EXTERIOR WALL/WINDOW EVALUATION AT BOXFORD TOWN HALL/LIBRARY

7 Spofford Road
Boxford, Massachusetts 01921

April 10, 2018

Boston
Baltimore
Orlando
San Francisco

P 781.335.6465 F 781.335.6467 www.gainc.com

EXTERIOR WALL/WINDOW EVALUATION AT
BOXFORD TOWN HALL/LIBRARY
7 Spofford Road
Boxford, Massachusetts

Table of Contents

Gale Associates, Inc.
163 Libbey Parkway | Weymouth MA 02189
P 781.335.6465 F 781.335.6467 www.gainc.com

Exterior Wall/Window Evaluation at the Boxford Town Hall/Library Boxford, Massachusetts Gale JN 833440

BACKGROUND INFORMATION

In accordance with our agreement, Gale Associates, Inc. (Gale) has performed an existing conditions evaluation at the Boxford Town Hall (Town Hall). The intent of the evaluation is to review the as-built condition of the exterior wall assembly, fenestrations, roof transitions, and associated components with specific focus on the cause and origin of reported water and air infiltration. This report includes Gale's findings of the in-place components and recommendations for repair or replacement options. Supporting information can be found within the appendix, which includes, but is not limited to, preliminary cost estimates, field sketches, and reduced size drawings.

The two-story building utilized as office space for the Town Hall and Public Library, is approximately 15 years old. The exterior façade is constructed of brick veneer or precast concrete panels over a metal stud backup wall gypsum sheathing and extruded polystyrene are installed within the wall cavity. The precast concrete elements are installed above windows on the second floor, below select second floor windows, at the foundation level of the building, and at roof eave and rake locations. The roof consists of an asphalt shingle roof system with copper flashings at the valleys and eave locations. A standing seam copper roof is installed on the Assembly Room on the North Elevation.

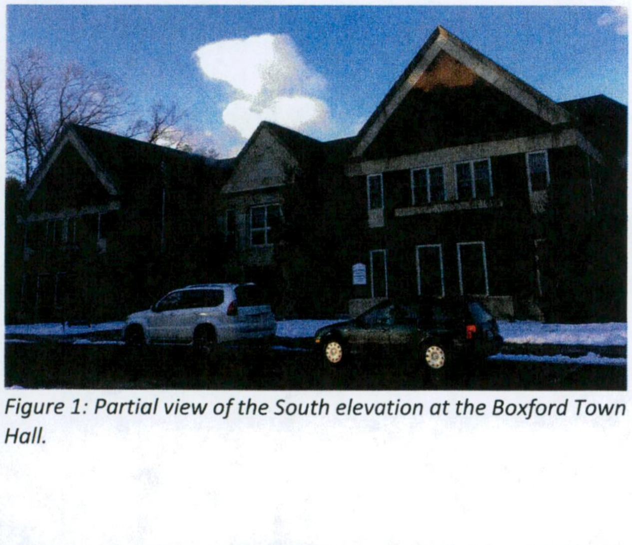


Figure 1: Partial view of the South elevation at the Boxford Town Hall.

REVIEW OF EXISTING DOCUMENTS

To assist Gale in performing the evaluation of the Town Hall, representatives from The Town of Boxford provided Gale with the following drawings:

1. Boxford Town Hall – Designed by J. Stewart Roberts Associates, Inc, Architects and Dated March 6, 2002. The set of drawings includes a full set of original design drawings including; site development, architectural, structural, plumbing, heating and ventilating, and electrical sheets.

INTERIOR LEAK AUDIT

On January 31, 2018, Gale reviewed the interior building components and interviewed building staff including the Department of Public Works (DPW) personnel and building occupants, to understand the history of reported air leaks and water infiltration. Evidence of water infiltration – e.g. water staining on interior ceiling tiles, and blistering/peeling paint on interior finishes – was noted at multiple interior locations.

Gale observed 15 active leaks throughout the building. The majority of these leaks appear to be concentrated at or adjacent to window locations on the first and second floors. Damaged interior finishes were observed at leak locations. Interior damage consisted of: stained ceiling tiles, stained interior finishes, blistered and peeling paint, deteriorated gypsum wall board, deteriorated wood trim, corroded metal studs, and stained floor tiles. Typically, interior finishes were damaged at window head and jambs, and at additional isolated locations. Refer to Appendix C of this report for reported leak locations.

Figure 2: Blistered paint on the window header and jambs was observed at multiple locations.

Figure 3: Evidence of water infiltration based on rusted metal-stud framing inside the Payment Drop closet on the 1st floor

INFRARED SURVEY

On January 31, 2018, Gale conducted a non-destructive, visual, thermographic infrared (IR) survey of the exterior walls. An IR Survey was performed to help identify areas of energy transfer (cold air infiltration or warm air exfiltration). The IR Survey was performed on both the interior and exterior sides of the walls. The purpose of the IR survey was to locate anomalies within the wall system that may indicate potential areas of wet insulation, missing insulation, insulation not in substantial contact to the backup wall, allowing air movement behind the thermal layer of the exterior wall, and areas of air infiltration or exfiltration. The intended results of the IR survey are to help determine areas of concern on the building. Additionally, these areas allowed Gale to focus on evaluation efforts and determine locations for destructive testing in the form of interior and exterior test cuts.

The IR Survey results indicated that areas of energy transfer appeared to typically consist of the window perimeters, the floor lines, inside and outside corners of the walls, below the gable ends of the roof and the roof eaves. Though most areas of energy transfer from the IR scan were at these above-mentioned locations, isolated areas in the field of the wall were observed.

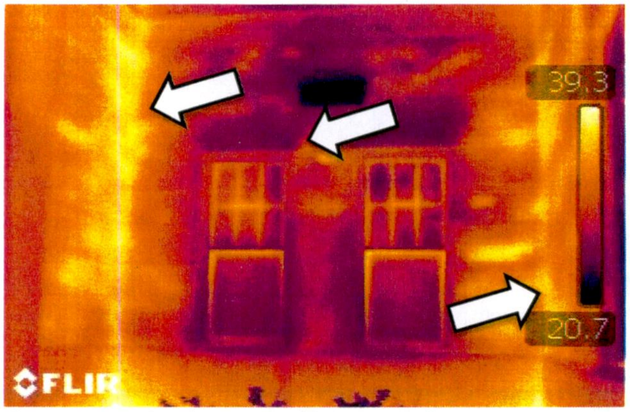


Figure 4: Exterior thermographic image indicates warm energy transfer at the inside corners and at the window perimeters.

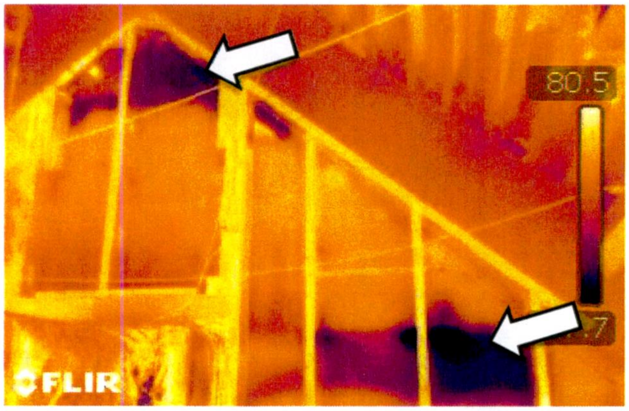


Figure 5: Thermographic image from inside the attic shows cold air infiltration at the gable wall transition to the roof ridge.

EXISTING CONDITIONS

A visual evaluation of the building's exterior wall systems, masonry façade, windows, roof transitions, and associated components was performed at the Town Hall from ground level. Select representative areas of brick masonry, precast stone, roofing components, and windows were reviewed close-up using an aerial lift. Destructive masonry test cuts were performed at representative areas on the interior and exterior wall locations to allow review and documentation of as-built conditions of the façade construction.

Typical Construction Observations:

1. The typical wall construction of the building was observed to be a steel framed building with light gauge metal stud walls, over which an exterior grade gypsum sheathing board was attached. The exterior gypsum sheathing is Georgia-Pacific Gypsum Corporation DensGlass Gold (DensGold) with six-inch strips of Carlisle self-adhered membrane (SA membrane) installed over the seams. Outboard of the DensGold is 2-inch extruded polystyrene insulation board (XPS), an open cavity varying between 1" and 2-1/2", and brick veneer/precast concrete elements. The brick and precast were secured to the backup stud wall with masonry or stone ties. The metal studs are not insulated, and painted gypsum sheathing is installed on the interior of the studs.

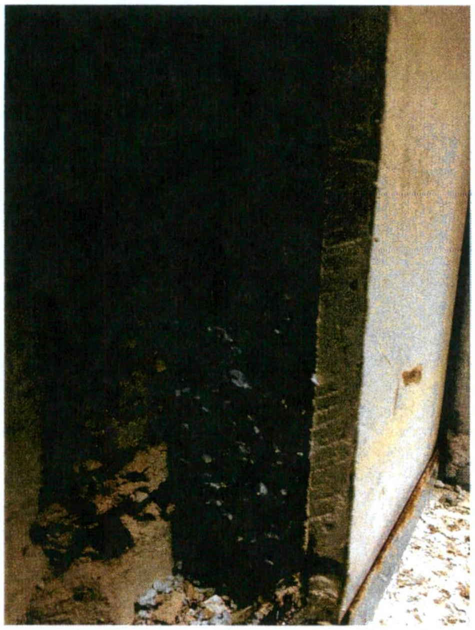


Figure 6: View of the typical wall construction from the interior with precast concrete exterior cladding.

2. Windows were typically observed to be vinyl - clad wood, double hung windows. Wood trim is installed at the interior perimeter of the windows.

3. Based on the original design drawings, the roof consists of asphalt shingles atop insulation, an underlayment membrane, and metal deck. The exact configuration and insulation thickness at the roof could not be confirmed. The roof incorporates copper edge flashings. At eaves, the edge flashing extends over the precast wall components. At rake edges, the edge flashing is terminated approximately 8" from the edge of the precast wall components.

Brick Masonry and Precast Concrete Observations:

4. Precast concrete units are utilized at the roof eave, roof rake, second floor window sills, base of the foundation, and at the front entrance locations.

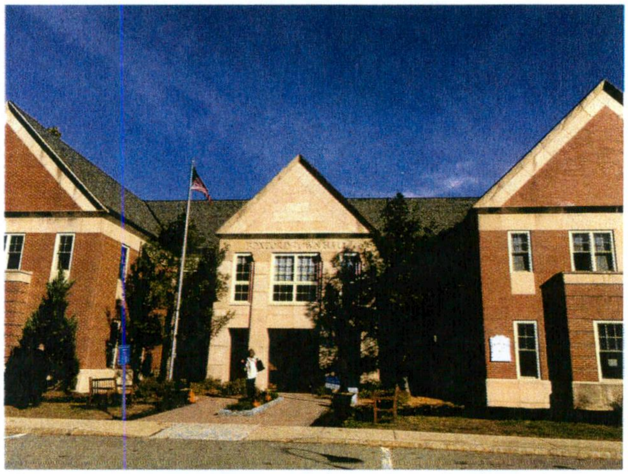


Figure 7: Precast concrete cladding is utilized at the front entrance of the building, at the rake and eave lines of the roof, second-floor window sills, and at the foundation level.

5. Precast units at the rake edge locations extend out further than the roof edge creating shelves for snow, ice, and water to accumulate directly atop the precast.

Figure 8: Exposed precast extends out beyond the roof edge on the rake edges of the roof.

6. Unsealed seams in the sheet metal flashings were observed on the rake edges of the roof.

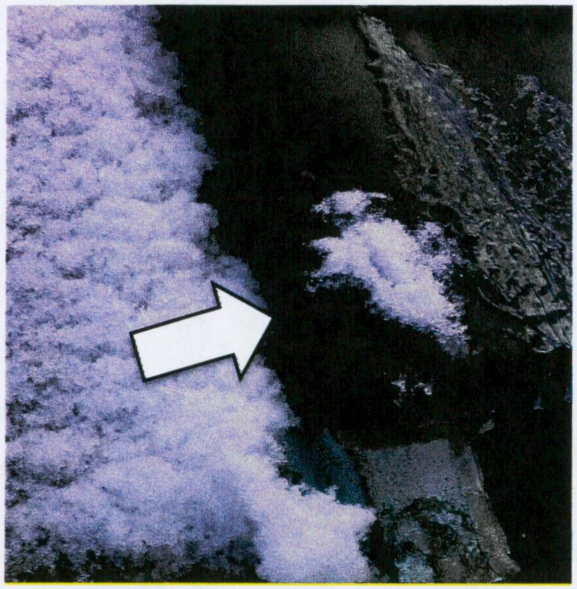


Figure 9: Open seams were observed in the flashings along the rake edge.

7. A copper sheet metal cap flashing has been installed over the precast stone shelf below the roof eaves. It was reported that the metal cap was installed after the original construction due to snow and ice build-up on the precast shelf, as the roofing was originally designed to stop short of the precast unit (similar to the existing rake edge detail). Note the cap was only installed at the eaves, and not at the rake edges. The metal cap does not appear to be sloped, and ice/snow had accumulated on top of the shelf during the evaluation.

Figure 10: Precast stone shelves are located at the eave locations allowing snow, ice, and water to build up. Eave locations were covered with a sheet metal cap.

8. The mortar joints in the precast stone units are typically in failed condition in the form of open, cracked, and debonded mortar. The open mortar joints were observed at horizontal surfaces at the rake edges and other isolated areas. Horizontal surfaces are most susceptible to moisture infiltration.

Figure 11: Mortar joints were typically observed to be failed at the precast concrete.

9. The brick mortar joints appeared to be in good condition with minimal deteriorated joints observed.

10. RILEM tube tests were performed at five (5) locations; two (2) brick types and three (3) mortar locations, including head and bed joints. The RILEM test concluded that the porosity of the mortar and brick meets industry standards.

11. Jack arches are installed in the brick masonry above the first-floor windows.

Figure 12: Jack arches are installed above the first-floor windows.

12. Minimal throughwall flashings were observed at the brick façade and precast stone locations;

typically, only at first floor window heads, above precast headers along the second floor windows, and at the foundation level. The throughwall flashing consists of fabric coated copper. The throughwall flashings typically extend half the depth of the brick or precast stone and are set in mortar.

13. The original design drawings indicate that throughwall flashings are installed at the heads of all windows, between precast elements near the roof line, and below the precast sills and sill panels. Interior test cuts revealed that head flashing was not installed at the second-floor windows. Flashing between precast elements and below precast sills could not be confirmed.
14. Where observed, the throughwall flashings were not sealed nor adequately terminated to the backup wall. The vertical back leg of the fabric flashings, which extended up onto the gypsum sheathing approximately 8", were only stapled in place. No seal or tie-in to the sheathing was observed.
15. Due to the lack of seal, the back side of the fabric coated copper showed signs of moisture staining at an interior test cut location at the foundation level.
16. Rope weeps were typically observed at the base of the walls. Several locations incorporated cored holes in the mortar, however rope weeps or similar were not observed. The weeps were typically spaced sporadically. Weep openings were typically obstructed with mortar and debris.
17. Large areas of ice on the outside face of the brick was observed at multiple locations around the building. Note that the field evaluation was performed the day after a snow event and outside temperatures were below freezing.
18. Heavy copper staining was observed on the precast stone units along the Assembly Room walls below the copper roof.

Figure 13: Heavy copper staining on the precast was observed along the assembly room walls.

<u>*Cavity Wall Insulation Observations:*</u>

19. Two-inch XPS was observed in the cavity of the wall at the majority of the test cut locations. XPS has an approximate R-Value of R-5 per inch; therefore, it appears the wall was designed to provide an R-10.
20. Gaps and areas of non-continuous insulation was observed around windows, at penetrations, and at roof-to-wall transitions.

Figure 14: Gaps in the insulation were observed at multiple locations.

21. Large areas of missing insulation were observed typically behind the precast concrete panels along the rake edge and beneath the roof ridge.

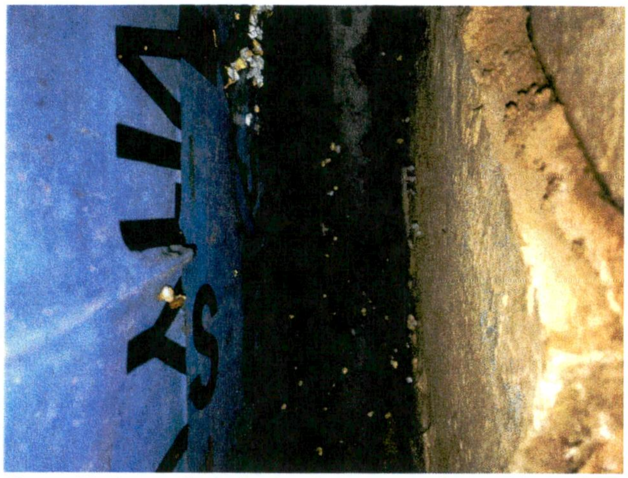


Figure 15: Areas of missing insulation were observed behind the precast units and below the ridge.

22. The XPS insulation was not installed tight against the gypsum sheathing in isolated locations, allowing for air movement behind the insulation.
23. Insulation joints were not observed to be taped or sealed.
24. Insulation appears to have been designed to be continuous based on the original drawings but was not installed per the design drawings.
25. The insulation at grade level does not extend down past the floor line, as indicated in the original drawing details.

<u>*Air Barrier (AB) and Gypsum Sheathing Observations:*</u>

26. The DensGold is installed on the exterior side of the metal stud wall and appears to incorporate the Carlisle SA membrane at the seams. The SA membrane was also used as a transition strip at select window and penetration locations.

Figure 16: The DensGlass Gold sheathing seams appear to be stripped in with AVB transition membrane.

27. Multiple fish mouths and wrinkles were observed in the SA membrane across all test cut locations at gypsum sheathing joints and window perimeter locations.

Figure 17: SA membrane was observed to have multiple fish mouths and wrinkles.

28. The SA membrane was typically observed to wrap around the wood blocking at the jamb of the window, with the intent to "tie-in" to the window and provide a continuous air barrier. However, no seal was observed between the SA membrane and the window. In some locations, gaps were observed in the SA membrane at the perimeter blocking around the window openings.
29. It appears that the DensGold was intended to act as the air barrier for field areas of the walls. The seams of the DensGold appeared to be sealed with the SA membrane, however all seam locations were not observed during the evaluation. The SA membrane, if installed continuously and correctly, is also a form of an air and vapor barrier (AVB).
30. Isolated areas of the DensGold show signs of moisture damage in the form of facer delamination.
31. Precast concrete anchors were observed to penetrate the DensGold to secure to structural framing elements. At these penetrations, the DensGold was cut and does not provide a continuous air seal.

Figure 18: DensGold cut to allow steel anchor for precast.

Roof Edge Observations:

32. The roofing underlayment membrane installed at the roof eave locations transitions to the DensGold wall sheathing; however, the membrane is unsupported and was observed to have tears and open joints.

Figure 19: View of the roofing underlayment that is not supported at the roof to wall transition.

33. There is no continuous insulation from the roof to wall transition, as evident by the original design drawings and by melted snow along the eave and rake locations, which results in energy loss.

