

## REPORT ON CAPITOL HILL HOUSING’S UNREINFORCED MASONRY BUILDINGS

**DATE:** July 31, 2018  
**TO:** Leadership Team  
**FROM:** Dylan Locati  
**REGARDING:** CHH’s Unreinforced Masonry (“URM”) Buildings

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**SUMMARY:** The Seattle City Council is currently contemplating adopting an ordinance that would mandate owners of “Unreinforced Masonry” (URM; see Addendum A for description) buildings to make seismic retrofits in order to make them more earthquake resilient. Although the ordinance is currently in draft form and anticipated to be brought to a vote in 2019, the Seattle Department of Constructions and Inspections (SDCI) has done outreach to building owners and compiled a list of properties preliminary research has identified as being possible URM buildings. Capitol Hill Housing has received letters from the City for ten of our properties that may be subject to the ordinance’s retrofit requirements.

**ACTIONS TAKEN:** CHH has engaged the structural engineering services of Swenson Say Fagét (SSF) to review each of the ten properties. Additionally, CHH tasked SSF to evaluate five other properties not identified by the City but which share similar characteristics with URM buildings (e.g. brick masonry façade). The following is a summary of their findings:

<u>Building</u>	<u>Identified by City</u>	<u>Vulnerability</u>	<u>Engineer’s Findings</u>
Berneva	No	n/a	Not URM; exempt
<i>Bremer</i>	<i>Yes</i>	<i>High</i>	<i>Not URM; exempt<sup>(1)</sup></i>
<b>Brewster</b>	<b>Yes</b>	<b>Medium</b>	<b>URM; mandated retrofits</b>
Devonshire	No	n/a	Not URM; exempt
<b>Fleming</b>	<b>Yes</b>	<b>Medium</b>	<b>URM; mandated retrofits</b>
Fredonia	No	n/a	Not URM; exempt
Helen V	No	n/a	Not URM; exempt
<b>Larned</b>	<b>Yes</b>	<b>Medium</b>	<b>URM; mandated retrofits</b>
Lincoln Court	Yes	Medium	Not URM; exempt
<b>Melrose</b>	<b>Yes</b>	<b>Medium</b>	<b>URM; mandated retrofits</b>
Oleta	No	n/a	Not URM; exempt
Park Hill	Yes	Medium	Not URM; exempt
<b>Silvian</b>	<b>Yes</b>	<b>Medium</b>	<b>URM; mandated retrofits</b>
<b>Villa</b>	<b>Yes</b>	<b>High</b>	<b>URM; mandated retrofits</b>
<i>El Nor<sup>(2)</sup></i>	<i>Yes</i>	<i>Medium</i>	<i>TBD</i>

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(1) Although Bremer was found to not technically be a URM building, SSF strongly recommends it be retrofitted as one. Bremer will be included in the “CHH Portfolio 1” project and will have earthquake protection retrofits included.  
(2) El Nor evaluation and potential retrofit is being led by the Property Development team as part of the resyndication process.

**NEXT STEPS:** The Policy Committee advising the City Council on the draft ordinance has proposed the following timeline for implementing URM retrofits:

<b>Timeline for URM Policy Compliance</b>			
	<b>Critical vulnerability URM</b> s	<b>High vulnerability URM</b> s	<b>Medium vulnerability URM</b> s
<b>Notification</b>	year 0	year 0	year 0
<b>Assessment</b>	+1 year	+2 years	+3 years
<b>Apply for permit</b>	+1 year	+2 years	+2 years
<b>Approve permit</b>	+1 year	+1 year	+1 year
<b>Retrofit completion</b>	+4 years	+ 5 years	+ 7 years
<b>Total time allowed (notification to retrofit completion)</b>	<b>7 years</b>	<b>10 years</b>	<b>13 years</b>

*\*Year 0 is the year in which City Council passes ordinance and initiates program (anticipated 2019)*

Total time allotted for policy implementation ranges from 7 – 13 years based off the vulnerability of the building, as determined by the Committee. Vulnerability categories are determined by factors such as the number of residents living at the building, it’s primary use, and soil conditions. CHH has two properties classified as “High”: the Bremer and the Villa. SSF has determined that the Bremer is in fact not a URM bearing wall building and can thus be removed from the City’s list, however, they strongly recommend it be retrofitted as if it were a URM building. Property Development has included the Bremer in the “Capitol Hill Portfolio 1” project in order to finance seismic upgrades and other improvements.

