floor system has caused a gap in the connection at the bottom of the joists.

The middle support beam consists of a 10" wide by 12" deep beam that is supported by 6 ½" square wood posts along its length. The beam has also suffered damage from fire and smoke in locations along its length and is deflecting substantially as referenced above (see Photo #27). The largest deflection of the beam appears to be at the north support wall where the beam frames into a gable end beam. The gable end beam is supported by wall framing directly under the beam but the presences of two exterior doors minimize the amount of vertical support for the beam. The reinforcing beams on the west side of the middle beam consist of various sized beams that were installed most likely to support additional loading from concrete slabs placed over a portion of the floor framing. The beams were installed with no consistency in size or location indicating that they were most likely an after thought (see Photo #30). Two of the beams are insufficiently supported without end posts and with long cantilevers making their effectiveness minimal as reinforcing beams (see Photo #31). The remainder of the reinforcing beams are supported by either 6" square wood posts or 12" square brick piers. We observed that some of the wood posts are experiencing early signs of rot at their bases.

The foundation for the wood addition consists of a concrete foundation perimeter wall. The majority of the wall is below grade and inaccessible to view. We did observed a large vertical crack in the north foundation wall directly below the main support post for the middle support beam (see Photo #32). The interior floor of the space consists of a combination of uneven concrete and dirt floor. We could not verify the support for the wood posts but it appears that they set directly on the concrete slab portion.

The exterior wall framing consists of a combination of 2x6 and 2x4 studs spaced between 16" and 18" on center. The exterior of the building is covered with wood clapboards and trim throughout. The majority of the woodwork is in good condition with minor flaking and chipping paint with some locations showing signs of damage and rot. At the northeast corner and along the east wall, clapboards and trim have been damaged and/or removed most likely due to vehicle impacts from a neighboring parking lot (see Photo #33). The removal has caused the wall framing to be exposed to the elements and cause rot at these locations including the wall sill and framing. Various wall studs have had to be reinforced with small sections of wall framing due to missing sections and rot. We observed that the north exterior wall is deflecting substantially at the middle of the wall as noticed by the unevenness of the trim over the access doors to the basement (see Photo #33). The north wall is also showing signs of bowing outwards toward the north.

Fire Tower

The fire tower is a wood framed structure that was most likely added to the original fire station at the same time as the wood addition was added. The tower was originally used for the hanging of fire hoses in order to dry them after a fire. Currently the tower is abandoned and not in use. An exterior observation of the tower shows that the tower is leaning considerably in the easterly direction away from the original fire station. A steel cable has been installed around the perimeter of the tower and attached to the ridge of the original fire station. The cable was most likely installed to resist the leaning movement of the tower.

We were unable to access the interior of the tower above the first floor level due to the installation of insulation on the first floor ceiling. From our observation in the basement and on the second floor, the framing for the tower consists of 6" square wood posts at each corner. The 6" square posts continue down into the basement but are enclosed in wall sheathing. The support of the posts could not be confirmed.

Analysis

We conducted an analysis of the observed framing for each section in order to determine the loading capacities. For our analysis we used the design properties for Hemlock for all of the framing including a bending stress Fb of 775 PSI (pounds per square inch), a shear stress Fv of 75 PSI, a tension stress Ft of 370 PSI, and a modulus of elasticity E of 1,400,000 PSI. Along with these properties, we used adjustment factors including a repetitive factor Cr of 1.15 and appropriate size factors to finalize our values.

Original Fire Station

An analysis of the roof joist framing showed that it has a total load capacity of approximately 35 PSF (pounds per square foot). Based on a dead loading of 10 PSF for the framing, sheathing and covering, this leaves a live load capacity of 25 PSF. We did not conduct an analysis of the truss framing. The current snow load requirement for the City of Hallowell is a ground snow load of 70 PSF, which translates into a roof snow load of 49 PSF.

An analysis of the observed second floor joist framing showed that it has a total load capacity of approximately 65 PSF. Based on a dead loading of 10 PSF for the framing, sheathing and covering, this leaves a live load capacity of 55 PSF. The second floor space consists of an abandoned apartment and a meeting room. The current code required live loading for a residential unit is 40 PSF. The meeting room could be considered either an office or an assembly area. For an office space, the code required live load is 50 PSF where the loading is 100 PSF for an assembly area.

An analysis of the first floor joist framing showed that the joists have a total load capacity of approximately 300 PSF. Based on a dead loading of 100 PSF for the framing, sheathing and covering, this leaves a live load capacity of 200 PSF. An analysis of the original support beams showed that the beams have a total load capacity of approximately 250 PSF. Based on a dead loading of 100 PSF for the framing, sheathing and covering, this leaves a live load capacity of 150 PSF. An analysis of the reinforcing support beams showed that the beams have a total load capacity of approximately 325 PSF. Based on a dead loading of 100 PSF for the framing, sheathing and covering, this leaves a live load capacity of 225 PSF. The live load requirements for a fire station vary depending on the size of vehicle that is going to be supported where new designs typically take the wheel loadings directly from the manufacturer of the vehicle. However, a standard baseline for loading is using a H20 loading designated by the AASHTO (*American Association of State Highway and Transportation Officials*). This loading equates to a uniform loading of 250 PSF.