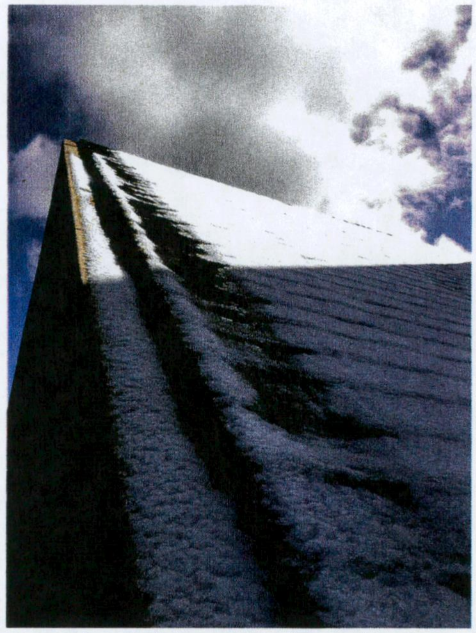


Figure 20: Areas of melted snow were observed on the roof rake and eave locations of the roof, these are locations that gaps in the insulation were observed.

34. The original design drawings indicate that the roof underlayment is set directly atop the metal roof deck. The underlayment appears to be bituminous-based, as observed from the attic. Bituminous based underlayment set atop the roof deck may not be in compliance with the current fire codes. Gale could not confirm the roof configuration to determine if the roof system was installed per the design drawings, as test cuts were not performed at the roof. Therefore, further review of the roof system may be considered in subsequent project phases to confirm the roof configuration and conformance with building and fire codes.

Window Observations:

35. Double-hung vinyl clad wood windows are installed throughout the building. The windows appear to be in good condition and appear to operate well with no issues reported. Windows are secured to wood substrates at the jambs using 2-inch wide clips, spaced approximately 16-inches on center.

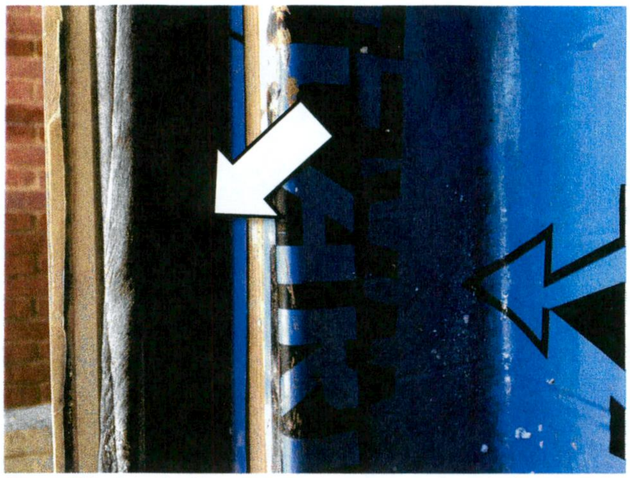


Figure 21: 2-inch clips are used to secure the windows to the wood blocking.

36. Wood blocking constructed at the perimeters of the window appears to be inconsistent. Some areas were observed to have multiple layers of blocking and others had one layer or two layers of plywood.
37. Backer rod and sealant is installed at the window perimeters and is typically in good condition.
38. Continuous air barriers and continuous insulation was not observed between the window jambs and the wood blocking/wall insulation.
39. Sill pan flashings were not observed at window units.
40. At first floor windows with brick masonry jack arches above, fabric coated copper window head flashings appeared to be deteriorated and no end dams were observed.

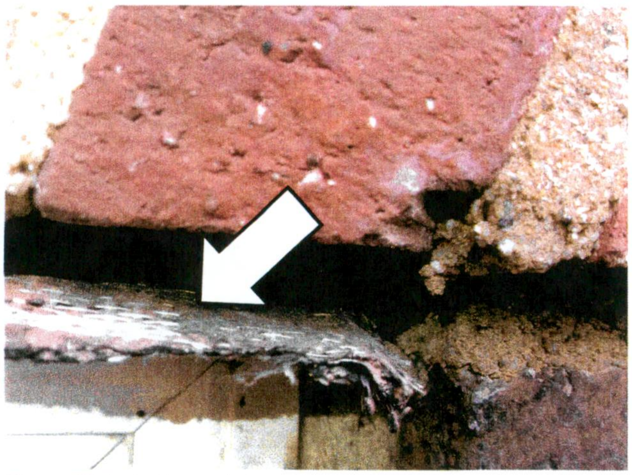


Figure 22: Deteriorated throughwall flashing was observed at the window heads on first floor windows with jack arches.

Miscellaneous Observations:

41. The bottom track of the light guard metal stud wall was observed to be corroded below the mail drop box at the South elevation.

Figure 23: The bottom track of the metal stud was observed to be corroded at interior test cut locations.

42. Sealant joints associated with the masonry control joints appeared to be in failed condition. Sealant joints are adhesively and cohesively failed.

DISCUSSION AND CONCLUSIONS

Based upon the findings of Gale's evaluation of the exterior walls and fenestrations, it appears that the current enclosure system has systemic issues associated with both the design and construction of the exterior wall assembly and associated components (air barrier, flashings, insulation, etc.) that are contributing to air and moisture infiltration into the facility.

It appears that there are three main issues with the Boxford Town Hall building enclosure components. The first issue is moisture infiltration into the interior of the building. Multiple active leaks were observed and reported throughout the building, with the majority concentrated around windows on the first and second floors. The leaks appear to be primarily associated with improperly installed flashings at window head, jamb and sill locations. Although throughwall flashings (TWF) are indicated on the original design drawings at window head locations, TWF were only observed at the first-floor windows below brick jack arches. TWF was not observed at the heads of second floor windows. Even where flashings were observed, they were not installed in accordance with industry standards of practice; the TWF do not extend to the outside face of the wall; do not incorporate drip edges; do not utilize end dams; and were observed to be improperly terminated and sealed to the backup wall. It is important to note that all masonry walls, due to their nature, allows water to penetrate into the cavity between the brick and backup wall. Throughwall flashings are installed to redirect that moisture out of the cavity to the outside, not into the building. Lack of or improperly installed TWF allows water to penetrate the wall into the interior space, as is the case of this facility.

In addition to insufficient TWF, deteriorated mortar joints in the precast concrete units were observed above window units and just below the roof rake and eave edges. The observed unbonded and open mortar joints in the precast can allow excessive moisture to travel into the wall cavity. Defects in the TWF, weather barrier system (DensGold sheathing/ Carlisle AVB membrane) behind the exterior masonry cladding, improper transition details at roof to wall connections, building corners, and at window perimeters were observed. These deficiencies allow the moisture within the cavity to penetrate into the interior of the building.

The second issue observed and reported at the Boxford Town Hall is air infiltration/movement through the exterior walls. Air movement may be contributing to performance issues with the HVAC system in the building. Excessive air infiltration could also be contributing to moisture damage to the interior finishes through condensation and vapor drive.

The exterior walls at Boxford Town Hall are constructed as cavity wall assemblies. Cavity wall assemblies are designed to incorporate a semi-permeable cladding (brick/precast/mortar), an air space cavity, a continuous moisture-resistant thermal barrier (XPS), a continuous weatherproof air barrier (gypsum sheathing/Carlisle AVB membrane), and backup wall (metal studs). Per the International Building Codes (current and 2001), an impermeable vapor retarder is also a required element in the exterior wall assembly for the New England climate zones and similar. The placement of the vapor retarder is dependent on the location and configuration of the insulation. At the Town Hall, continuous insulation is installed outboard of the stud walls, which implies a vapor barrier should be installed on the inboard-side (warm side) of all the insulation. Although the DensGold sheathing can be utilized as the air barrier (when installed properly), gypsum is typically vapor permeable and therefore cannot perform as a vapor retarder.

The air infiltration issues at the facility appear to be a lack of vapor retarder and/or an improperly installed and non-continuous air barrier within the wall assembly. It appears that the DensGold sheathing was utilized as a weather barrier within the cavity and was intended to serve as part of a "continuous air barrier system". The joints in the DensGold sheathing appear to have been stripped with the Carlisle AVB transition membrane at test cut locations. Gale was unable to confirm if all of the joints in the sheathing were stripped in. The test cuts confirmed that the air/vapor barrier system was not continuous at the majority of observed window locations. Improper installation of the AVB was observed in the form of gaps, discontinuities, and lack of continuous support. These deficiencies are allowing uncontrolled movement of air through the exterior wall; between warm conditioned space and the cold exterior environment. The severity of this condition is highlighted in the infrared survey results included in this report.

The third issue is related to issues associated with improperly installed thermal insulation. The design intent was to provide a continuous layer of insulation onto the exterior of the DensGold sheathing within the cavity wall. The XPS insulation was observed to be non-continuous, as large areas of insulation were missing, large gaps were observed at the joints of the insulation, the joints were not taped, and the insulation typically did not fully extend to the perimeters of the window openings. Additionally, the insulation was not installed tight against the gypsum sheathing in isolated locations, which can allow for air movement behind the insulation.

The two (2) inch XPS insulation within the cavity (R-10 value) appears to comply with the Massachusetts State Building Code (MSBC) that was in effect at the time of the Town Hall's 2002 design (R-7 value). However, the code required the XPS insulation be continuous, with sealed/taped joints, no gaps, and connection to the fenestration units. Therefore, the insulation was not installed continuously, as intended.

The non-continuous insulation creates thermal bridges in the wall assembly which will allow warm air to escape from the interior of the building during the winter months, and vice versa during the summer months. Air spaces behind the insulation enables the movement of warm air from within the building to cold areas where there are gaps in the insulation, which ultimately can result in condensation within the wall assembly. Moisture vapor within the air naturally flows from hot to cold, humid to dry, and high pressure to low pressure, until it reaches its dew point and condenses into liquid moisture. The lack of (or discontinuity of) an air barrier, thermal barrier and vapor retarder, create differential pressures and temperatures within the wall assembly, which will potentially cause condensation within the wall. It appears this is occurring at the Town Hall and is causing substantial moisture within the wall, which may be contributing to the reported moisture leaks.

RECOMMENDATIONS

Based on Gale's evaluation of the façade components and knowledge of the Boxford Town Hall's leak history, Gale recommends that the Town of Boxford consider full scale repairs to address exterior wall moisture infiltration, air movement and thermal loss issues noted throughout this report. This recommended option, as noted as *Option 1,* is Gale's primary recommendation for repairs. Option 1 includes, but is not limited to, the following scope of work:

1. Fully remove the exterior brick and precast concrete veneer, including existing throughwall flashings, masonry ties, and precast anchors to gain access to insulation and sheathing within the wall cavity. It is the intent to salvage as much brick masonry and precast concrete units as possible for reuse.
2. Remove the existing extruded polystyrene insulation (XPS).
3. Remove and replace any areas of deteriorated DensGold sheathing. It is assumed that 5% of sheathing will require replacement.
4. Remove the edges of shingle roofing at eave and rake locations, down to the existing underlayment.
5. Install new continuous air and vapor barrier (AVB) to the existing exterior gypsum sheathing. Strip-in all penetrations. Install continuous AVB at fenestration perimeters and seal AVB to window and door units. Note it is the intent to leave windows in place. Provide a solid support for the installation of the AVB at the roof edges to provide a continuous barrier from the roof underlayment to the wall AVB.
6. Install XPS insulation and add additional insulation to provide an R-value to meet current codes (R-15.625). It is anticipated that a total insulation thickness of 3.5" will be required. The insulation board seams should be staggered and taped. Insulation shall be installed tight against the AVB and gypsum sheathing.
7. At windows, extend insulation to window frames to provide continuous thermal barrier. Low-expanding spray foam may be required to fill gaps around window frames and other miscellaneous voids.
8. Install insulation at roof eave and rake locations to provide continuous insulation between wall system and roof system. All insulation shall be outboard of the new AVB.
9. Install steel lintels at first floor windows and doors.
10. Install new sheet metal and fabric throughwall flashings at all window and door heads, floor lines, and at the building foundation. Install full head joint baffle weeps at flashings.
11. Install brick masonry and precast concrete veneer, including new masonry ties and precast anchors. Note that due to the increased insulation thickness, the veneer components will be protruded out one to two inches from the existing plane of the wall. The configuration of the brick (i.e. jack arches, recessed brick, etc.) shall match the existing aesthetic.

12. Replace all perimeter sealants at windows, doors, control joints and other wall penetrations.
13. Install new sheet metal flashings and caps at roof to wall transitions at the eave and rake edges to fully cover exposed horizontal surfaces of the precast concrete units.
14. Install new step flashing at the brick rising wall along the Assembly Room.

Should funding for the full-scale repairs not be available at this time, phasing of the work could be considered. For example, one building elevation or one building component, such as the roof edge repairs and roof precast repointing, could be repaired per year, or as funding is available. Although phasing may be more affordable per year, there are drawbacks to phasing the construction. There would be multiple mobilizations by the contractor and engineer/architect, resulting in an overall higher project cost. Additional detailing and construction materials/labor would be required to provide temporary tie-ins with the surrounding walls during each phase, which also would result in added costs. Furthermore, the moisture leaks, air infiltration, and energy deficiencies within the building would not be fully remedied until the repairs had been performed throughout the whole building and all phases are complete. Please note that Gale's cost estimate for Option 1 does not include increased costs incurred by phasing the project.

The Town of Boxford may also consider repairing only the areas with reported active leaks, as shown in Appendix C – Interior Leak Audit, to reduce the potential for future leaks in these areas. Please note that these repairs will only address the active moisture infiltration and will not address all the noted air movement/infiltration and thermal loss issues associated with the façade. This option, as noted as *Option 2,* includes repairs at active leak locations only. The areas included in Option 2 scope of work are designated in Appendix D – Reduced Drawings. Option 2 includes, but is not limited to, the following scope of work:

1. Remove precast concrete units and insulation above designated second floor windows and at the foundation level around the main entrance. Install new throughwall flashings with end dams and full head joint baffle weeps. Install new AVB and insulation and reinstall precast units with new anchors.
2. At designated locations, cut the existing precast concrete mortar joints. Install new sealant joints over existing mortar.
3. Install traffic grade sealant at the base of the wall at the front entrance.
4. Remove brick masonry to install continuous AVB, connecting the gypsum sheathing to the window frame, at designated locations. Seal AVB to windows and provide spray foam insulation at window frames, as required to provide continuous insulation. Reinstall brick masonry and replace perimeter sealants around full window.
5. Remove and replace designated window perimeter sealants.
6. Remove and replace deteriorated lintel with a new galvanized lintel above one designated door. Install new throughwall flashings with end dams at new lintel. Remove and reinstall brick masonry as required to replace the lintel.

Gale recommends that Option 1 be considered as the preferred option, as this will address the noted issues with moisture, air movement, vapor drive, and thermal loss with the exterior wall construction at the Town Hall. Option 2 includes work associated with active leak locations only and will not address any of the air movement or thermal loss concerns. The Town of Boxford should be aware that if Option 2 repair scope is selected, additional leaks may occur in the future. This may result in similar repairs being required throughout the life of the building.

Please note that the Town of Boxford had previously discussed and considered applying a waterproof coating to the exterior face of the building components in an effort to help mitigate moisture leaks. Although the cost of this repair may be more affordable, Gale would not recommend applying a coating at the Town Hall. Deteriorated mortar joints (typically at the precast elements) and failed sealants were observed, which would not provide a suitable substrate for a waterproofing coating. Therefore, masonry repairs would be required prior to applying the coating. Additionally, a coating would be a temporary repair to mitigate moisture intrusion only and would not provide any air infiltration or thermal improvements. A coating would also slightly change the appearance of the building and will require inspection and maintenance throughout the life of the coating.

COST ESTIMATE

The budget estimates presented in this report have been broken down for the recommendations listed for each option. These estimates, which are based on current construction costs, should be considered preliminary and should not be used for sensitive budgeting. All estimating was performed using historical and market trends to establish unit pricing. These estimates have been generated by various sources and may not reflect the actual conditions at the time of construction. These budget estimates do not include additional engineering evaluation or design services, construction administration services, or permitting costs. These budget estimates also do not include soft costs associated with Boxford's project management, site supervision, designer fee's or site renovations associated with the site logistics. The line items within the estimate include a twenty-percent (20%) design and construction contingency, as a defined scope has not been determined, as well as to account for potential unforeseen conditions that may be encountered. The work, as presented and further defined in Appendix A – Cost Estimate of this report, should be budgeted at:

Option 1

Material and Labor Subtotal $2,501,300
General Conditions, Mobilization, Bonds, Insurance, Overhead and Profit $777,920
Design and Construction Contingency $655,850

Option 1 Construction Budget $3,935,100

Option 2

Material and Labor Subtotal $162,160
General Conditions, Mobilization, Bonds, Insurance, Overhead and Profit... $50,440
Design and Construction Contingency $42,520

Option 2 Construction Budget $255,100

I:\833440\01 Evaluation\report\030 Report final.docx

GALE

APPENDIX A

PRELIMINARY COST ESTIMATE

PRELIMINARY COST ESTIMATE SHEET MASONRY WALL REPAIR OPTION 1				
Project Location: 7B Spofford Road	Date: February 28, 2017			
Job Number: 833440 / Prepared/Checked By: EWM/KRM				
Evaluation of Exterior Wall and Fenestration Systems Boxford Town Hall 7 Spofford Road Boxford, MA				
Item Description	**Quantity**		**Material + Labor**	
	Number	Unit	Unit Cost	Total
Option 1				
General Conditions				
Temporary Protection	5	units	$1,500.00	$7,500
Dumpster	8	units	$1,100.00	$8,800
Full Pipe Staging	14,610	square feet	$5.00	$73,050
Removal				
Temporary Protection of the Windows	100	units	$250.00	$25,000
Brick Masonry (Salvage 50%)	7,510	square feet	$35.00	$262,850
Extruded Polystyrene (Salvage 50%)	14,610	square feet	$2.00	$29,220
Masonry Ties	7,510	square feet	$2.00	$15,020
Precast Concrete	7,110	square feet	$45.00	$319,950
Replace/Reinstall				
Continuous Air-Vapor Barrier	14,610	square feet	$3.75	$54,788
Extruded Polystyrene (XPS)	14,610	square feet	$3.50	$51,135
Masonry Ties	7,510	square feet	$1.25	$9,388
Precast Concrete Panels and Anchors	7,110	square feet	$100.00	$711,000
Brick Masonry (Replace 50%)	3,760	square feet	$80.00	$300,800
Brick Masonry - Reinstall	3,760	square feet	$75.00	$282,000
Install Traffic Grade Sealant at Base of Wall	30.00	linear feet	$18.00	$ 540.00
Window Perimeter				
Perimeter Backer Rod and Sealant	1,330	linear feet	$12.00	$15,960
Air Vapor Barrier Tie In	1,330	linear feet	$4.00	$5,320
Exterior Sealant	1,330	linear feet	$9.00	$11,970
Windows - Brick Header				
Replace Lintel and Install Through Wall Flashing	70	linear feet	$250.00	$17,500
Windows - Concrete Header				
Install Through Wall Flashing	190	linear feet	$50.00	$9,500
Roofing				
Remove Roofing From Edge	1,350	square feet	$5.00	$6,750
Replace Shingles, Insulation, and Underlayment	1,350	linear feet	$12.00	$16,200
Install Edge Metal	680	linear feet	$10.00	$6,800
Install New Step Flashing	50	linear feet	$20.00	$1,000
AVB Tie-In at Eaves/Rakes	680	linear feet	$5.00	$3,400
Insulation Connection	680	linear feet	$4.50	$3,060
Unit Price				
Precast Concrete Panel	500	square feet	$500.00	$250,000
Exterior Sheathing	700	square feet	$4.00	$2,800
Materials and Labor Sub Total:			$2,501,300	
10% General Conditions/Mobilization Costs			$250,130	
4% Bonds, Insurance, and Permit			$100,060	
15% Overhead and Profit:			$427,730	
Sub Total			$3,279,220	
20% Construction Contingency:			$655,850	
TOTAL RECOMMENDED CONSTRUCTION BUDGET			**$3,935,100**	

* Note that all unit costs listed above are based on averages of public bid prices for similar projects.