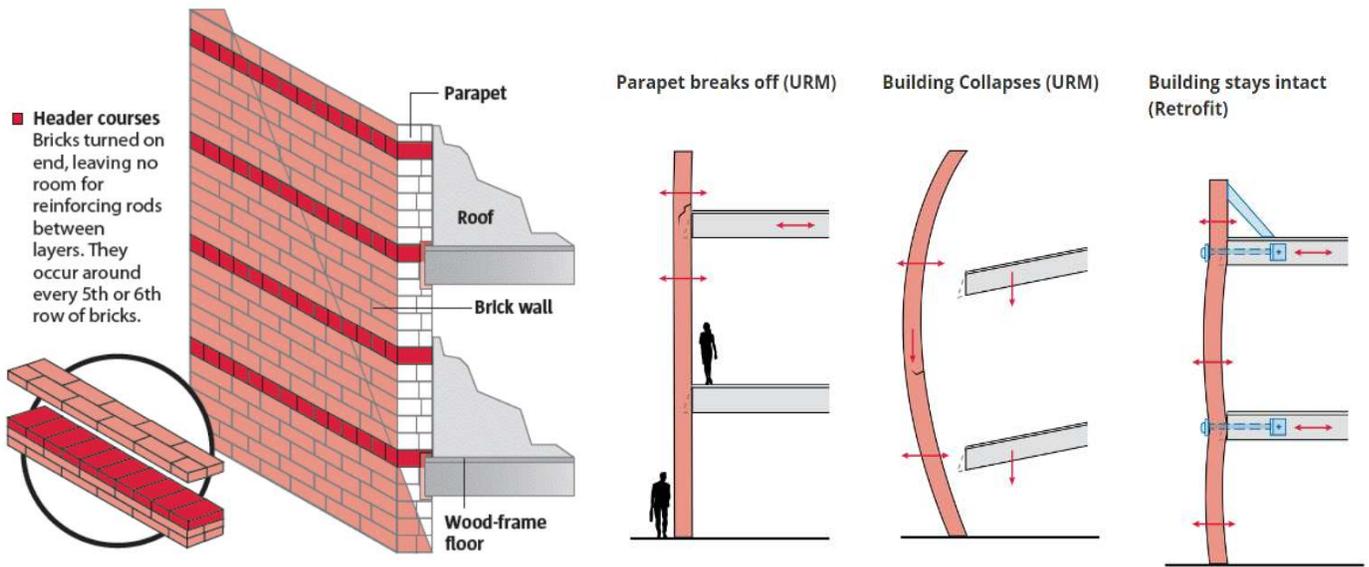
The remaining eight buildings on the City’s list are classified as “Medium vulnerability”; the lowest priority category. As noted in the table on page 1, two of these buildings (Park Hill and Lincoln Court) have been determined to be non-URM buildings. CHH’s next steps will be to send the engineer’s findings to the City in order to remove Park Hill, Lincoln Court, and the Bremer from the URM list.

CHH will review the engineer’s recommendations for confirmed URM buildings (see Addendum B for summary and detailed recommendations) and begin crafting action plans and establishing timelines for retrofit work. Additionally, CHH will review the engineer’s recommendations for retrofits at several non-URM buildings (Bremer, Lincoln Court, and Park Hill). The preliminary nature of the ordinance leaves the financing aspect uncertain and will likely alter CHH’s project timing once those details become known.

**CONCLUSION:** CHH is dedicated to providing safe and affordable communities. Moreover, CHH has been recognized for its work in preserving structures that capture the character and design of prior eras. Unfortunately, many of these buildings do not meet current seismic code standards. We believe that our commitment to providing safe housing has been demonstrated by prior safety-enhancing retrofits that we have made as well as the proactive approach we have taken in confronting this challenge.