Wood Addition

An analysis of the roof rafters showed that the rafters have a load capacity of approximately 50 PSF. Based on a dead loading of 10 PSF for the framing, sheathing and covering, this leaves a live load capacity of 40 PSF. The required snow loading would be the same as the original station.

An analysis of the second floor joists showed that the joists have a total load capacity of approximately 40 PSF. Based on a dead loading of 10 PSF for the framing, sheathing and covering, this leaves a live load

capacity of 30 PSF. The space consists of office and living space with a live load requirement would be 50 PSF.

An analysis of the first floor joists showed that the joists have a total load capacity of approximately 40 PSF. Based on a dead loading of 10 PSF for the framing, sheathing and covering, this leaves a live load capacity of 30 PSF. The space is used for a combination of office and light storage, which have live load code requirements of 50 and 125 PSF.

Fire Tower

Due to the lack of access to observe the structural elements of the tower, we did not conduct a gravity or wind loading analysis of the fire tower framing.

Recommendations

Based on our site observation and analysis of the framing, we offer the following recommendations for each section of the building.

Original Fire Station

Our observation and analysis has revealed that the original fire station structure is in good structural condition but needs maintenance in order to prevent further damage from occurring. The structure was originally built very well using the best materials of the time. The manner for which it was built and the materials used has allowed the building to be used with minimal maintenance. We feel that this portion of the building can continue to be used as a fire station or as some other use into the foreseeable future. We have provided the following recommendations in order to address issues that we have observed in order to help preserve the use of the building.

The first recommendation is to eliminate water infiltration into the building. Water infiltration and the subsequent damage is the leading cause of damage to any building. The largest culprit of water infiltration is a leaking roof. The roof covering was not part of our observation but from the water and creosote damage observed in the meeting room on the second floor and basement, there appears to be past water leakage at either the intersection of the roof and chimney or in the chimney itself. The installation of the metalbestos chimney within the chase of the original chimney may have corrected this problem. If not, we recommend conducting a thorough investigation of the roof and chimney flashing by a reputable roofing company in order to get recommendations for current and future maintenance of the roof covering. If the leaking is coming through the chimney, the chimney itself needs to be evaluated by a chimney mason to determine if the leaking is coming from rainwater exiting through the wall. If rain is coming through the wall, a water diversion cap on the top of the chimney should provide enough cover to minimize future damage. The metalbestos chimney should be inspected and cleaned annually to reduce creosote build up as well.

The next item that needs attention is the leaking of the concrete floor due to cracks in the slab. The cracks in the slab are causing major damage to the planking below. Therefore the cracks need to be repaired. The wood planking, which served as the main floor sheathing for the original building, acted as forms for the concrete slab when it was placed. Now the concrete supports the floor by spanning in between the joists and beams. The wood planking does aid in distributing the loading but due to the tight spacing of the members, it isn't required to deliver the loading to the joists and beams. However, water infiltration through the concrete will also cause the rotting of the structural members. A solution to this problem also needs to address the lack of a method to drain water and melting snow that comes off from the vehicles. Currently the water is draining at the vent locations as well as other floor cracks.

We see two options available to address the draining of water and melting snow off from the vehicles. Both options include the recommendation of removing the existing floor ventilation system. The system allows water to drain at the vent locations and infiltrate the wood planking which creates a large maintenance issue. The vents need to be removed and the system replaced with an engine exhaust removal system that can be hung from the ceiling. The first option is to install new interior floor drains in the floor. Independent floor drains instead of floor trench drains would need to be used in order to not disturb the existing slab and joists as much as possible. The floor would be pitched to multiple drains that would be interconnected in the basement. Drainage from the floor drains will need to consist of either draining into an exterior holding tank with an alarm system that could be pumped out or an oil and grease separator that would then be connected into the public sewer system. The other option is not to install any floor drainage in the floor and clean the floor as needed.

In order to repair the cracks in the floor, we recommend installing a waterproof membrane under an epoxy floor covering over the entire floor. The waterproof membrane will fill and seal any existing cracks in the slab and therefore will prevent additional water from infiltrating into the planking. The epoxy covering over the membrane will be a durable hard surface that will resist vehicle loading and chemical damage from road salt. Both coatings will need to be applied from the wood addition to beyond the overhead doors. The coating needs to be installed by a professional company that is familiar with the product and the manufacturers installation recommendations. Field preparation of the existing slab will be crucial in the installation of the coating. The slab will need to be shot blasted in order to remove existing paint, dirt, oil, etc. Any existing large cracks will also need to be cleaned out and loose pieces removed. Once prepared, a waterproof membrane similar to Elast-o-coat with a NO-SAG #1 admixture by Dur-a-flex, Inc. can be applied to the surface.