PRELIMINARY COST ESTIMATE SHEET MASONRY WALL REPAIR OPTION 2				
Project Location: 7B Spofford Road	Date: February 28, 2017			
Job Number: 833440 — Prepared/Checked By: EWM/KRM				
Evaluation of Exterior Wall and Fenestration Systems Boxford Town Hall 7 Spofford Road Boxford, MA				
	Quantity		**Material + Labor**	
Item Description	Number	Unit	Unit Cost	Total
Option 2				
General Conditions				
Temporary Protection	2.0	units	$1,500.00	$ 3,000.00
Material Disposal	2.0	unit	$1,100.00	$ 2,200.00
Lift	4.0	weeks	$1,500.00	$ 6,000.00
Removal				
Temporary Protection of the Windows	26.00	units	$250.00	$ 6,500.00
Brick Masonry	100.00	square feet	$35.00	$ 3,500.00
Extruded Polystyrene (XPS)	460.00	square feet	$2.00	$ 920.00
Masonry Ties	100.00	square feet	$2.00	$ 200.00
Precast Concrete	360.00	square feet	$45.00	$ 16,200.00
Reinstall/Install				
Continuous Air-Vapor Barrier	460.00	square feet	$3.75	$ 1,725.00
Extruded Polystyrene (XPS)	460.00	square feet	$3.50	$ 1,610.00
Masonry Ties	100.00	square feet	$1.25	$ 125.00
Reinstall Precast Concrete Panels	360.00	square feet	$125.00	$ 45,000.00
Brick Masonry - Replace	100.00	square feet	$80.00	$ 8,000.00
Throughwall Flashing w/ End Dams - Precast Concrete Panels	360.00	square feet	$150.00	$ 54,000.00
Install Traffic Grade Sealant at Base of Wall	30.00	linear feet	$18.00	$ 540.00
Window Perimeter				
Perimeter Backer Rod and Sealant	160.00	linear feet	$12.00	$ 1,920.00
Air Vapor Barrier Tie In	70.00	linear feet	$4.00	$ 280.00
Exterior Sealant	160.00	linear feet	$9.00	$ 1,440.00
Doors				
Replace Lintel and Install Through Wall Flashing	10.00	linear feet	$250.00	$ 2,500.00
Repointing/Resealing				
Cut Precast Concrete Panel Mortar Joints	380.00	square feet	$5.00	$ 1,900.00
Install Sealant at Precast Concrete Panel Joints	380.00	square feet	$12.00	$4,560.00
Materials and Labor Sub Total:			$162,120	
10% General Conditions/Mobilization Costs			$16,220	
4% Bonds, Insurance, and Permit			$6,490	
15% Overhead and Profit:			$27,730	
Sub Total			$212,560	
20% Construction Contingency:			$42,520	
TOTAL RECOMMENDED CONSTRUCTION BUDGET			**$255,100**	
* Note that all unit costs listed above are based on averages of public bid prices for similar projects.				

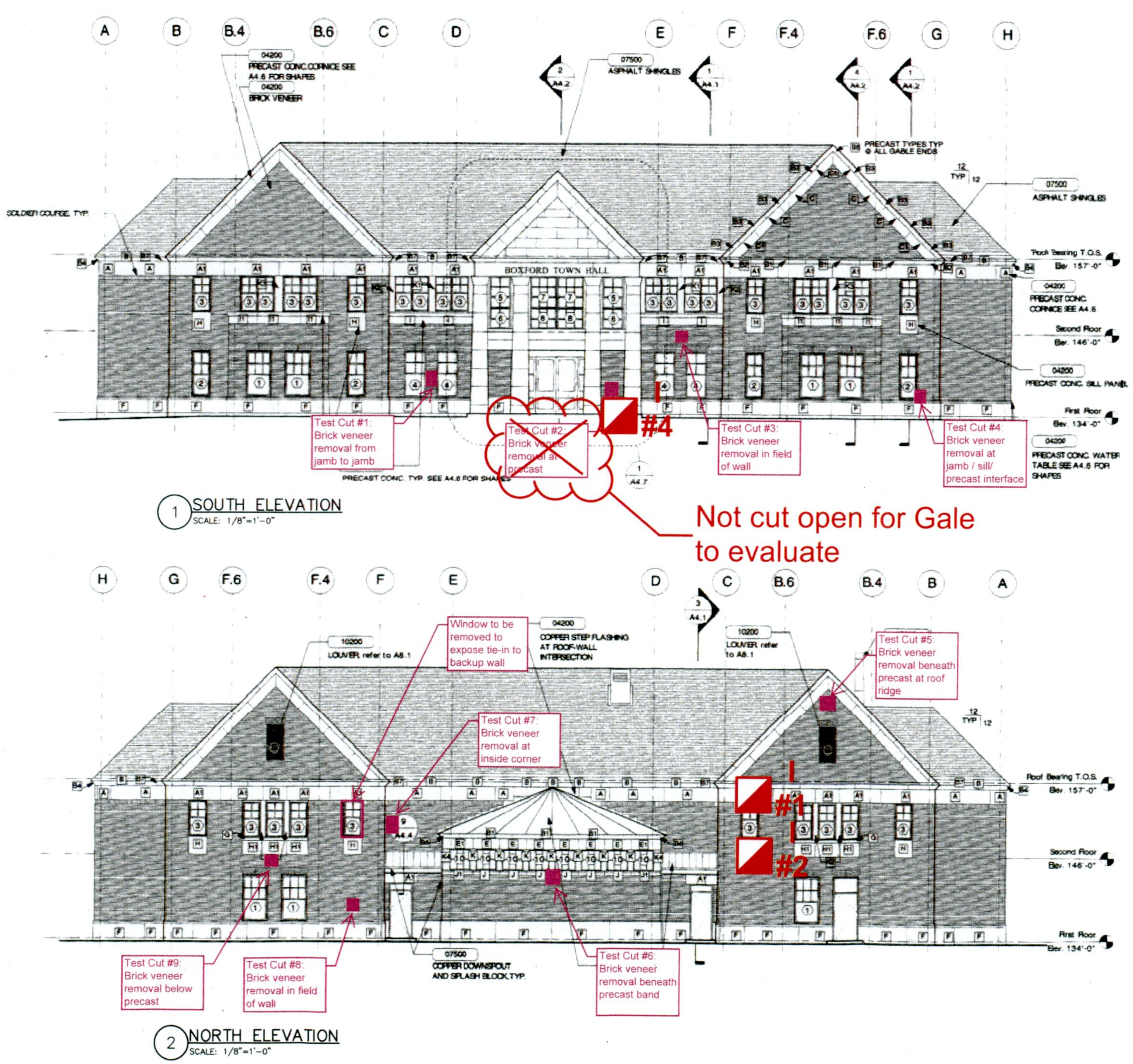
APPENDIX B

FIELD SKETCHES

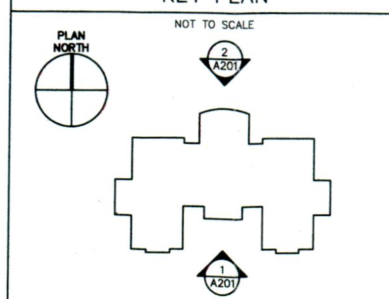
GALE ASSOCIATES, INC.
TEST CUT LOCATION DRAWING
BOXFORD TOWN HALL / LIBRARY
BOXFORD, MA

Interior Test Cut

Exterior Test Cut



KEY PLAN
NOT TO SCALE



GALE

Gale Associates, Inc.

163 LIBBEY PARKWAY | WEYMOUTH, MA 02189
781.335.6465 781.335.6467 www.gainc.com

PROJECT

OWNER

NO.	DATE	DESCRIPTION	BY
PROJECT NO.			
CADD FILE	833440 A100s		
DESIGNED BY			
DRAWN BY			
CHECKED BY			
DATE			
DRAWING SCALE	1/8"=1'-0"		

GRAPHIC SCALE

SHEET TITLE

NORTH & SOUTH ELEVATIONS

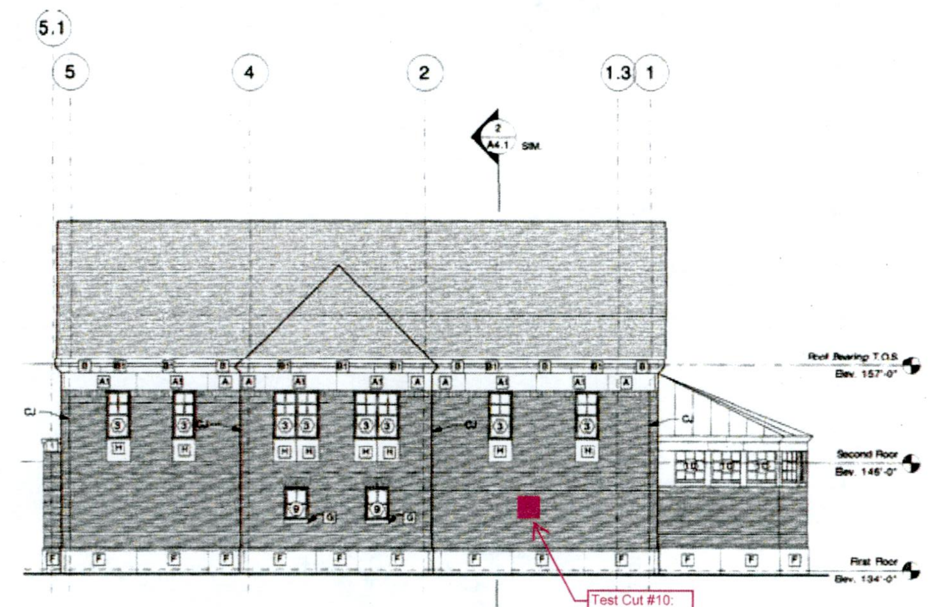
DRAWING NO.

A201

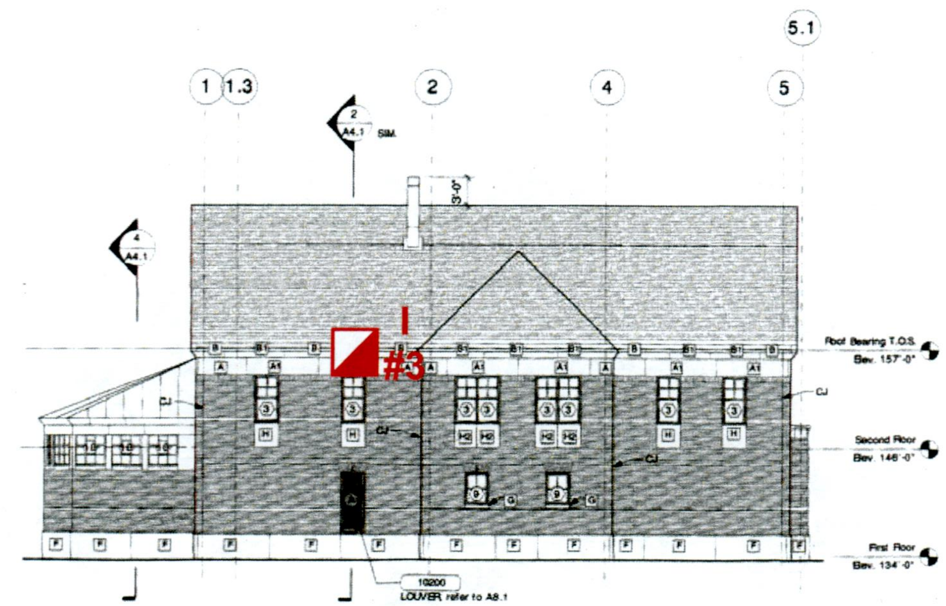
GALE ASSOCIATES, INC.
TEST CUT LOCATION DRAWING
BOXFORD TOWN HALL / LIBRARY
BOXFORD, MA

I # Interior Test Cut

Exterior Test Cut

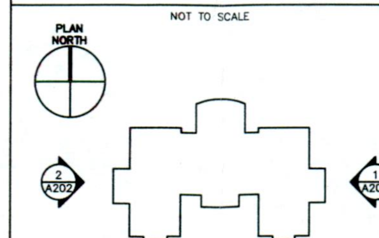


1 EAST ELEVATION
SCALE: 1/8"=1'-0"



2 WEST ELEVATION
SCALE: 1/8"=1'-0"

KEY PLAN
NOT TO SCALE



GALE

Gale Associates, Inc.

163 LIBBEY PARKWAY | WEYMOUTH, MA 02189
781.335.6465 781.335.6467 www.gainc.com

This drawing and the design and construction features disclosed are proprietary to Gale Associates, Inc. and shall not be altered or reused in whole or part without the express written permission of Gale Associates, Inc. Copyright©2018

PROJECT

OWNER

NO.	DATE	DESCRIPTION	BY

PROJECT NO.	
CADD FILE	833440 A100s
DESIGNED BY	
DRAWN BY	
CHECKED BY	
DATE	
DRAWING SCALE	1/8"=1'-0"

GRAPHIC SCALE
0 4' 8' 16'

SHEET TITLE

EAST & WEST ELEVATIONS

DRAWING NO.
A202

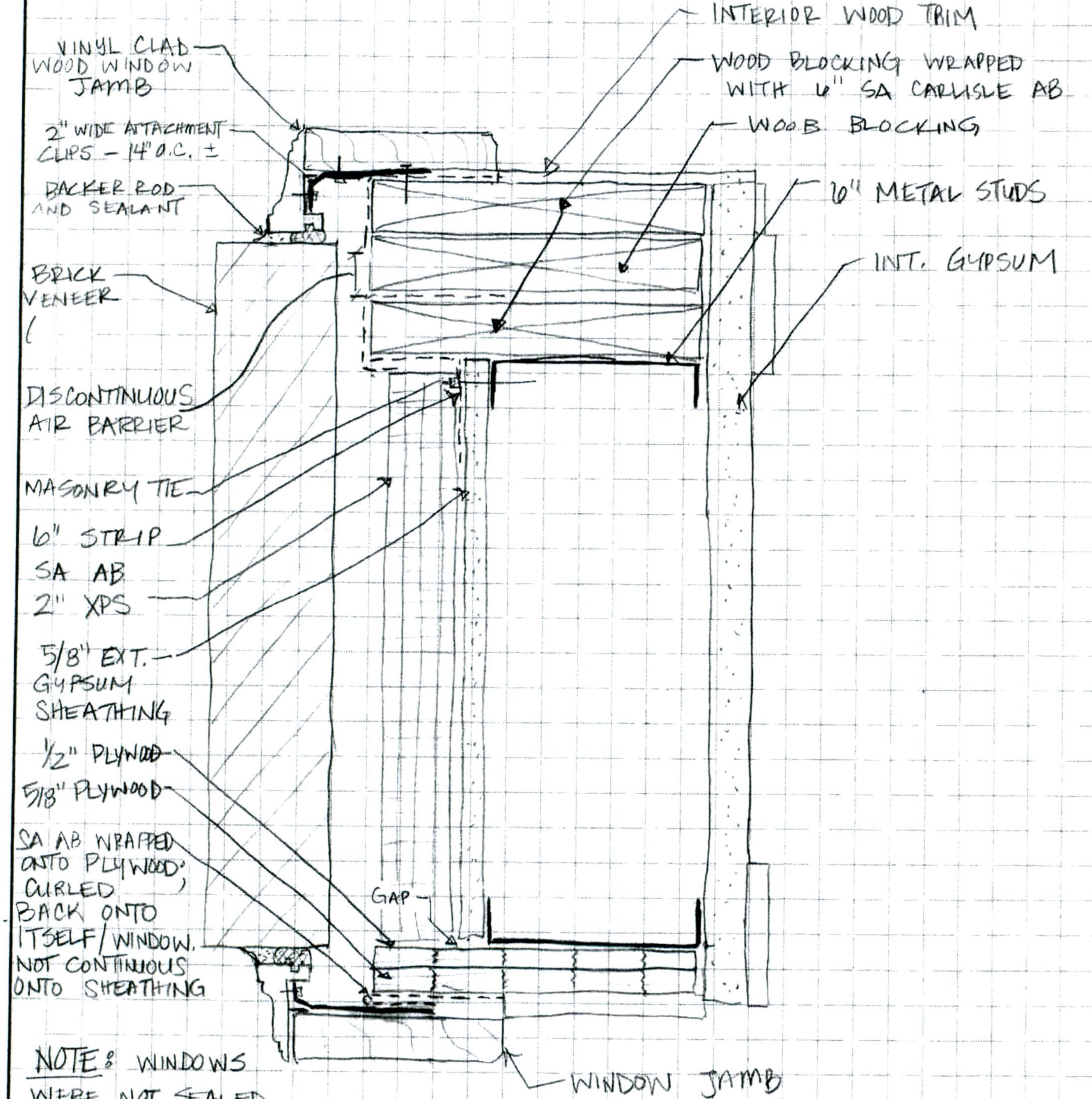
GALE

GALE ASSOCIATES INC
163 LIBBEY INDUSTRIAL PARKWAY
WEYMOUTH, MA 02189
(781) 335-6465

JOB 833440 - BOXFORD
SHEET NO. 1 OF 3
CALCULATED BY KRM DATE 2/8/18
CHECKED BY ______ DATE ______
SCALE 3" = 1'-0"

WINDOW JAMB @ BRICK PIER

TEST CUT #1 - FRONT ELEVATION WINDOW JAMBS
↳ 6 COURSES TALL BY 2½ COURSES WIDE REMOVED



NOTE: WINDOWS WERE NOT SEALED TO AB.