## ADDENDUM A

“Unreinforced Masonry” buildings are buildings where load bearing walls, non-load bearing walls or other structures, such as chimneys, are made of brick, cinderblock, tiles, adobe or other masonry material that is not braced by reinforcing material, such as rebar in a concrete or cinderblock. URM structures are vulnerable to collapse in an earthquake. One problem is that most mortar used to hold bricks together is not strong enough. Additionally, masonry elements may “peel” from the building, and fall onto occupants or passersby outside. In Seattle, most of these buildings were built prior to 1945.



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## ADDENDUM B

### CHH Unreinforced Masonry Building Summary Matrix

 : URM Bolts+ Qualifies

 : Non-URM

Retrofit	Brewster	Fleming	Larned <sup>(1)</sup>	Melrose	Silvian <sup>(2)</sup>	Villa	Bremer	Lincoln Court	Park Hill	El Nor <sup>(3)</sup>
URM Shear Walls					X	X				
Wall Anchorage	X	X	X	X	X		X			
Force Transfer to Shear Walls	X	X	X	X	X	X	X			
Wall Bracing					X					
Diaphragms			X		X					
Wall Height-to-Thickness Ratio				X			X			
Parapets		X	X				X			
Chimneys		X								
Moment Frames			X							
Girder-Column Connections			X							
Settlement Remediation								X		
Veneer Re-Anchor									X	
<b>Estimated Cost Range</b>	\$	\$\$	\$\$	\$\$	\$\$\$	\$	\$\$	\$	\$	

- 1) Partially qualifies; has vertical irregularity (soft or weak first story) on the east and west elevations and the east and west walls at first floor have 0% qualifying piers (minimum of 40% to qualify)
- 2) Partially qualifies; cross walls do not extend above the attic to roof diaphragm and North South and East Walls are 31% solid (minimum of 40% to qualify)
- 3) El Nor evaluation and potential retrofit is being headed by Property Development department as part of the resyndication process

**█ : Non-URM Brick Masonry Buildings**

<b>Retrofit</b>	<b>Helen V</b>	<b>Oleta</b>	<b>Fredonia</b>	<b>Berneva</b>	<b>Devonshire</b>
URM Shear Walls					
Wall Anchorage					
Force Transfer to Shear Walls					
Wall Bracing					
Diaphragms					
Wall Height-to-Thickness Ratio					
Parapets					
Chimneys					
Moment Frames					
Girder-Column Connections					
Settlement Remediation					
Veneer Re-Anchor					
<b>Estimated Cost Range</b>	<b>n/a</b>	<b>n/a</b>	<b>n/a</b>	<b>n/a</b>	<b>n/a</b>

The following retrofit details have been extracted from the SSF evaluation reports and can be found on Integratec (under Documents → select “Consultant Reports” under Main Type → select “URM report” under Secondary Type

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## Bremer (included in Property Development “CH Portfolio 1” Project)

Non-URM

(should be retrofitted as if URM)

Recommended retrofits (in order of priority):

### 1. Parapet and chimney bracing

- a. **Finding:** The 1992 drawings included details for bracing of the roof parapet walls. During our site visit, no evidence of the parapet bracing installation was observed. The work was noted on plans as “Deferred until roofing replacement” and presumably was never completed. URM parapets are a known falling hazard during a seismic event and should be braced if they project above the roof level more than 1.5 times their thickness. All parapets at the building exceed this height limitation. The unreinforced masonry chimneys extending above the roof are a known hazard during a seismic event. Chimneys should be braced when their height exceeds twice the smallest dimension. The chimney at the Bremer Apartments does not exceed the maximum recommended height-to-thickness ratio.
- b. **Recommendation:** We recommend installing parapet bracing around the perimeter of the roof. Parapet bracing may consist of steel angle braces spaced at 48” on center connecting the parapet to the roof deck. Typical bracing anchorage includes epoxy grouted threaded rods at the URM wall and blocking installed in the roof joists to support the out-of-plane forces. Though the chimney does not exceed the maximum height to thickness ratio, we recommend bracing it at the same height as the adjacent parapet.