After the waterproofing membrane has been installed, the epoxy covering can be installed on the floor. If the floor is to have new floor drains installed, a Dur-a-crete epoxy mortar would need to be installed over the membrane. The mortar can be installed in varying thicknesses in order to pitch the floor to the drain locations. After the install of the mortar is complete, a 1/8" thick Dur-a-flex Shop Coat wearing surface is then installed with a final topcoat. The final surface can be painted with line striping for guiding the trucks into the bays. If the floor drains are not to be installed, the Dur-a-crete layer can be eliminated and the wearing surface and topcoat can be installed.

The overall condition of the first floor framing is good. Our analysis has shown that the floor framing is capable of supporting very large loading even when assuming conservative safety factors. At this point, the replacement or reinforcing of the planking is not required at the rot locations due to the concrete spanning to the joists. Once the floor drainage issue is repaired, we recommend adding additional joists of similar size to the few joists at locations of rotted planking incase the joist framing is rotten on the topside and not visible. On the south side of the basement demising wall, we recommend the following for the floor framing. The beam that supports the removal of a post at the air compressor tanks has a void on the west end between the top of the beam and the bottom of the post support for the floor beam. This void needs to be infilled with solid 8x8 wood blocking in order to transfer the loading through to the lower wood post. At the southeast chimney, a double 2x6 support header needs to be installed in order to support the open floor framing. On the north side of the demising wall, we recommend the following recommendations to the floor framing. Solid blocking needs to be installed between the bottom of the floor framing and the top of the cantilevered beam at the northeast entrance into the Food Pantry. Lastly, the dry rot observed in the support beam needs to be monitored annually for cracking or movement.

The foundation for the original building appears to be in good condition with no recommendations at this time. The mortar joints appear to be intact and not in need of repair.

The bottom of the post supports for the first floor framing on the north side of the building are being subjected to moisture due to the leaking of stormwater at the entry door. The constant moisture is

progressing the rot process of the wood posts which if left as is will require the posts be replaced sooner than normally required. Water is being allowed to enter the building due to the insufficient exterior grade along the north side. The entire length of the building needs to be re-graded in order to divert water away from the door. This may require the moving or modification of the existing catch basin to the east of the door. If the change to the exterior grade is not made, the condition of the posts needs to be monitored annually.

Due to the limited observation of the second floor framing, we have no recommendations for the second floor framing. Based on our structural analysis of the joist framing observed, it appears that the framing is capable of supporting the loading from an apartment or office on the second floor. However, the second floor meeting room should not be used as a large assembly and should be limited to an occupant load of fewer than 50 people. An assembly use would require the space be rated for a live load of 100 PSF.

The roof framing for the original fire station appears to be in good condition despite its low loading capacity and age. The various locations of replaced roof sheathing shows that periodic maintenance has been taking place. The maintenance needs to continue with yearly observations of the roof covering to make sure the roof isn't allowing water to enter the building. The purlin that was replaced with a smaller member needs to be replaced with a triple 2x12 built up beam. The replacement purlin needs to be attached to the original trusses using Simpson LUS212-3 face mount hangers. The connection of the roof joists to the replacement purlin also needs to consist of Simpson face mount hangers of appropriate size.

The repointing of the remainder of the exterior brick needs to be put into a maintenance plan for the building. The repointing will lengthen the life of the building by not giving water a ledge to collect and freeze which will deteriorate the brick. The deterioration will cause cracking which will expose more of the brick to water and additional cracking. If water is allowed to enter the building, it will lead to the deterioration of the interior brick and wood framing.

Wood Addition & Fire Tower

The foundation, structural framing and wall framing of the wood addition are in overall poor condition. The various signs of deflection in the first and upper floor framing along with the damage observed in the north wall suggests that the foundation support system has failed with a concentration of the failure along the north wall. The failure is most likely due to the settlement of the foundation. Reasons for the settlement include the foundation being of insufficient size to handle the imposed loading, the foundation having been constructed on a fill site or a combination of the two. Construction on a site that had been previously filled without proper compaction or consisting of organic material would cause the foundation to settle over time. At the second floor framing, the failed foundation has lead to the settlement of the support beams causing a lack of support for the floor framing and the cracking of a floor joist. The damage to the wall framing and sheathing has also been caused by the addition separating from the original fire station due to the settlement. Extensive fire and water damage throughout the building has compounded the problem by weakening members and connections along with reducing loading capacities of members that originally did not meet minimal loading capacities.