NOTE: ONE (1) HORIZ. JOINT IN EXT. GYP. SHEATHING OBSERVED TO BE TAPED WITH CARLISLE SA AB

GALE

GALE ASSOCIATES INC
163 LIBBEY PARKWAY
WEYMOUTH, MA 02189
(781) 335-6465

JOB 833410 - BOXFORD

SHEET NO. ______ OF ______

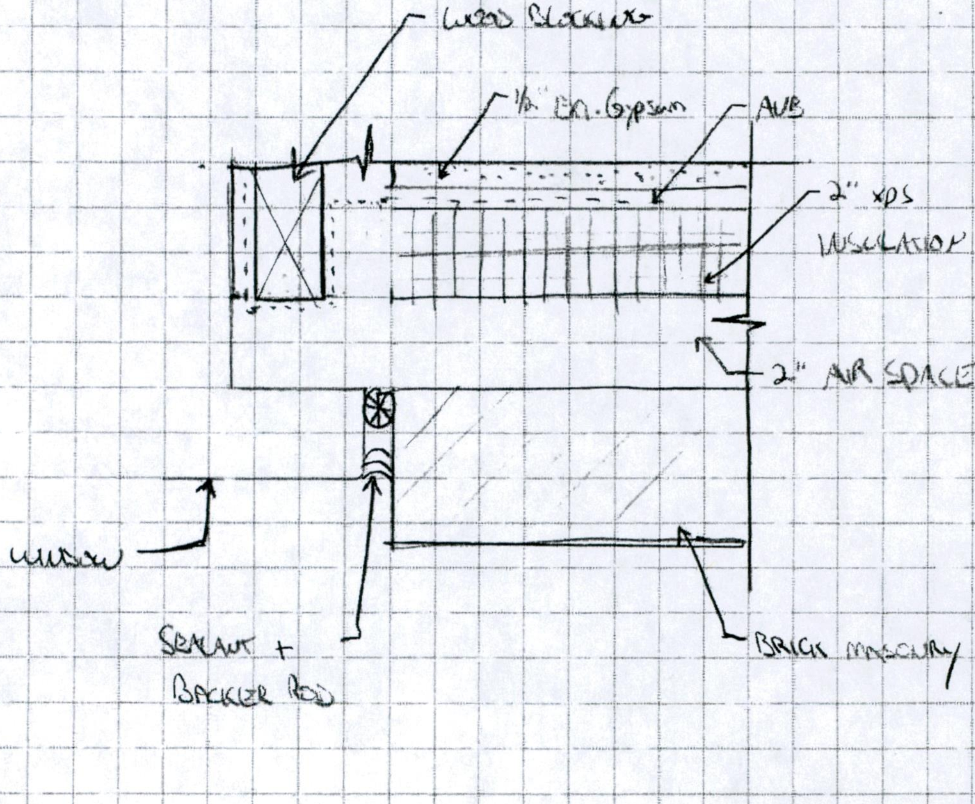
CALCULATED BY CTM DATE 2/8/18

CHECKED BY ______ DATE ______

SCALE 3" = 1'-0"

TEST CUT # 2

- AIR BARRIER EXTENDS ONTO GYPSUM 6"
- INSULATION IS DAMP
- ICE RUNS DOWN FACADE OVER TEST CUT



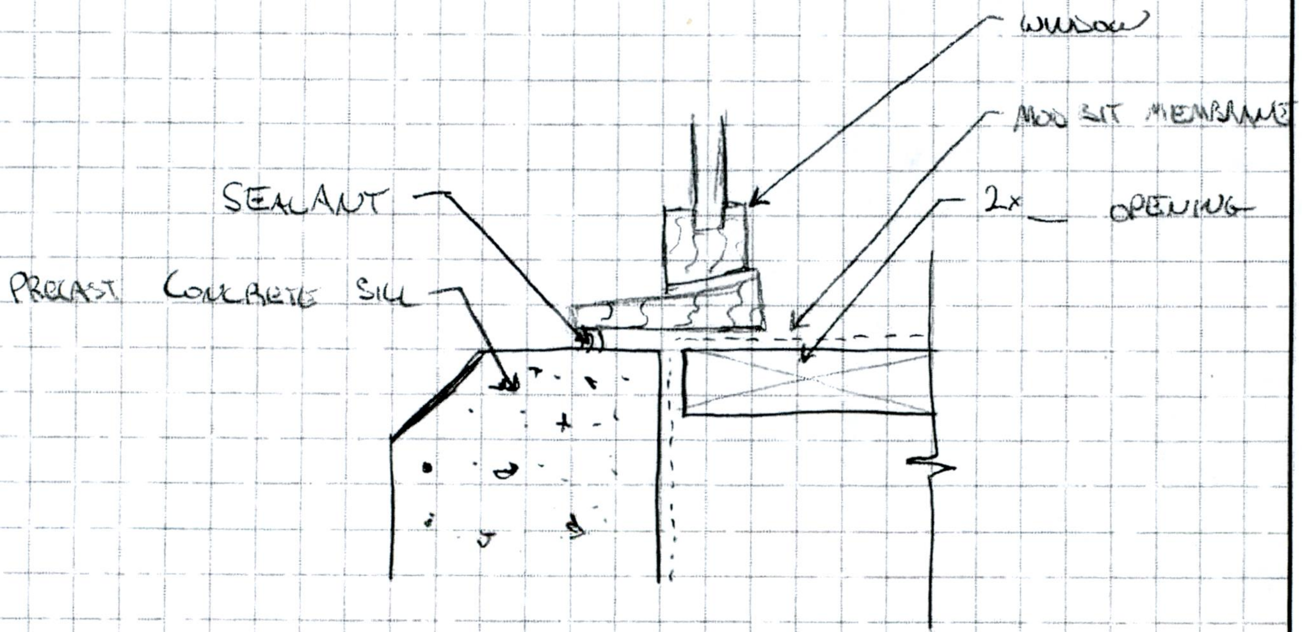
PRODUCT 204-1 (Single Sheets) 205-1 (Padded)

GALE ASSOCIATES INC
163 LIBBEY PARKWAY
WEYMOUTH, MA 02189
(781) 335-6465

JOB 833440- BOXFORD
SHEET NO. ____ OF ____
CALCULATED BY CTM DATE 2/8/18
CHECKED BY ____ DATE ____
SCALE 3" = 1'-0"

TEST CUT #2A - WINDOW SILL

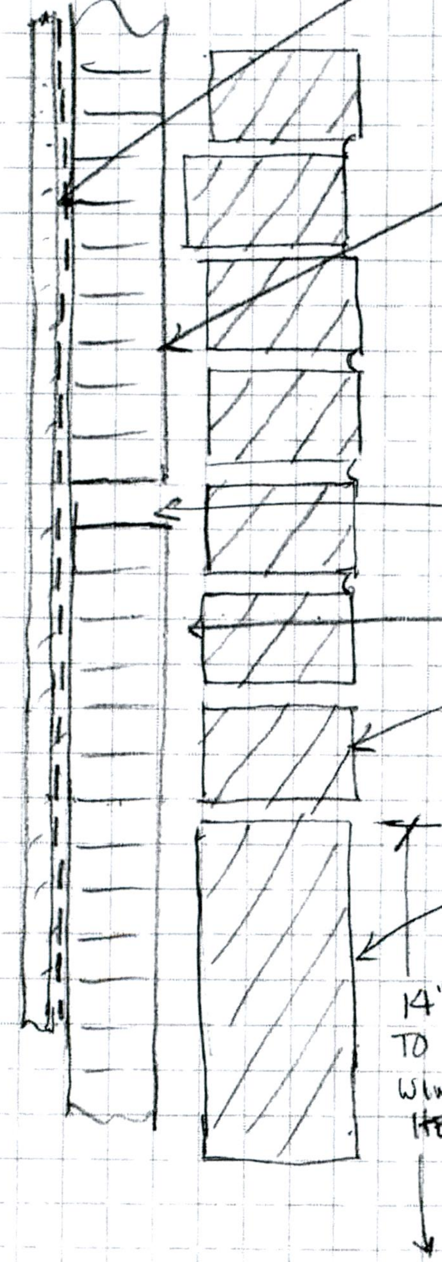
- LAYER OF ICE ON STONE SILL



GALE ASSOCIATES INC
P.O. BOX 890189
163 LIBBEY INDUSTRIAL PARKWAY
WEYMOUTH, MA 02189
(781) 335-6465

JOB 833440
SHEET NO. 1 OF 1
CALCULATED BY REM DATE 2-8-18
CHECKED BY ______ DATE ______
SCALE 3" = 1'-0" ±

T.C. #3 : FIELD OF WALL BETWEEN 2ND FLR PRECAST AND 1ST FLOOR WINDOW HEADER - SOUTH ELEV.



DENS GLASS GWS BACKUP WALL, WATER STAINED, WITH AUB STRIPPING AT PANEL JOINTS

2" THK EXTRUDED POLYSTYRENE INSULATION, NOT IN SUBSTANTIAL CONTACT WITH GWS; HORIZONTAL GAPS BETWEEN PANELS

GAP WITH LOOSE INFILL

1"± CAVITY SPACE

2"x 3½"x 7½" BRICK VENEER RECESSED EVERY 6TH COURSE

SOLDIER COURSE DOWN TO WINDOW HEADER

14" TO WINDOW HEAD

FABRIC COATED COPPER (FCC) TWF NOTED AT WINDOW HEAD

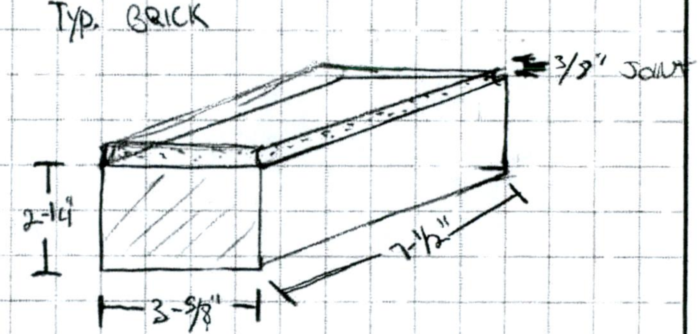
JOB 833440 - BOXFORD

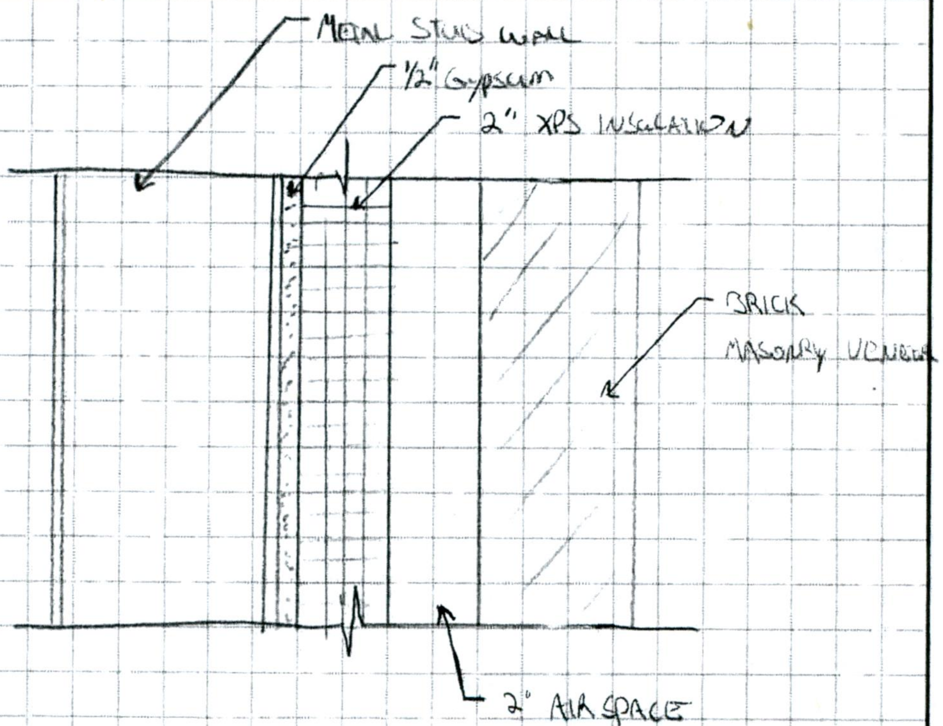
GALE ASSOCIATES INC
163 LIBBEY PARKWAY
WEYMOUTH, MA 02189
(781) 335-6465

SHEET NO. ______ OF ______
CALCULATED BY CTM DATE 2/8/18
CHECKED BY ______ DATE ______
SCALE 3" = 1'-0"

TEST CUT # 4 - FIELD OF WALL

- XPS INSULATION NAILED TO GYPSUM
- NO AVB
- MATERIALS ARE DRY
- INSULATION IS LOOSE IN SOME LOCATIONS
- ICE TRAVELING DOWN FACADE





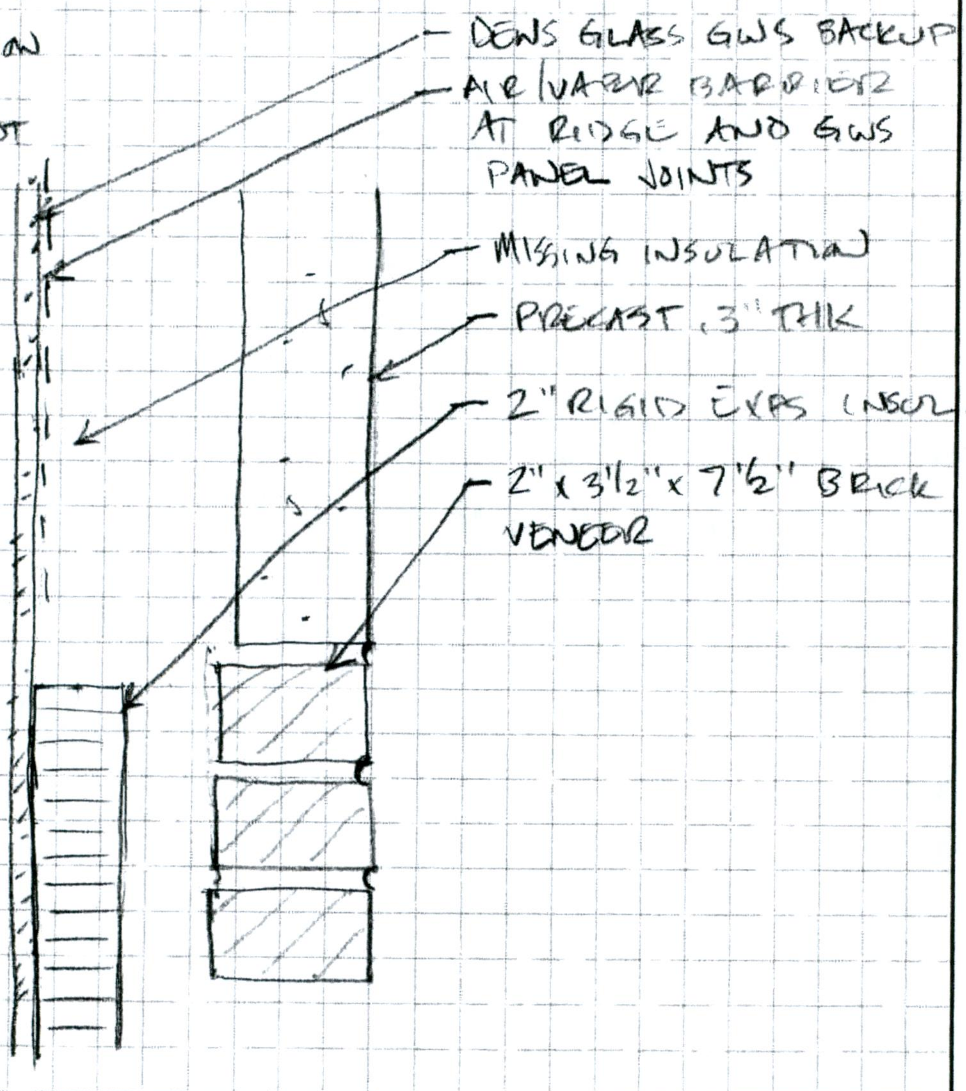
PRODUCT 204-1 (Single Sheets) 205-1 (Padded)

GALE ASSOCIATES INC
P.O. BOX 890189
163 LIBBEY INDUSTRIAL PARKWAY
WEYMOUTH, MA 02189
(781) 335-6465

JOB 833440
SHEET NO. 1 OF 1
CALCULATED BY RFM DATE 2-8-18
CHECKED BY DATE
SCALE 3" = 1'-0" ±

TEST CUT #5: RIDGE :- NORTH ELEVATION

NOTE: RIGID INSULATION VISIBLE AT TOP OF PRECAST – COULD NOT VERIFY AVB TIE-IN TO ROOF.



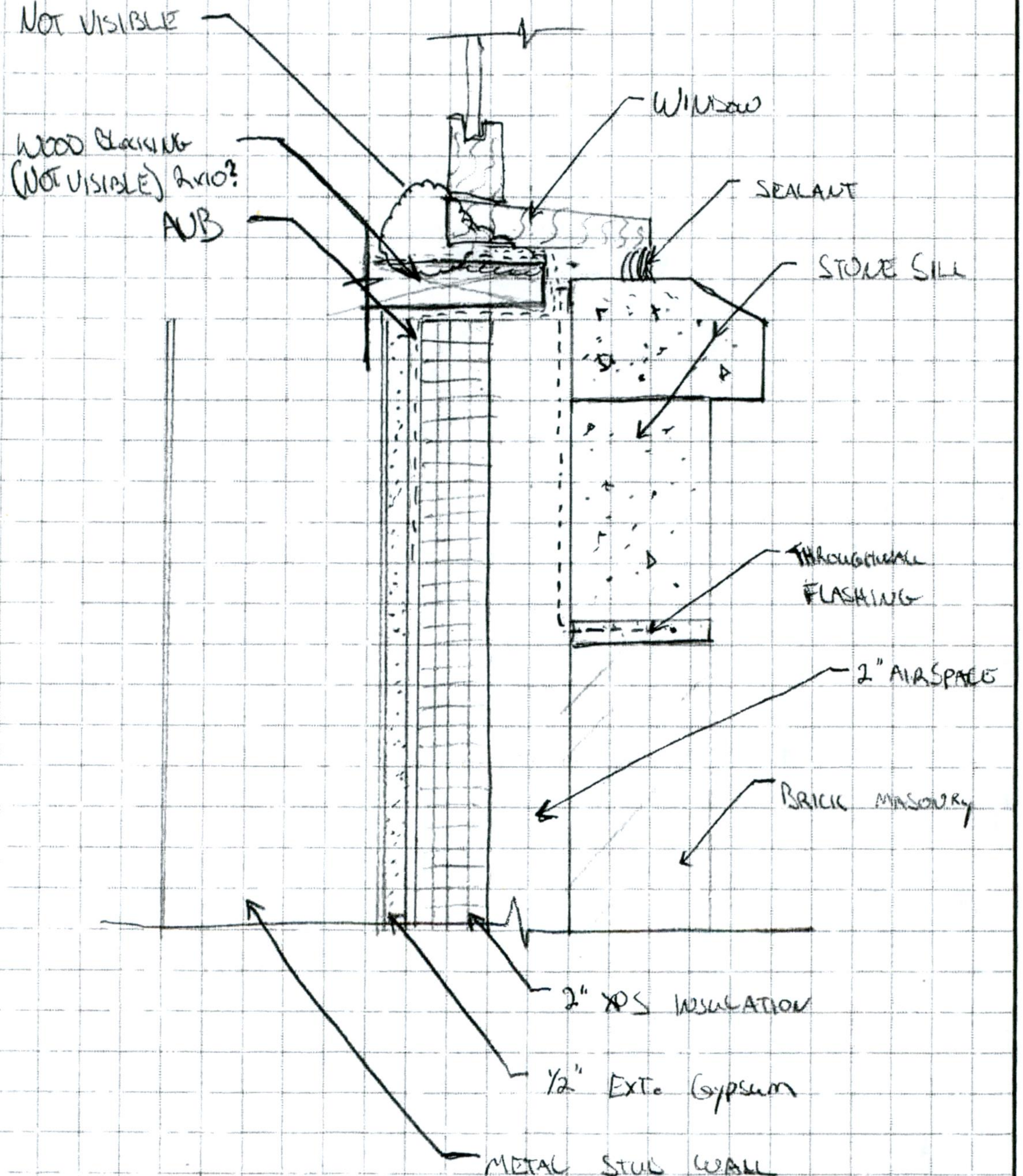
GALE

GALE ASSOCIATES INC
163 LIBBEY PARKWAY
WEYMOUTH, MA 02189
(781) 335-6465

JOB 835130 - BOXFORD
SHEET NO. ______ OF ______
CALCULATED BY CJM DATE 2/8/18
CHECKED BY ______ DATE ______
SCALE 3" = 1'-0"