### 2. Force Transfer to Shear Walls

- a. **Finding:** There does not appear to be a connection to transfer in-plane shear forces from the floor and roof diaphragms to the exterior walls.
- b. **Recommendation:** To transfer the seismic forces to the URM shear walls, we recommend installing threaded rod shear bolts through existing blocking and joists, where they are perpendicular to the walls. Wall anchor rods, described above, provide shear transfer between the walls and blocking (or joists, where parallel to the wall) at 4’ on-center. We also recommend nailing the perimeter of the diaphragm to the blocking/joists with 16d box nails @ 4” on-center.

### 3. Wall Anchorage

- a. **Finding:** The exterior URM walls depend on attachment to the floor and roof diaphragms for lateral out- of-plane bracing. Wall anchorage was not observed at the roof or floor levels, and no evidence of anchorage was observed from the exterior of the building. Non-conforming wall anchorage is typical for this type and age of construction.

- b. **Recommendation:** Wall anchorage would likely consist of premanufactured steel anchors, Simpson LTT19 or equivalent, spaced at 4 feet on center, and attached to the floor joists and walls with ¾" diameter threaded rod and rosettes. Anchorage should be placed at all elevated diaphragm levels on all elevations.

#### 4. Wall Height-to-Thickness Ratio

- a. **Finding:** Walls exceeding the recommended height to thickness ratios are susceptible to collapse in a seismic event. Due to the wood framed bearing walls adjacent to the exterior URM walls, the URM walls are thinner than a typical building of similar size. The exterior walls are only two wythe thick and exceed the height to thickness ratio between the third floor and the roof by a factor of 2.0.
- b. **Recommendation:** Because of the wood bearing wall construction, we believe the risk associated with out-of-plane wall collapse is lesser than compared with a typical URM bearing wall building. It is worth having a conversation with the SDCI regarding exceptions to the wall thickness restrictions. If the walls are determined to be out of compliance, then we recommend reinforcing the third-floor walls with vertical strong back posts at six feet on center. Strong backs would consist of HSS tubes or heavy gage steel studs anchored to the wall with epoxy anchors and a braced to the floor and roof diaphragms.

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## Brewster

URM

Qualifies for Bolts+ Retrofit

Recommended retrofits (in order of priority):

#### 1. Force Transfer to Shear Walls

- a. **Finding:** Connections to transfer in-plane shear forces from the floor and roof diaphragms to the exterior walls occurs only at the North and South elevations at the 3rd floor. The 10d panel edge nailing transfers lateral loads from the new plywood overlay into 2x wood ledgers connected to the exterior URM walls with the out-of-plane anchorage thru bolts which double as shear anchors. These connections, however, do not provide sufficient capacity to meet the strength criteria of the proposed ordinance.
- b. **Recommendation:** To transfer the seismic forces to the URM shear walls, we recommend installing threaded rod shear bolts at 48 inches on center at locations of existing bent plate anchors, which occur at the East and West walls at the 1st, 2nd, 3rd, and roof levels and at the South wall at the roof level. We also recommend nailing the perimeter of the diaphragm to the blocking/joists with 16d box nails at 4 inches on-center at all wall and floor locations.

#### 2. Wall Anchorage

- a. **Finding:** The exterior URM walls depend on attachment to the floor and roof diaphragms for lateral out- of-plane bracing. Wall anchorage is present at the roof and all floor levels. Wall anchorage at the North and South elevations at the 3rd floor and at the North elevation at the roof consists of ¾" diameter thru bolts at 48 inches on center with

rosettes at the exterior face and interior MTT28 straps connected to perpendicular floor or roof joists. Wall anchorage at all other locations consists of ¾" diameter thru bolts at 48 inches on center with rosettes at the exterior face and interior ¼" steel bent plates nailed to two or three bays of blocking between joists. According to our analysis the bent plate anchors do not meet the anchor strength criteria of the proposed ordinance, so only the wall anchorage at the North and South elevations at the 3rd floor and the North elevation at the roof conforms with the minimum requirements for Bolts Plus retrofit.