A recommendation on how to proceed with the wood addition needs to consider both the proposed usage of the space as well as the condition of and recommendations for the fire tower. With both the tower and addition being constructed at the same time with integrated framing and foundation types, a decision on one affects the other. As discussed, the fire tower is leaning considerably in the easterly direction. Without observing the framing for the tower, the most likely reason for its movement is also the settlement of the support foundation similar to the cause of the damage associated with the wood addition. The settlement of the support posts for the tower would produce a lean in the tower similar to what is seen today.

Assuming that this is the reason for the lean, the lean can be stabilized with additional posting down to a new foundation supports in the basement. However, the lean itself is not easily repaired. An attempt to raise the east side of the tower may cause additional damage to existing members and connections in the tower and wood addition. Another unknown is the condition of a connection between the tower and the east wall of the original station. Due to the height of the tower, it is most likely attached to the east wall along its height. The lean may have caused these connections to fail or weaken. Lastly, the tower represents a large public safety concern because if the tower were to completely fail, the damage would be devastating and life threatening. Therefore based on the knowledge gained to date on the tower, immediate steps need to be taken in order to stabilize the tower in order to minimize the potential of a failure. We also feel that the tower would require an extensive remedial structural renovation in order to repair current damage, rehabilitate and strengthen the structure to ensure its future stability. Due to the costs associated with such a task and the lack of usefulness of the tower, the option of razing the tower should be considered before taking additional steps to stabilize it. The removal of the tower can be accomplished without the removal of the wood addition. The tower framing would be removed below the level of the addition's roof and then new roof framing could be installed over the void left by the tower. If the roof covering could not be tied into the existing covering on the addition, the entire covering may need to be replaced. From our observation, there appears to be no openings in the east wall of the original fire station above the roof level of the addition that would need to be infilled. However, there will most likely be some brick repair if the connections between the wall and the tower were compromised due to the lean of the tower.

For the wood addition, if the intention was to save the structure in order to make it safe and useable for light storage, minimal steps could be taken in order to stabilize the structure and meet current code loading requirements. The stabilization would include the installation of new support beams and posts to new foundation supports along with reinforcing joists and bracing as needed. This would decrease span lengths and increase loading capacities of the existing framing. The settlement would be minimized by the installation of additional foundation supports, which would allow the loading for the structure to be spread out over a larger area. However the increase in added support walls, beams and foundation supports would not make the space functional for any other use than storage.

If the intention were to utilize the space for office or living space, the first step would be to determine the exact reason for the settlement in the foundation. This could be determined by conducting test pits on the interior and exterior side of the north foundation wall. The test pits would determine if the supporting grade was part of a fill site and the size of the existing foundation footing. Knowing the size of the footing would allow us to determine the bearing pressure being exerted on the subgrade and whether the footing is undersized for the loading. Upon completion of the soil and foundation investigation, we would know if the foundation needed to be replaced or if the existing foundation could be repaired or reinforced.

Assuming a solution could be resolved for the foundation, the next step would be the complete gutting of the interior in order to completely reinforce all of the roof and floor framing and support members. This would be required in order to both repair fire damage and meet current code requirements. In addition, the wall framing would need to be reinforced in areas damaged from fire and rot. Before the reinforcing could be completed, an effort would need to be made to relieve the sag in the exterior walls and floors. In addition to all of the structural reinforcing, portions if not all of the electrical, plumbing and heating systems would also have to be replaced. The results of this work would be a reinforced building that would most likely still show some signs of past movement. Given the amount of reinforcing required and the condition of the end product, a cost analysis would need to be done to determine if the better option would be to raze the wood addition and build a new building in its place.

If the intention is to put minimal effort and resources into the addition and leave it as is, we recommend that the addition be razed before a failure occurs which would most likely create damage to the east wall of the original fire station. After our visual observation and structural analysis of the members, we feel that the damage suffered by the addition from the fire and foundation settlement will continue to occur with further settlement and movement.

The razing of the addition will require the razing of the fire tower as well. The tower cannot stay intact without the support of the addition. The razing of the addition will require provisions be made to the east wall of the original fire station. The east wall has several existing door openings into the wood addition that were most likely window openings when the building was originally constructed. These openings will need to be infilled with either windows to match the existing windows or brick. The existing openings in the granite foundation will also need to be infilled with granite, brick or an exterior door to the south side of the basement.

Conclusion

This concludes the visual structural observation report portion of the Engineering/Environmental Services for the fire station. We have attached elevations and floor plans of the existing building as well as two options that show the removal of just the fire tower and the removal of both the fire tower and wood addition. Once you have reviewed the report and the attached drawings, please feel free to contact us with any questions. We will also be available to discuss options and provide an additional proposal if it is decided to keep and renovated the wood addition.

Sincerely,

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LICENSED PROFESSIONAL ENGINEER

10/14/09