TEST CUT #6 - BELOW STONE SILL OF MEETING ROOM

- INSULATION APPEARS LOOSE
- CONCRETE SILL DETERIORATED
- COPPER FABRIC THROUGHWALL FLASHING

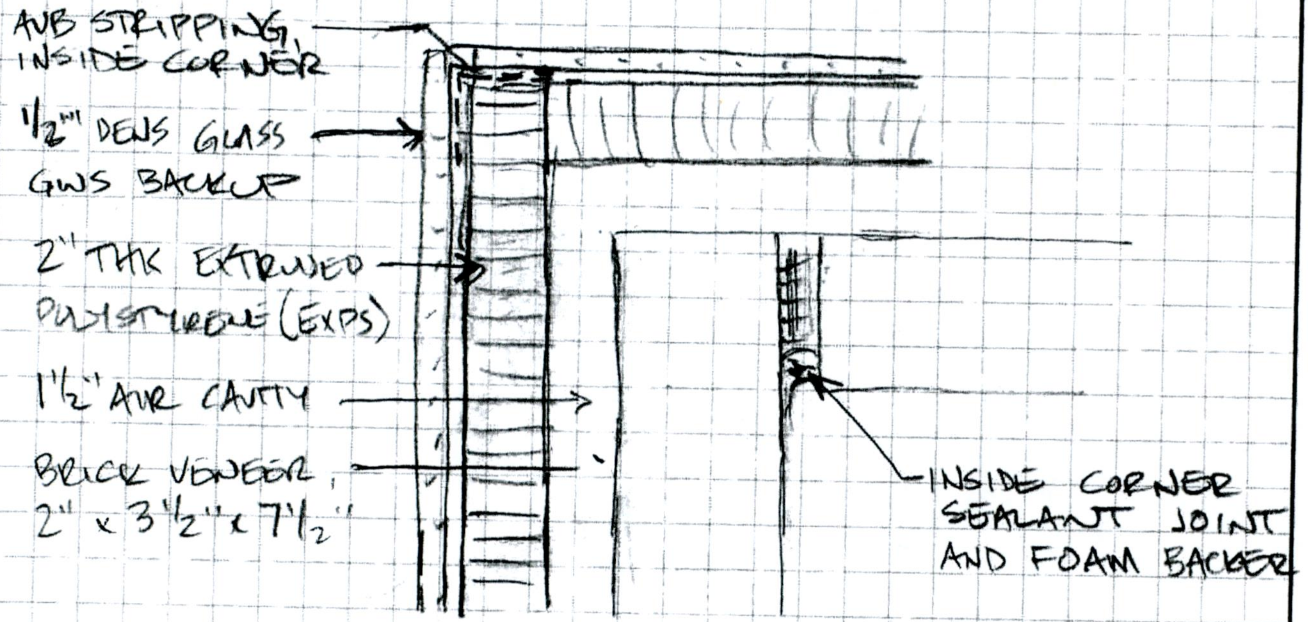


GALE ASSOCIATES INC
P.O. BOX 890189
163 LIBBEY INDUSTRIAL PARKWAY
WEYMOUTH, MA 02189
(781) 335-6465

JOB 833440
SHEET NO. 1 OF 1
CALCULATED BY RFM DATE 2-8-18
CHECKED BY ________ DATE ________
SCALE 3" = 1'-0" ±

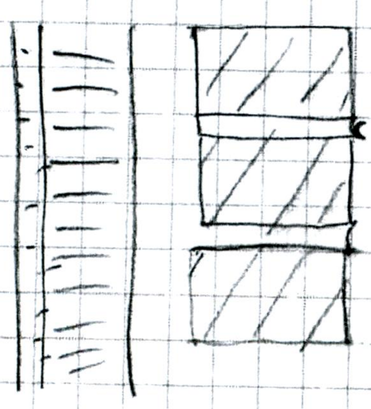
TC#7: INSIDE CORNER - NORTH ELEVATION

PLAN AT INSIDE CORNER



SECTION AT INSIDE CORNER

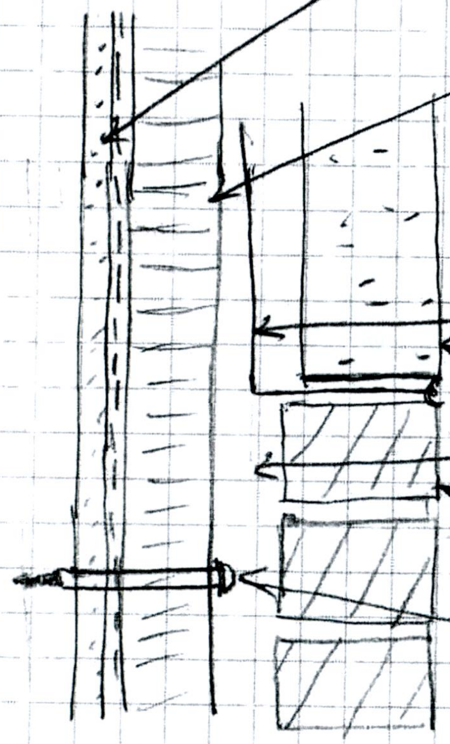
SEE NOTES ABOVE



GALE ASSOCIATES INC
P.O. BOX 890189
163 LIBBEY INDUSTRIAL PARKWAY
WEYMOUTH, MA 02189
(781) 335-6465

JOB 833440
SHEET NO. 1 OF 1
CALCULATED BY REM DATE 2-2-18
CHECKED BY DATE
SCALE 3" = 1'-0" ±

TEST CUT #9: PRECAST AT TRIPLE WINDOW - NORTH



DENS GLASS GWS W/ 6" TUB STRIPS AT JOINTS

2" THK EXTRUDED POLYSTYRENE, NAILED TO BACKUP - NOT IN SUBSTANTIAL CONTACT; GAPS AT JOINTS

FCC TWF - COULD NOT CONFIRM EXTENTS

3" THK PRECAST

1½" CAVITY SPACE

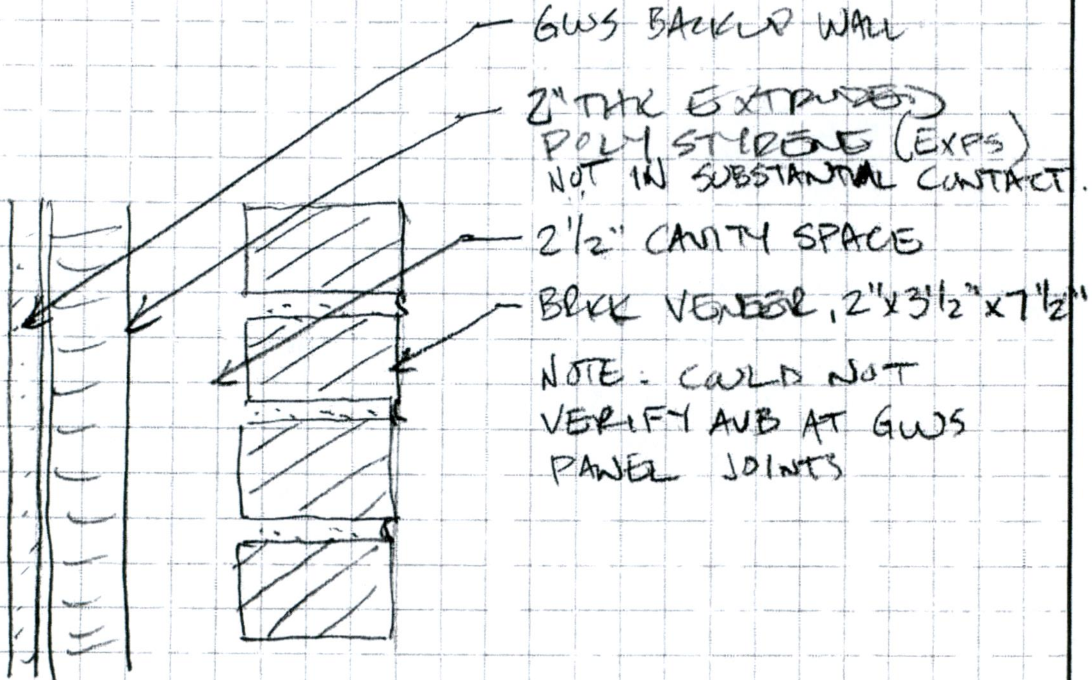
BRICK VENEER, 2" x 3½" x 7½"

MASONRY ANCHORS APPEARS FASTENED THROUGH GWS TO METAL-STUD FRAMING

GALE ASSOCIATES INC
P.O. BOX 890189
163 LIBBEY INDUSTRIAL PARKWAY
WEYMOUTH, MA 02189
(781) 335-6465

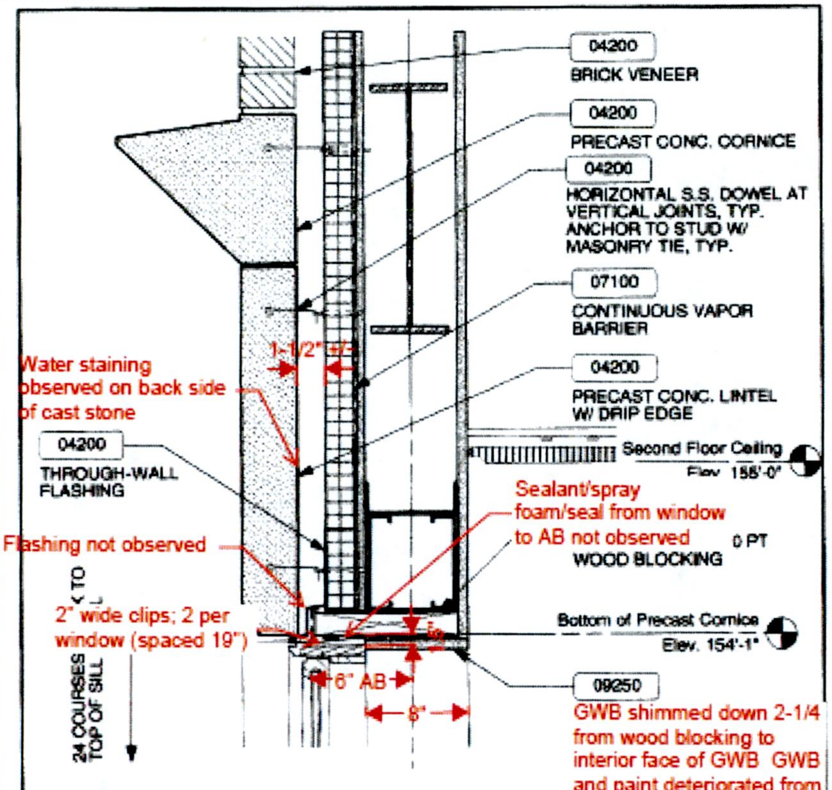
JOB 833446
SHEET NO. 1 OF 1
CALCULATED BY RFM DATE 2-8-18
CHECKED BY ______ DATE ______
SCALE 3" = 1'-0" ±

TEST CUT #10 - FIELD OF WALL - EAST



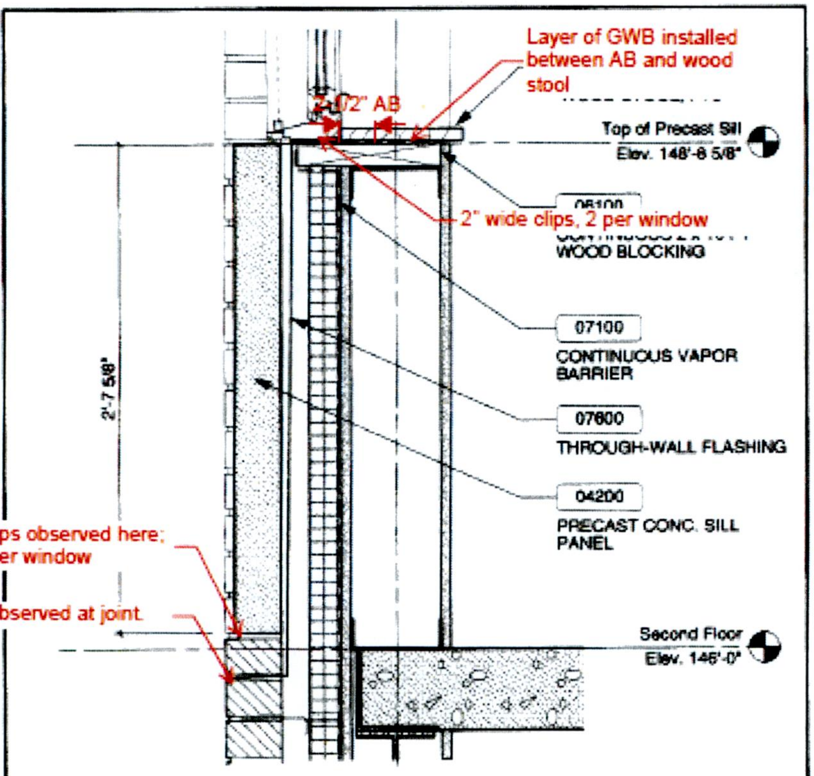
INTERIOR TEST CUT NOTES

2/8/18 KRM



5 / A4.3 SECTION DETAIL @ GABLE CC 1 1/2"=1'-0"

Interior test cut #1 - storage room back elevation



10 / A4.3 SECTION DETAIL AT PRECAST SILL PANEL 1 1/2"=1'-0"

Interior test cut #2 - storage room back elevation

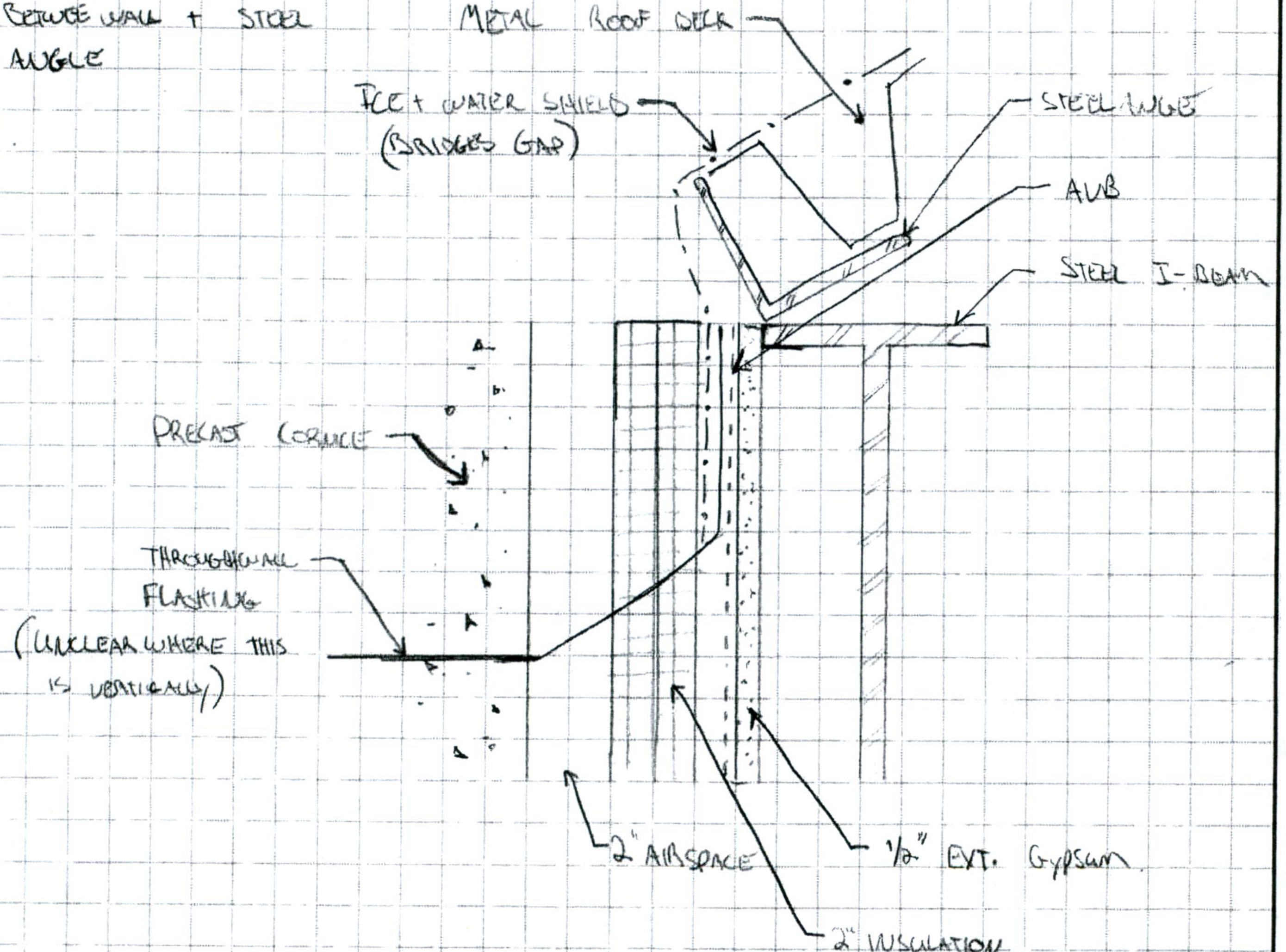
GALE

GALE ASSOCIATES INC
163 LIBBEY PARKWAY
WEYMOUTH, MA 02189
(781) 335-6465

JOB 833440 - BOXFORD
SHEET NO. ____ OF ____
CALCULATED BY CTM DATE 2/8/18
CHECKED BY ____ DATE ____
SCALE 3" = 1'-0"

INTERIOR TEST CUT #3 - EAVE

- DETAIL IS SIMILAR TO EXISTING DRAWING EXCEPT FOR ICE + WATER SHIELD OVER AVB
- GAPS IN THE I+W AND AVB ARE COMMON AT EAVE AND THE CONNECTION
- ICE + WATER BRIDGES GAP BETWEEN WALL + STEEL ANGLE

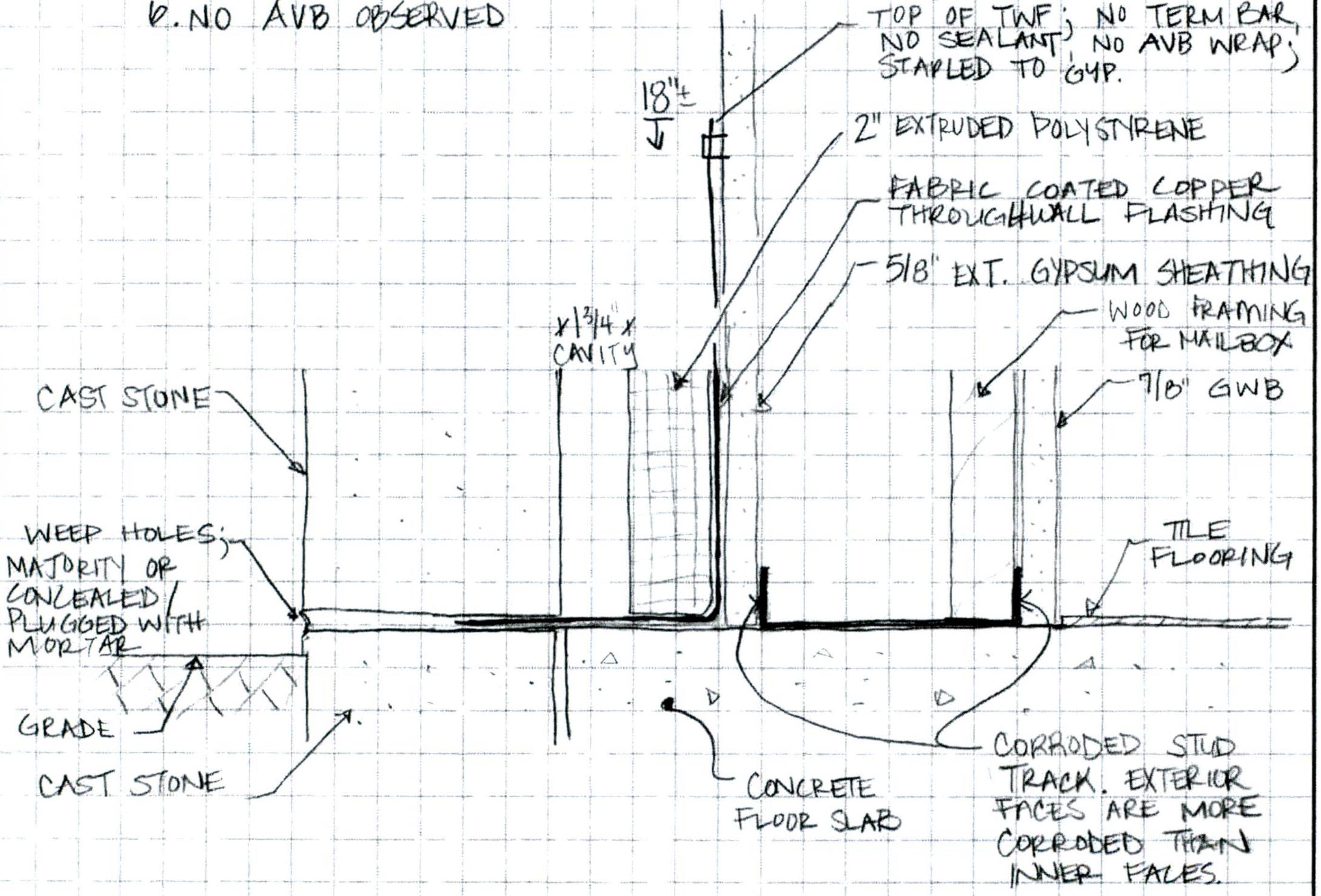


GALE
GALE ASSOCIATES INC
163 LIBBEY INDUSTRIAL PARKWAY
WEYMOUTH, MA 02189
(781) 335-6465

JOB 933440 - BOXFORD
SHEET NO. 2 OF 3
CALCULATED BY KRM DATE 2/8/18
CHECKED BY ______ DATE ______
SCALE 3" = 1'-0"