- b. Recommendation:** Nonconforming bent plate anchors may be retrofitted by providing new steel plates between the existing bent plates and thru bolt heads.

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## Fleming

URM

Qualifies for Bolts+ Retrofit

Recommended retrofits (in order of priority):

### 1. Parapet and chimney bracing

- a. Finding:** The URM parapets have not been braced for out-of-plane forces. URM parapets are a known falling hazard during a seismic event and should be braced if they project above the roof level more than 1.5 times their thickness. All parapets at the building exceed this height limitation. The unreinforced masonry chimneys extending above the roof are a known hazard during a seismic event. Chimney should be braced when their height exceeds twice the smallest dimension. The chimney at the Fleming does not exceed the maximum recommended height-to-thickness ratio.
- b. Recommendation:** We recommend installing parapet bracing around the perimeter of the roof. Parapet bracing may consist of steel angle braces spaced at 48" on center connection the parapet to the roof deck. Typical bracing anchorage includes epoxy grouted threaded rods at the URM wall and blocking installed in the roof joists to support the out-of-plane forces. Though the chimney does not exceed the maximum height-to-thickness ratio, we recommend bracing it at the same height as the adjacent parapet.

### 2. Wall Anchorage

- a. Finding:** The exterior URM walls depend on attachment to the floor and roof diaphragm for lateral out-of-plane bracing. Wall anchorage was not observed at the roof or floor levels, and no evidence of anchorage was observed from the exterior of the building. Non-conforming wall anchorage is typical for this type and age of construction.
- b. Recommendation:** Wall anchorage would likely consist of premanufactured steel anchors, Simpson LTT19 or equivalent, spaced at 4' on center, and attached to the floor joists and walls with ¾" diameter threaded rod and rosettes. Anchorage should be placed at all elevated diaphragm levels on all elevations.

### 3. Force Transfer to Shear Walls

- a. Finding:** There does not appear to be a connection to transfer in-plane shear forces from the floor and roof diaphragms to the exterior walls.

- b. **Recommendation:** To transfer the seismic forces to the URM shear walls, we recommend installing threaded rod shear bolts through existing blocking and joists, where they are perpendicular to the walls. Wall anchor rods, described above, provide shear transfer between the walls and blocking (or joists, where parallel to the wall) at 4' on-center. We also recommend nailing the perimeter of the diaphragm to the blocking/joists with 16d box nails @ 4" on-center.

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## Larned

URM

Partially Qualifies for Bolts+ Retrofit

Recommended retrofits (in order of priority):

### 1. Wall Anchorage

- a. **Finding:** The exterior URM walls depend on attachment to the floor and roof diaphragms for lateral out-of-plane bracing. Retrofit wall anchorage was installed at all levels using rosettes and Simpson LTT20B tension ties on top of the floor diaphragm. However, the anchorage is of insufficient strength to transfer the anchor forces to the diaphragm.
- b. **Recommendation:** We recommend supplementing the existing anchors with additional epoxy grouted anchors and tension ties. These anchors would be installed in tandem with shear transfer anchors, below in Item 2.

### 2. Force Transfer to Shear Walls

- a. **Finding:** The 1991 renovation plans do not show a connection to transfer in-plane shear forces from the floor and roof diaphragms to the exterior walls.
- b. **Recommendation:** We recommend installing  $\frac{3}{4}$ " threaded rod epoxy anchors at 4' on center into the joist adjacent the exterior wall where parallel, or into continuous blocking where joists are perpendicular to the wall.

### 3. Parapets

- a. **Finding:** Parapets were either braced or rebuilt in 1991 and the installed bracing meets the maximum spacing requirements. The parapet on the north elevation was rebuilt with reinforced concrete masonry units (CMU). The rebuilt parapets are cantilevered from the URM wall below and still present a falling hazard to the sidewalk below.
- b. **Recommendation:** We recommend installing parapet bracing at 6' on center along the north parapet. Braces would be constructed of 4"x4"x1/4" angles, similar to the existing braces on the east and west elevations.