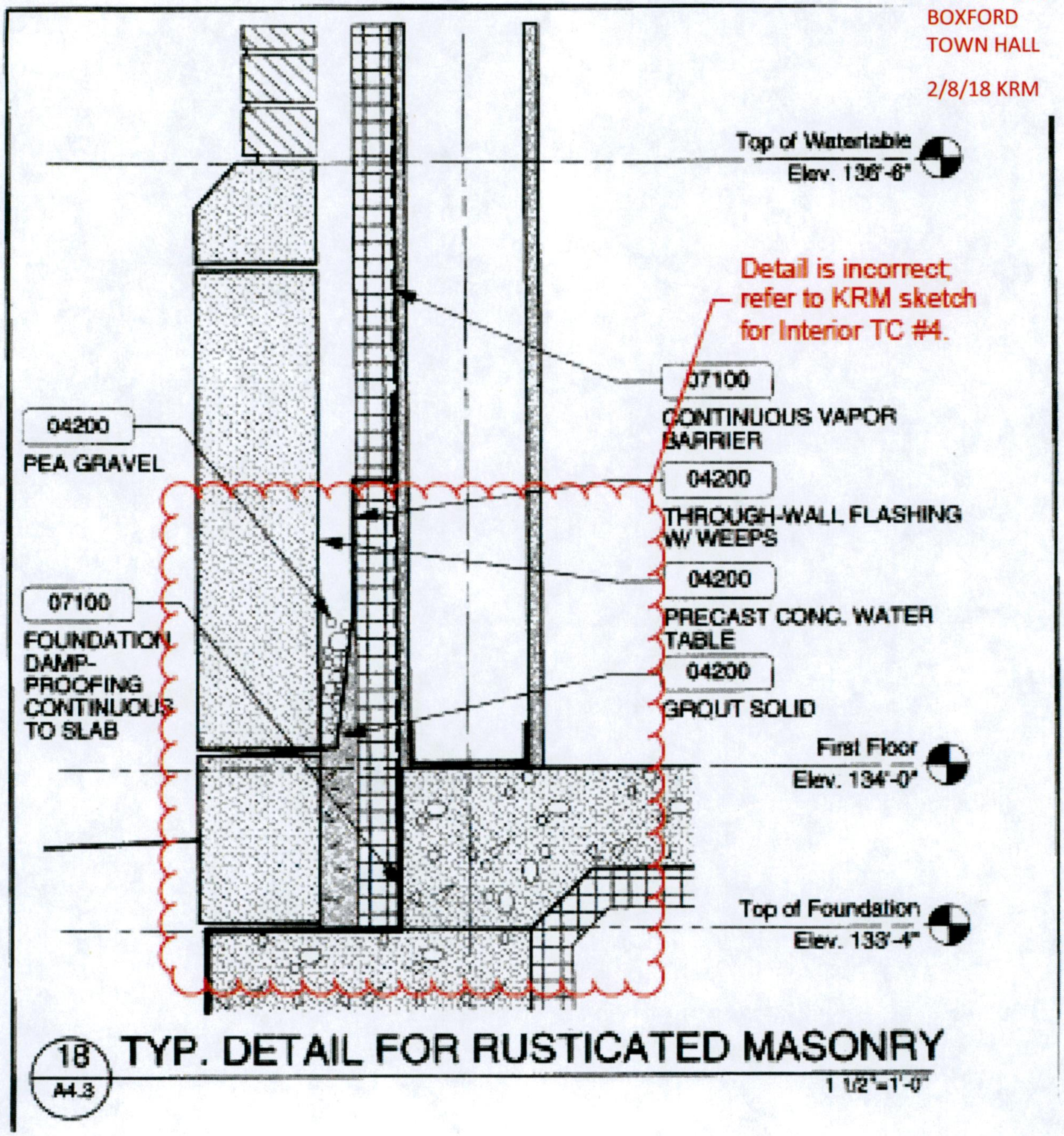
INTERIOR TEST CUT #4 - BELOW MAIL DROP

NOTE: 1. BACK SIDE (INTERIOR SIDE) OF FCC TWF SHOWS MOISTURE STAINING
2. EXTERIOR FACE OF GWB SHOWS MOISTURE DAMAGE; GOLD FACER PEELED OFF
3. WEEPS TYP. PLUGGED
4. TWF NOT TERMINATED @ TOP
5. XPS DOESN'T EXTEND DOWN PAST FLOOR SLAB, AS DWGS INDICATE
6. NO AVB OBSERVED

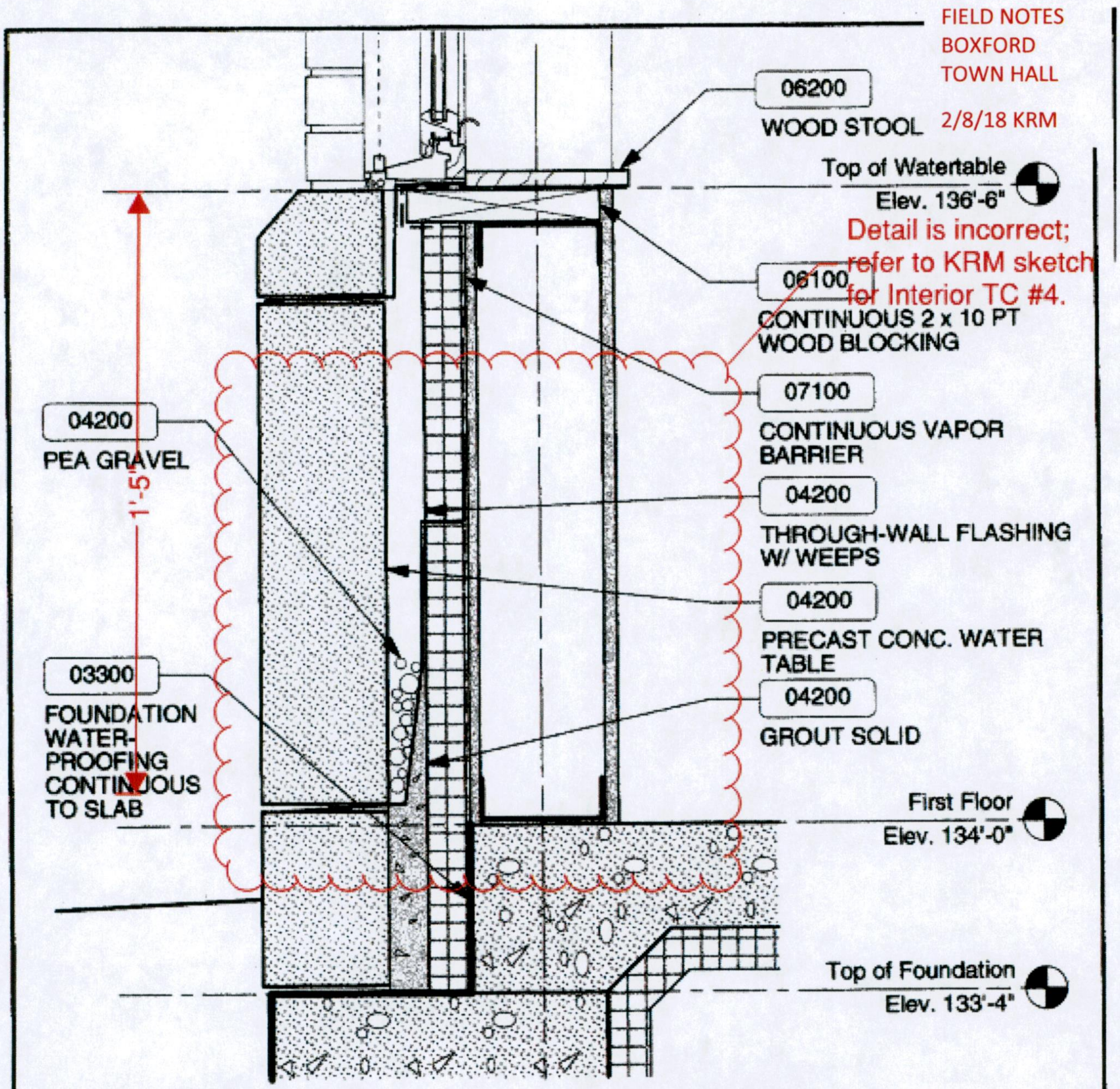


FIELD NOTES
BOXFORD
TOWN HALL

2/8/18 KRM



18
A4.3
TYP. DETAIL FOR RUSTICATED MASONRY
1 1/2"=1'-0"



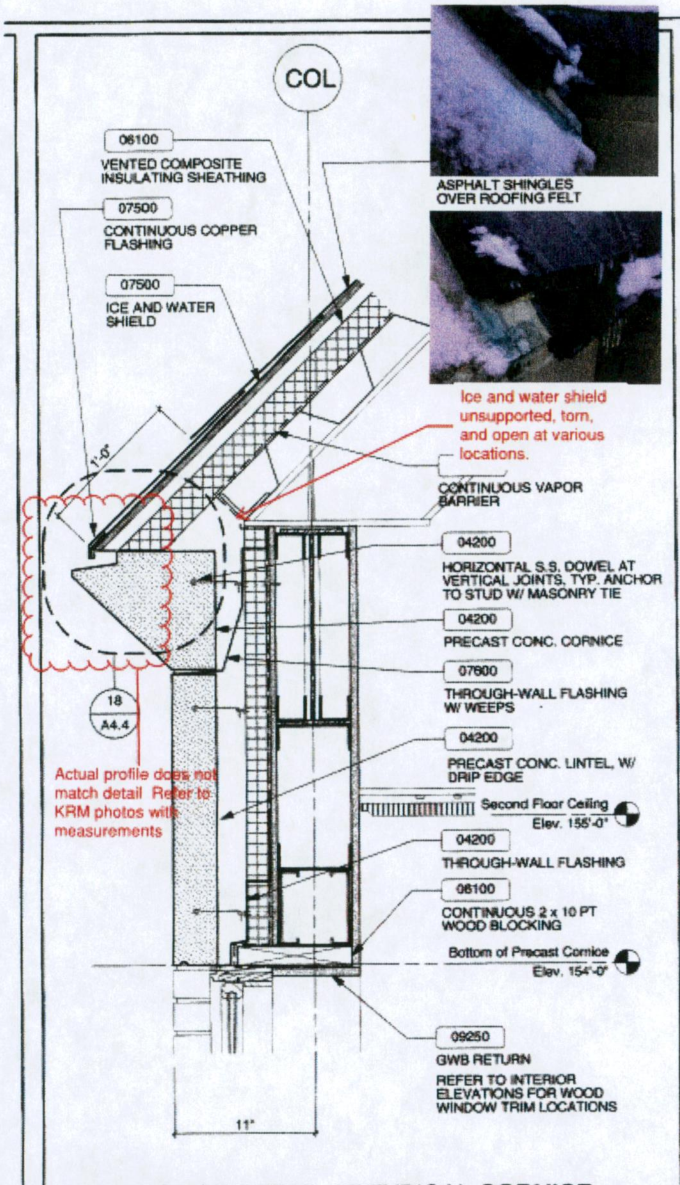
20
A4.3

SECTION DETAIL @ PRECAST BASE

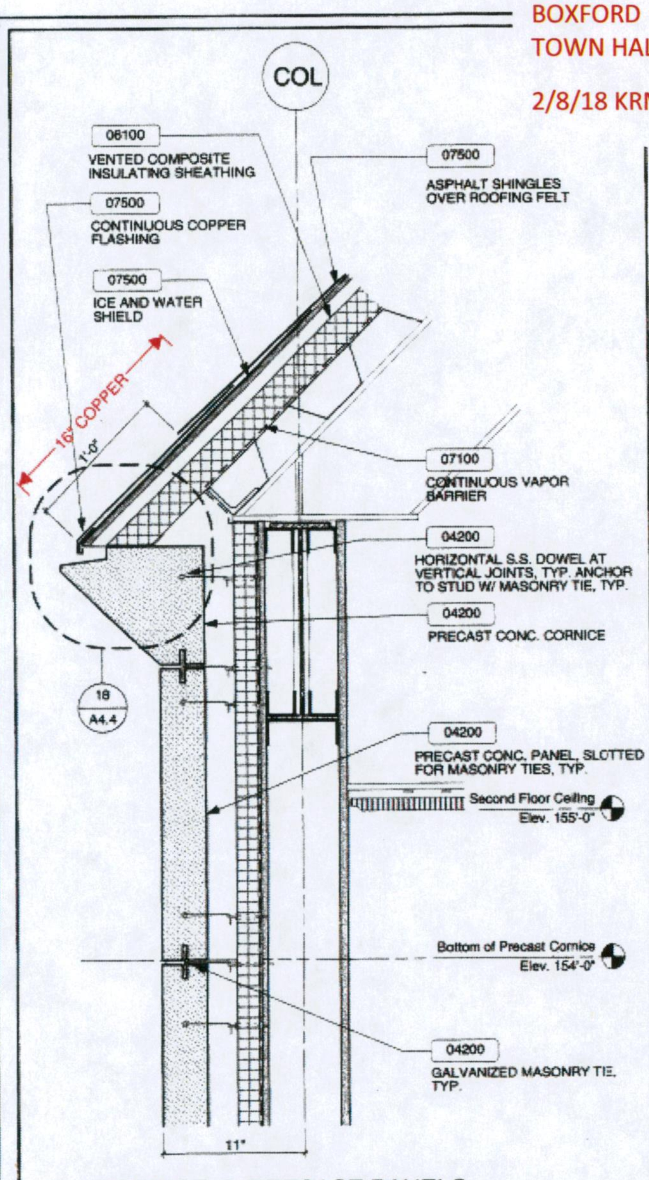
1 1/2"=1'-0"

FIELD NOTES
BOXFORD
TOWN HALL

2/8/18 KRM



7 A4.3 SECTION DETAIL AT TYPICAL CORNICE
1 1/2"=1'-0"



8 A4.3 CORNICE @ PRECAST PANELS
1 1/2"=1'-0"

GALE ASSOCIATES INC
163 LIBBEY INDUSTRIAL PARKWAY
WEYMOUTH, MA 02189
(781) 335-6465

JOB 833440 - BOXFORD
SHEET NO. 3 OF 3
CALCULATED BY KRM DATE 2/8/18
CHECKED BY ____ DATE ____
SCALE N.T.S.

NOTES:

1. SEALANT THROUGHOUT FAILED - OBSERVED @ ROOFS. CRAZING AND FAILED ADHESIVELY / COHESIVELY.

2. MORTAR JOINTS @ CAST STONE ELEMENTS TYP. FAILED; DEBONDED FROM STONE

3. WEEPS NOT CONSISTENTLY OBSERVED AT INTERMEDIATE FLASHINGS. WEEP HOLES OBSERVED AT CAST STONE, TYP PLUGGED W/ MORTAR.

RILEM TUBE TEST - SOUTH ELEVATION

1. BED RED BRICK JOINT - START @ 0 CC
   1 CC @ 2:45
   2 CC @ 4:53

2. HEAD RED BRICK JOINT - START @ 0 CC
   0 CC @ 5:00

3. RED BRICK - START @ -1/4 CC
   0 CC @ 5:00

4. HEAD BLACK BRICK JOINT - START @ 0 CC
   1/4 CC @ 5:00

5. BLACK BRICK - START @ 0 CC
   0 CC @ 5:00

PRODUCT 204-1 (Single Sheets) 205-1 (Padded)

APPENDIX C

<u>INTERIOR LEAK AUDIT</u>

Exterior Wall/Window Evaluation at the
Boxford Town Hall/Library
Boxford, Massachusetts
Gale JN 833440

INTERIOR LEAK AUDIT

On January 31, 2018, Gale reviewed the interior building components and interviewed building staff including the Department of Public Works (DPW) and building occupants, to understand the history of reported air leaks and water infiltration. Below is observed and reported leak locations

- Leak location #1 Room 220 - Selectman's Office, blistered paint at window header *Refer to Figure 2.*
- Leak location #2 Room 222 – Office of the Town Administrator, blistered paint on window header.
- Leak location #3 Room 224 – Inspectional Department, blistered paint at window header and jamb *Refer to Figure 3.*
- Location #4 Room 227 – Health Office, interior stool is bowed/displaced at the jambs. *Refer to Figure 4.*

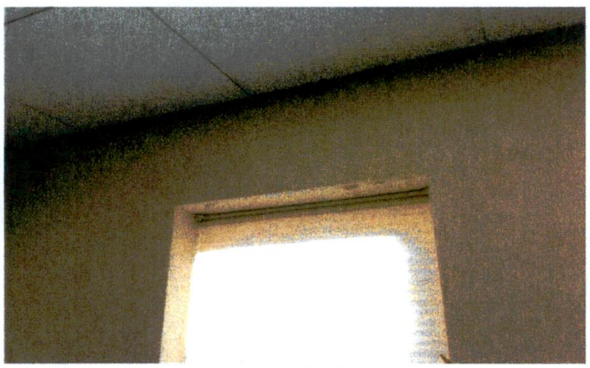


Figure 1: Water infiltration resulted in blistered paint on the window header in Room 220.

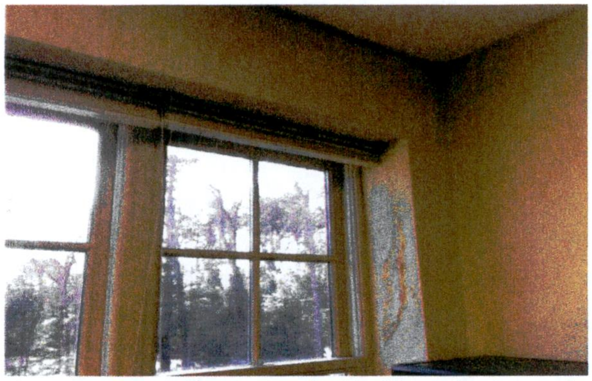


Figure 2: Water infiltration resulted in blistered paint on the window header and jamb in Room 224.

Figure 3: Bowed/displaced interior stool in Room 227.

- Leak location #5 Room 229 – Conservation/Planning Office, water staining on a ceiling tile inward of the window header Refer to Figure 5.

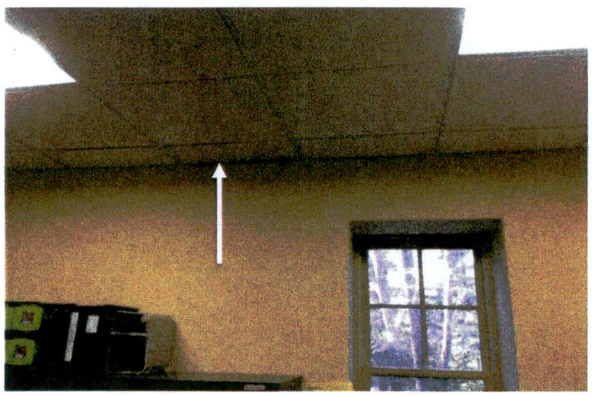


Figure 4: Water staining was noted on the ceiling tile inward of the window in Room 229.

- Leak location #6 Room 230 – Office of the Conservation Director, peeled paint at the window header.

- Leak location #7 Room 231 – Office of the Conservation Assistant, peeled paint at window headers and on the interior wall adjacent to the windows.
- Leak location #8 Room 232 – Planner's Office, blistered paint at window header, jamb, and jamb sill.

Figure 5: Water infiltration resulted in blistered paint on the window header and jamb in Room 232.

- Leak location #9 Payment Drop Closet Room on the 1st floor, rusted metal-stud framing noted via previously opened interior wall area Refer to Figure 7.

Figure 6: Evidence of water infiltration based on rusted metal-stud framing inside the Payment Drop closet on the 1st floor

- Leak location #10 1st floor closet west of the main entrance, blistered paint is noted on the interior wall finish, and efflorescent staining is noted around the floor tiles adjacent to the exterior wall Refer to Figure 8.

Figure 7: Evidence of water infiltration in the form of efflorescent staining around floor tiles in the closet west of the main entrance.

- Leak location #11 Children's Library, blistered paint on the wood trim at the window jamb Refer to Figure 9.

Figure 8: Blistered paint on interior wood trim adjacent to a window.

- Leak location #12 Children's Library, blistered paint at a window jamb/sill transition. Refer to Figure 10.

Figure 9: Water infiltration resulted in blistered paint on the window jamb/sill transition in the Children's Library.

- Leak location #13 Children's Library, stained ceiling tiles and blistered paint on interior wall finish adjacent to an inside corner of the building Refer to Figure 11.

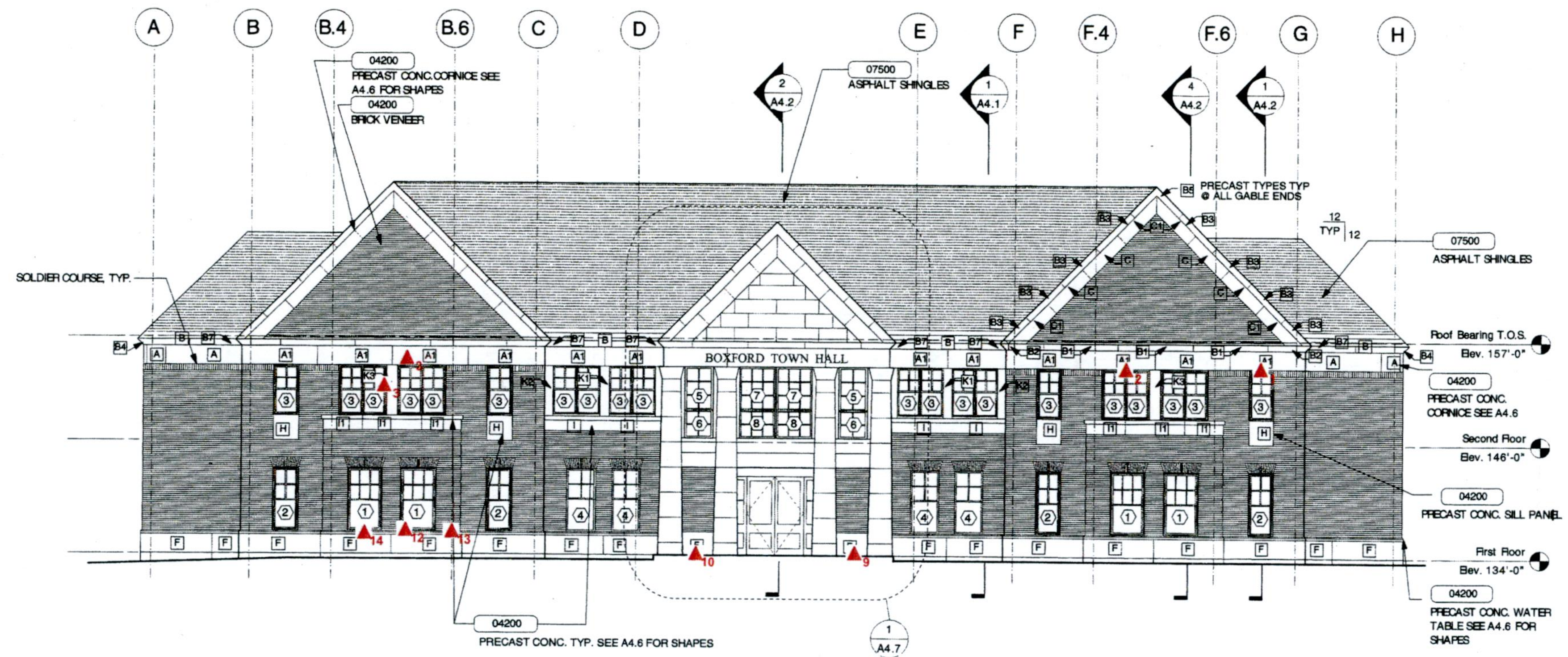
Figure 10: Water infiltration resulted in blistered paint on the interior wall in the Children's Library.

- Leak location #14 the Children's Library, blistered paint on interior wall below window stool.
- Leak location #15 Assembly Room, blistered paint noted on the interior wall adjacent to the entrance door on the west elevation of the Room. Lintel at door was observed to be corroded. Refer to Figure #12.

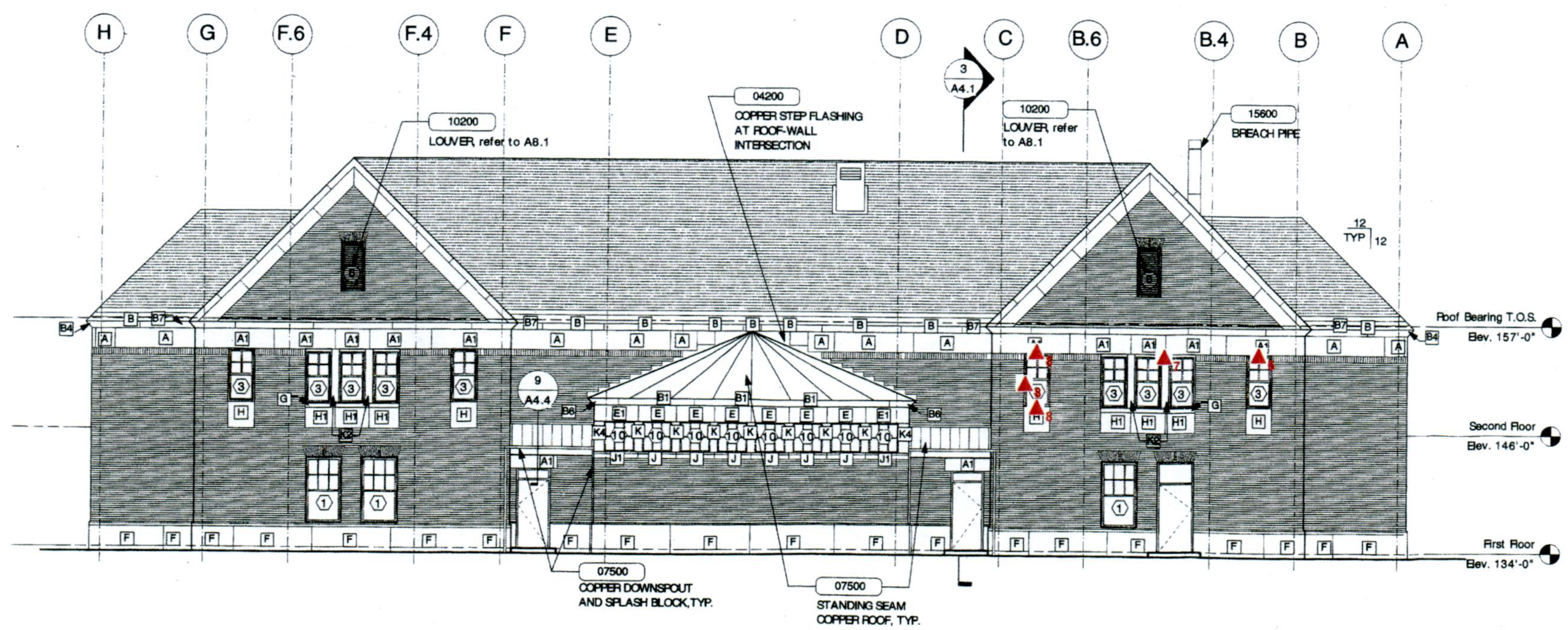
Figure 11: Water infiltration resulted in blistered paint on adjacent to the door in the Assembly Room

Additional interior leaks were reported, however did not appear to be caused by failures of the building envelope.

I:\833440\01 Evaluation\report\Appendix C - Interior Leak Audit\01 Appendix C Interior Leak Audit.docx



1 SOUTH ELEVATION
SCALE: 1/8"=1'-0"

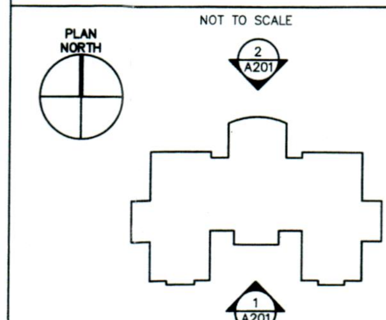


2 NORTH ELEVATION
SCALE: 1/8"=1'-0"

INTERIOR LEAK AUDIT
RFM/KRM
1/31/18

▲# LEAK LOCATIONS; REFER TO REPORT FOR ADDITIONAL INFORMATION.

KEY PLAN
NOT TO SCALE



GALE
Gale Associates, Inc.
Engineers and Planners
163 LIBBEY PARKWAY | WEYMOUTH, MA 02189
781.335.6465 | 781.335.6467 www.gainc.com
Boston Baltimore Orlando Hartford

LEAK AUDIT

PROJECT
EXTERIOR WALL/WINDOW EVALUATION
AT THE BOXFORD TOWN HALL/LIBRARY
BOXFORD, MASSACHESETTS

OWNER
TOWN OF BOXFORD
7B SPOFFORD ROAD
BOXFORD, MA 01921

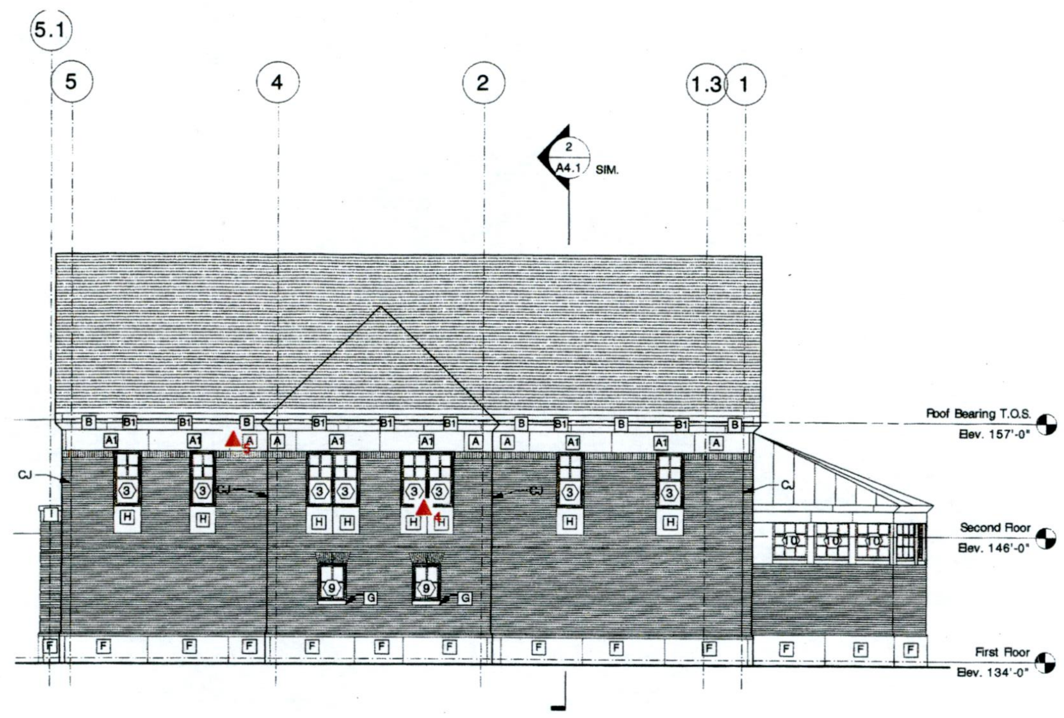
NO.	DATE	DESCRIPTION	BY

PROJECT NO.	
CADD FILE	833440 A100s
DESIGNED BY	
DRAWN BY	
CHECKED BY	
DATE	
DRAWING SCALE	1/8"=1'-0"

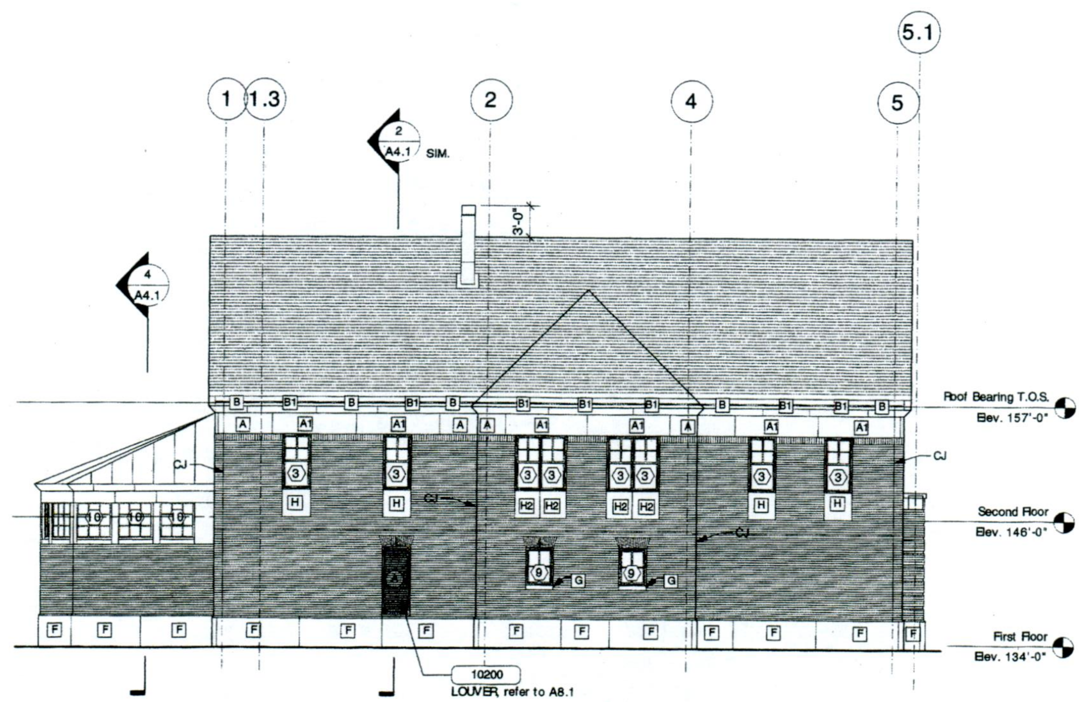
GRAPHIC SCALE
0 4' 8' 16'

SHEET TITLE
NORTH & SOUTH ELEVATIONS

DRAWING NO.
A201



1 EAST ELEVATION
SCALE: 1/8"=1'-0"

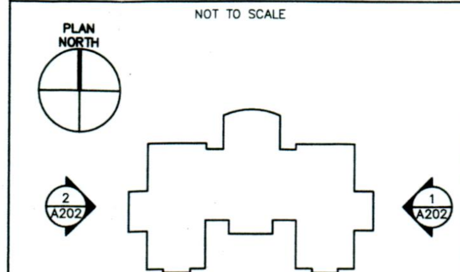


2 WEST ELEVATION
SCALE: 1/8"=1'-0"

INTERIOR LEAK AUDIT
RFM/KRM
1/31/18

▲# LEAK LOCATIONS; REFER TO REPORT FOR ADDITIONAL INFORMATION.