### 4. Moment Frames

- a. **Finding:** At the open storefronts, steel moment resisting frames were added in 1991 to resist lateral seismic forces. Subsequent code changes have affected the design and detailing of moment frames, and the existing frames do not meet current seismic requirements. Initial analysis of the frames found the columns overstressed by a factor of 2.2. The beam column connections and foundations were also found to be deficient.

- b. **Recommendation:** We recommend opening a discussion with the city on what is considered an acceptable amount of overstress for steel moment frames from earlier retrofits. In the event that the calculated DCR is beyond what is deemed acceptable by the city, we recommend further evaluation of the frames to determine if they can be brought up to current code. If they cannot be improved, then replacement with braced frames or concrete shear walls is recommended.

## 5. Diaphragms

- a. **Finding:** Long span diaphragms often experience large lateral deflections and diaphragm shear demands. Large deflections can result in increased damage or collapse of elements laterally supported by the diaphragm. Excessive diaphragm shear demands will cause damage and reduced stiffness in the diaphragm. The area cut out of the diaphragm at the third floor and roof amplifies diaphragm stresses around the opening.
- b. **Recommendation:** Diaphragm improvements are not required for Bolts Plus due to the cross walls and plywood sheathing being previously added to the roof. However, we recommend plywood sheathing in areas around the light well to prevent tearing of the diaphragm.

## 6. Girder-column connections

- a. **Finding:** A positive connection between beams and columns is required to prevent columns from shifting off their supports during a seismic event. In the basement, positive girder-girder connections were made with continuity straps, but no positive connection was made between the girders and the column.
- b. **Recommendation:** We recommend installing steel angle clips, fastened with lag screws, where girders are supported by interior columns.

*\*Extra Notes: SSF concluded that portions of Larned's 1991 retrofit do not comply with the current life safety standard, however, they believe the retrofit meets the spirit of the pending ordinance and that it has an improved margin against seismic collapse. Based off this opinion, SSF believes the City may be open to negotiating the extent of additional retrofit measures.*

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# Lincoln Court

Non-URM

Recommended issues to investigate/retrofit:

## 1. Building Settlement

- a. **Finding:** During the site visit we observed severely sloping and uneven floors in the second and third floor hallways on the north side of the building. This portion of the building, clouded in Figure 5 in the report, is over an unexcavated crawlspace with wood post and beam framing supported by a concrete pier block foundation system. We observed several large notches in the wood beams at the column supports. Horizontal shear failures were visible in the beams at these notches and are shown in Figure 4. Other support columns were observed with significant tilt out of plumb. The onsite manager also reported that the north side of the building had severe water infiltration issues prior to a

building envelope renovation in 2009. Water infiltration over time may have saturated the soils, reducing their bearing capacity and allowing the post and beam system to settle excessively. Undersized foundation pier blocks can exacerbate the settlement issue on compromised soils. We did observe a new roof drain system that directed all collected water away from the building and into the adjacent parking lot storm drain

- b. **Recommendation:** We recommend further investigation of the footing conditions, including a geotechnical report to establish the allowable bearing capacity of the soils. Remediation of the settlement would likely include new concrete foundations and steel posts supporting the existing beams. Where the existing beams are split due to excessive notching, we recommend replacement or repair with steel side plates. Repairing the beams, columns and foundations should limit future settlement of the building, however it may not be feasible to raise existing floors back to their original level condition.

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## Melrose

URM

Qualifies for Bolts+ Retrofit

Recommended retrofits (in order of priority):

### 1. Wall Anchorage

- a. **Finding:** The exterior URM walls depend on attachment to the floor and roof diaphragms for lateral out- of-plane bracing. Wall anchorage consisting of Simpson MTT28B anchors and  $\frac{3}{4}$ " threaded rod through bolted with 6" diameter rosettes spaced at 4' on-center is present at all levels. Wall anchorage at the North and South elevations is anchored to existing joists which develop the wall loads into the existing diaphragms. Wall anchorage at the East and West Elevations is anchored in the two bays of 2x blocking between existing joists. Two bays of blocking is not adequate to develop the wall anchorage forces into the diaphragm. In addition, the plans have conflicting information regarding anchors installed at the north end of the east wall. The elevation shows no anchors due to the presence of an adjacent building on the property line. The structural drawings call out anchors with rosettes. It is possible anchors were installed by drilling and epoxying, rather than with rosettes, but this could not be confirmed.
- b. **Recommendation:** We recommend installing additional bays of blocking at the east and west walls to develop the anchors into the floor diaphragm, and we recommend verifying the presence of anchors at the east wall.

### 2. Force Transfer to Shear Walls

- a. **Finding:** Connections are required to transfer in-plane shear forces from the floor and roof diaphragms to the exterior shear walls. Although new blocking was shown in the 1990 drawings, the connection does not provide sufficient capacity to meet the strength criteria of the proposed ordinance. However, the rosettes visible on the outside of the building indicate that the out-of-plane anchors may be installed between existing joists, rather than above the joists as shown in the existing drawings. If this is the case, the out-of-plane bolts could provide adequate shear anchor strength.

- b. **Recommendation:** We recommend investigating at least one location each, at the 2<sup>nd</sup> floor, 3<sup>rd</sup> or 4<sup>th</sup> floor, and roof at the east/west, and north/south walls. Six locations total. The investigation would determine the actual construction of the wall anchorage. The first step would be to accurately measure the location of the rosettes to determine if they occur between floor joists. If the rosettes are located between the joists, we recommend opening the veiling finishes to determine the as-built condition of the anchors. If the as-built condition of the anchors do not have capacity to meet ordinance requirements, or rosettes occur above or below the joists, we recommend installing  $\frac{3}{4}$ " threaded rod at 48" on-center, through the existing blocking between joists at all floors.

### 3. Wall height-to-thickness ratio

- a. **Finding:** Walls exceeding the recommended height to thickness ratios are susceptible to collapse in a seismic event. The exterior East and West walls at the 4th floor do not comply with the proposed ordinance.
- b. **Recommendation:** Provide strongback walls consisting of wood stud, or light gauge steel furring at the east and west walls at the 4th floor. Studs walls are typically 6" deep and with top and bottom plates screwed to the floor, and light gauge clips anchored to the masonry with  $\frac{3}{8}$ " diameter epoxy bolts at 24" on-center, vertically.

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## Park Hill

Non-URM

Recommended issues to investigate/retrofit:

### 1. Bulging Brick Veneer

- a. **Finding:** We did find evidence of bulging brick veneer on the south façade. The displacement was most pronounced at the stair, with a horizontal offset from plumb reaching 1" or more in some areas.
- b. **Recommendation:** We recommend having the veneer re-anchored to the building, in addition, we recommend installing a strongback in the stair well to brace the wall out-of-plane.

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## Silvian

URM

Partially Qualifies for Bolts+ Retrofit

Recommended retrofits (in order of priority):

### 1. Diaphragms

- a. **Finding:** Long span diaphragms often experience large lateral deflections and diaphragm shear demands. Large deflections can result in increased damage or collapse of elements laterally supported by the diaphragm. Excessive diaphragm shear demands will cause damage and reduced stiffness in the diaphragm. The roof diaphragm spans exceed the maximum 24' span for straight sheathed diaphragms without crosswalls.

- b. **Recommendation:** We recommend ½” plywood sheathing on the roof, with 8d nails at 4” o.c./ at panel edges. Improvement to the floor diaphragms is not required because of the interior crosswalls.

## 2. Wall Anchorage

- a. **Finding:** The exterior URM walls depend on attachment to the floor and roof diaphragm for lateral out-of-plane bracing. Retrofit wall anchorage was installed at all levels using rosettes and light-gage steel straps with bearing plates on top of the floor diaphragm. However, the anchorage is of insufficient strength to transfer the anchor forces to the diaphragm.
- b. **Recommendation:** We recommend reinforcing the existing wall anchorage by replacing the bearing plate with steel angle integrated with the shear transfer angle described below in item 3.

## 3. Force Transfer to Shear Walls

- a. **Finding:** The 1982 renovation plans do not show a connection to transfer in-plane shear forces from the floor and roof diaphragms to the exterior walls. The floor diaphragm has been nailed to blocking around the perimeter, however, there is no load path from the blocking to the URM wall.
- b. **Recommendation:** To transfer the seismic forces to the URM shear walls, we recommend installing a continuous steel 4”x4”x1/2” angle around the perimeter of the diaphragm on each level. The existing rosette bolts can be reused to anchor the angle to the wall. Shear transfer from the angle to the diaphragm can be accomplished by providing ¼” SDS screws through the bottom leg of the angle to the existing perimeter blocking. The shear transfer angle also functions as a drag strut to collect load to the new braced frames.

## 4. URM Shear Walls

- a. **Finding:** The URM walls are inadequate for resisting lateral seismic forces, largely due to the tall, narrow wall piers created by the multi-story wood infill framing or bay windows. The north, south and east elevations do not meet the minimum solid wall pier requirement. The west wall does not have any multi-story openings and it does meet the minimum 40% solid pier requirement.
- b. **Recommendation:** We recommend steel braced frames as a supplemental lateral system at the north, south, and east elevations, from the basement to the roof. Potential braced frame configurations and locations are shown in the schematic sketches in the report (Appendix B). New braced frames will also include steel angle or channel drag struts at the perimeter of the building to transfer load to the frames from elsewhere in the diaphragm. Foundations for the braced frames would likely consist of a concrete grade beam supported by micropile deep foundations. Due to the spalling bricks and generally deteriorated condition of the mortar joints, we recommend having the exterior URM walls evaluated by a masonry contractor for tuck pointing and repairs.

## 5. Diaphragms (Life Safety Upgrade)

- a. **Finding:** The floor diaphragms in the building benefit from the interior partition walls, aka crosswalls, which assist in dampening diaphragm deflection, however, the diagonal straight sheathing is overstressed by a factor of 2.6.
- b. **Recommendation:** We recommend re-sheathing the 1982 interior gypsum shear walls with plywood and adding new longitudinal and transverse shear walls. Proposed shear walls are shown on the schematic plans in the report (Appendix B).

**6. West elevation lateral system (Life Safety Upgrade)**

- a. **Finding:** The west URM wall does not have any multi-story openings and it does meet the minimum 40% solid pier requirement for Bolts Plus. However, further analysis of the wall indicates that it is overstressed by a factor of 3.5, which does not meet the Life Safety criteria.
- b. **Recommendation:** We recommend an additional steel braced frame as a supplemental lateral system on the west elevation, from the basement to the roof. Including a braced frame will bring the west elevations to the same level of compliance as the rest of the building. Drags struts and foundations will be similar as those described in item 1.

## Villa

URM

Qualifies for Bolts+ Retrofit

Recommended retrofits (in order of priority):

**1. Braced frame retrofit at the south wall ground floor (open storefront)**

- a. **Finding:** There is an open storefront on the south side of the building, which was retrofitted in 1998 with two chevron braced frames. According to our calculations, the retrofitted frames fail to meet current standards by a factor of two or more.
- b. **Recommendation:** We recommend steel braced frames be replaces or renovated to meet current earthquake code requirements. The retrofit would likely require enhancing or replacing the top and drag strut connection, and strengthening or replacing the existing grade beam.

**2. In-plane shear anchors**

- a. **Finding:** The 1998 renovation plans do not show a connection to transfer in-plane shear forces from the floor and roof diaphragms to the exterior walls. The floor diaphragm has been nailed to blocking around the perimeter, however, there is no load path from the blocking to the URM wall.
- b. **Recommendation:** To transfer the seismic forces to the URM shear walls, we recommend installing anchor bolts through the existing blocking. Anchors are typically ¾" diameter and spaced at 4' on-center.

*\*Extra Notes: The 1998 retrofit installed frames to the open storefront, however, the frames do not meet current seismic requirements. SSF is of the opinion that it may be possible to seek the City's approval to allow CHH to keep the current system and enhance the connections and retrofit the foundation to meet*

*current requirements. Absent City approval, or if it is not technically feasible to retrofit the current system, SSF believes the frames will need to be replaced with a standard braced frame.*