KEY PLAN
NOT TO SCALE



GALE

Gale Associates, Inc.
Engineers and Planners
163 LIBBEY PARKWAY | WEYMOUTH, MA 02189
P 781.335.6465 F 781.335.6467 www.galeinc.com
Boston Baltimore Orlando Hartford

LEAK AUDIT

PROJECT
EXTERIOR WALL/WINDOW EVALUATION
AT THE BOXFORD TOWN HALL/LIBRARY
BOXFORD, MASSACHESETTS

OWNER
TOWN OF BOXFORD
7B SPOFFORD ROAD
BOXFORD, MA 01921

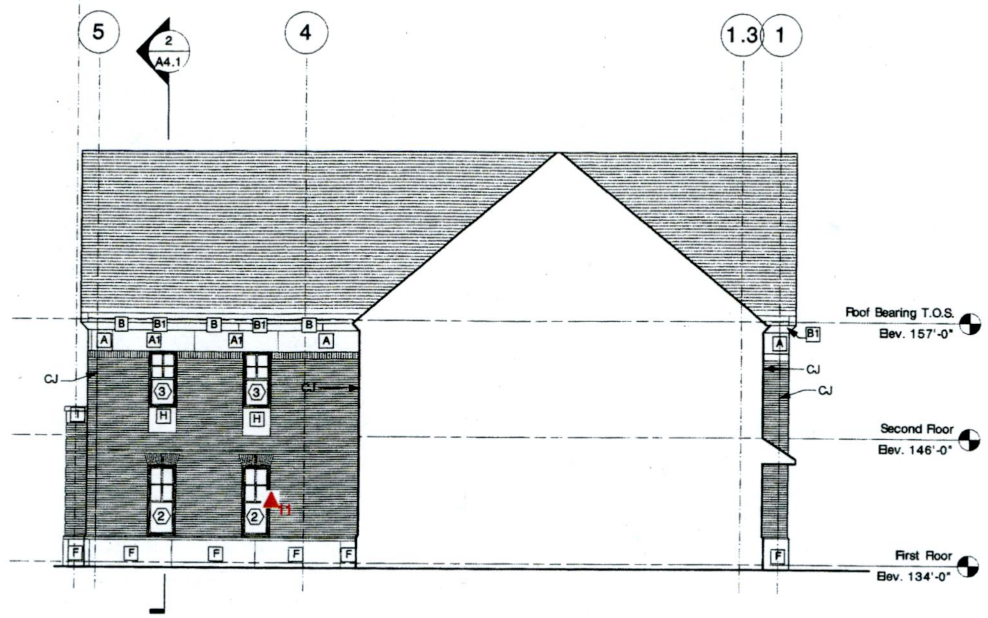
NO.	DATE	DESCRIPTION	BY

PROJECT NO.	
CADD FILE	833440 A100s
DESIGNED BY	
DRAWN BY	
CHECKED BY	
DATE	
DRAWING SCALE	1/8"=1'-0"

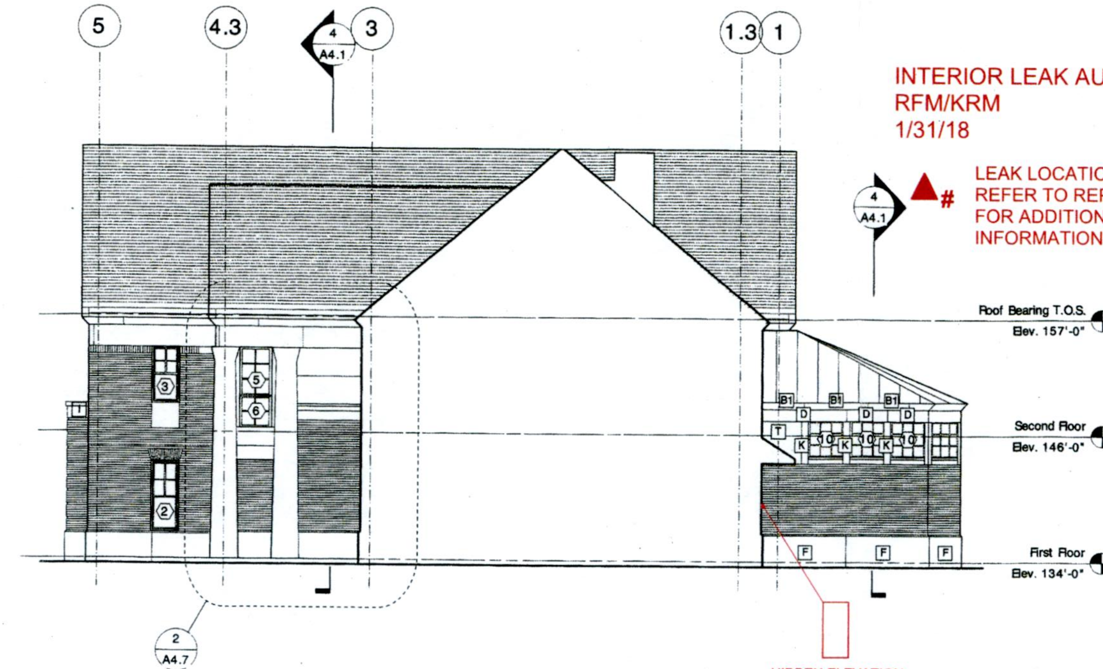
GRAPHIC SCALE
0 4' 8' 16'

SHEET TITLE
EAST & WEST ELEVATIONS

DRAWING NO.
A202



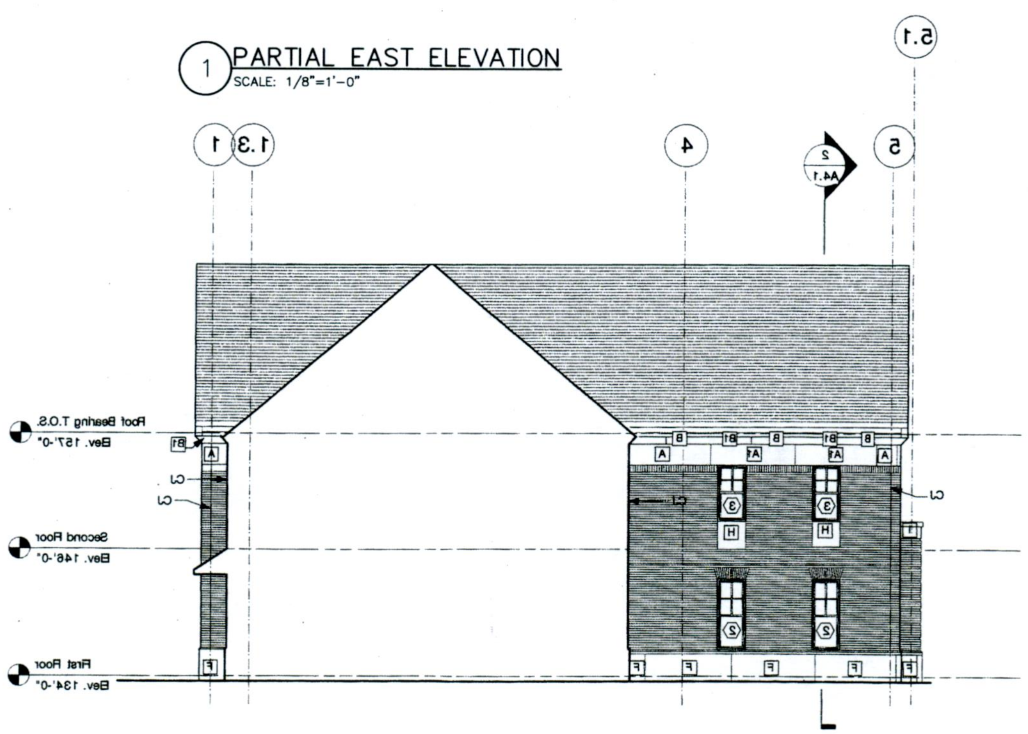
1 PARTIAL EAST ELEVATION
SCALE: 1/8"=1'-0"



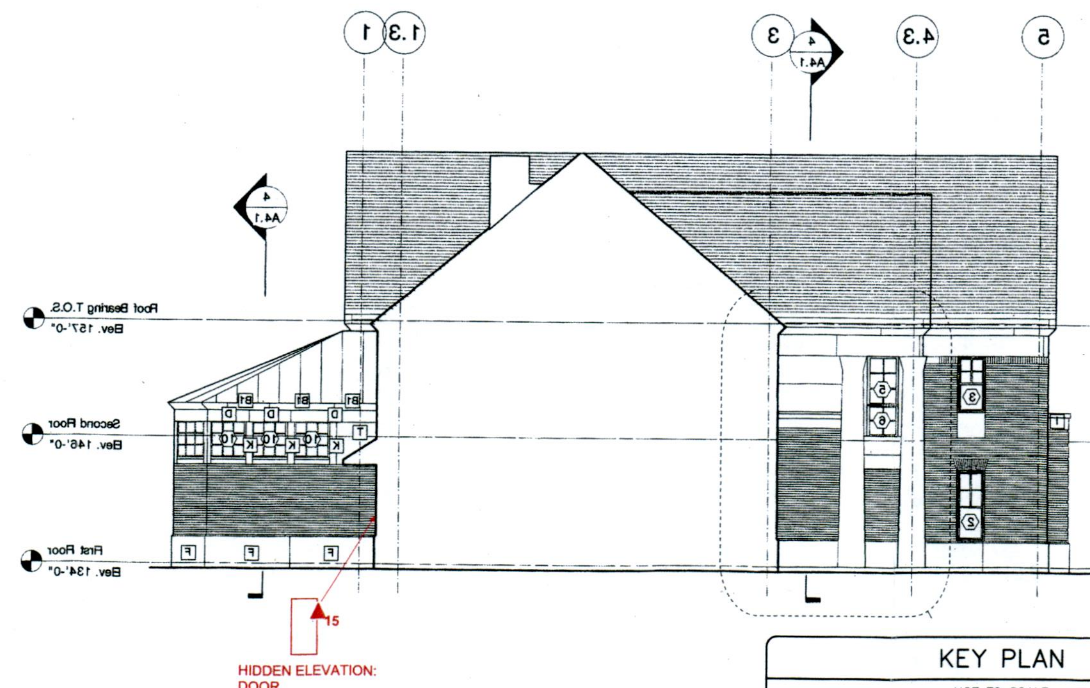
INTERIOR LEAK AUDIT
RFM/KRM
1/31/18

LEAK LOCATIONS;
REFER TO REPORT
FOR ADDITIONAL
INFORMATION.

2 PARTIAL EAST ELEVATION
SCALE: 1/8"=1'-0"

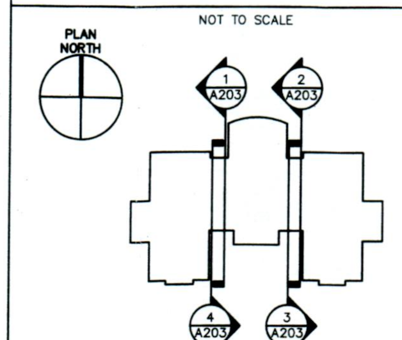


3 PARTIAL WEST ELEVATION
SCALE: 1/8"=1'-0"



4 PARTIAL WEST ELEVATION
SCALE: 1/8"=1'-0"

KEY PLAN
NOT TO SCALE



GALE
Gale Associates, Inc.
Engineers and Planners
163 LIBBEY PARKWAY | WEYMOUTH, MA 02189
P 781.335.6465 F 781.335.6467 www.gainc.com
Boston Baltimore Orlando Hartford

LEAK AUDIT

PROJECT
EXTERIOR WALL/WINDOW EVALUATION
AT THE BOXFORD TOWN HALL/LIBRARY
BOXFORD, MASSACHESETTS

OWNER
TOWN OF BOXFORD
7B SPOFFORD ROAD
BOXFORD, MA 01921

NO.	DATE	DESCRIPTION	BY

PROJECT NO.	
CADD FILE	833440 A100s
DESIGNED BY	
DRAWN BY	
CHECKED BY	
DATE	
DRAWING SCALE	1/8"=1'-0"

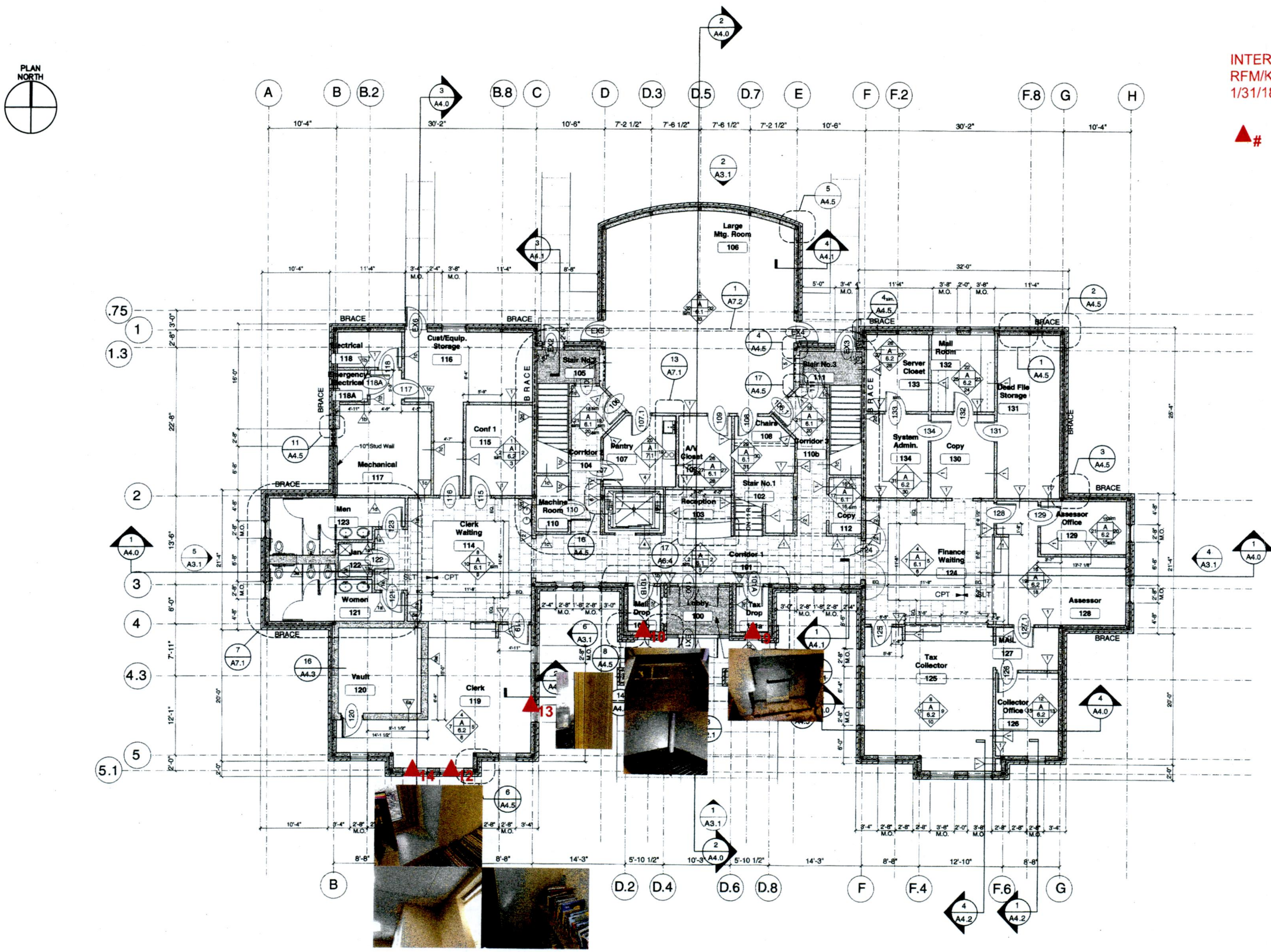
GRAPHIC SCALE
0 4' 8' 16'

SHEET TITLE
PARTIAL
EAST & WEST
ELEVATIONS

DRAWING NO.
A203

INTERIOR LEAK AUDIT
RFM/KRM
1/31/18

▲# LEAK LOCATIONS; REFER TO REPORT FOR ADDITIONAL INFORMATION.



1 FIRST FLOOR PLAN
SCALE: 1/8"=1'-0"

GALE
Gale Associates, Inc.
Engineers and Planners
163 LIBBEY PARKWAY | WEYMOUTH, MA 02189
P 781.335.6465 F 781.335.6467 www.gainc.com
Boston Baltimore Orlando Hartford

LEAK AUDIT

PROJECT

EXTERIOR WALL/WINDOW EVALUATION
AT THE BOXFORD TOWN HALL/LIBRARY
BOXFORD, MASSACHESETTS

OWNER

TOWN OF BOXFORD
7B SPOFFORD ROAD
BOXFORD, MA 01921

NO.	DATE	DESCRIPTION	BY

PROJECT NO.	
CADD FILE	833440 A100s
DESIGNED BY	
DRAWN BY	
CHECKED BY	
DATE	
DRAWING SCALE	1/8"=1'-0"

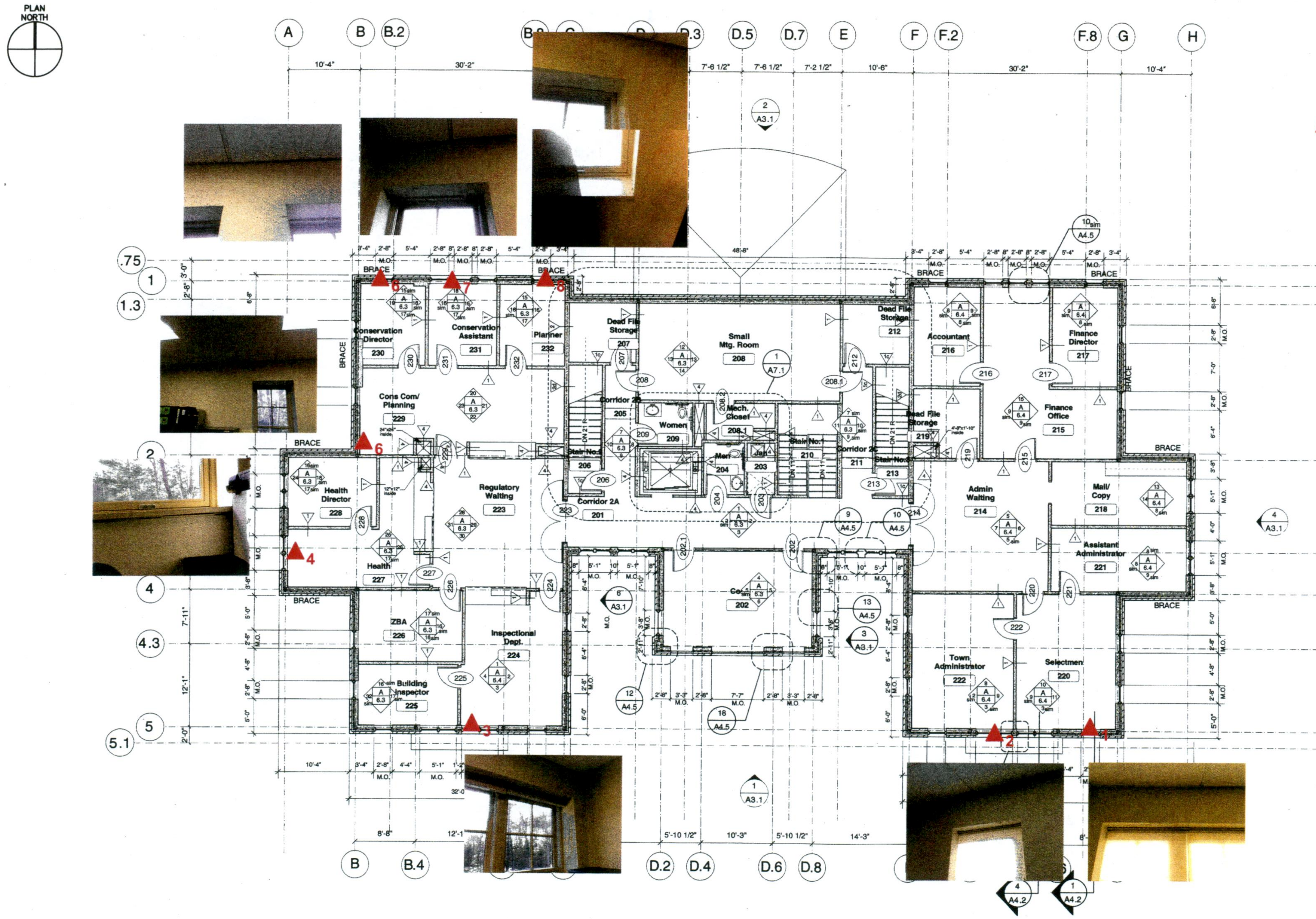
GRAPHIC SCALE
0 4' 8' 16'

SHEET TITLE

FIRST FLOOR PLANS

DRAWING NO.

A101



1 SECOND FLOOR PLAN
SCALE: 1/8"=1'-0"

INTERIOR LEAK AUDIT
RFM/KRM
1/31/18

▲# LEAK LOCATIONS; REFER TO REPORT FOR ADDITIONAL INFORMATION.

GALE

Gale Associates, Inc.
Engineers and Planners
163 LIBBEY PARKWAY | WEYMOUTH, MA 02189
T 781.335.6465 F 781.335.6467 www.gainc.com
Boston Baltimore Orlando Hartford

LEAK AUDIT

PROJECT
EXTERIOR WALL/WINDOW EVALUATION AT THE BOXFORD TOWN HALL/LIBRARY BOXFORD, MASSACHESETTS

OWNER
TOWN OF BOXFORD
7B SPOFFORD ROAD
BOXFORD, MA 01921

NO.	DATE	DESCRIPTION	BY

PROJECT NO.	
CADD FILE	833440 A100s
DESIGNED BY	
DRAWN BY	
CHECKED BY	
DATE	
DRAWING SCALE	1/8"=1'-0"

GRAPHIC SCALE 0 4' 8' 16'

SHEET TITLE
SECOND FLOOR PLANS

DRAWING NO.
A102

GALE

APPENDIX D

INFRARED SURVEY

Exterior Wall/Window Evaluation at the
Boxford Town Hall/Library
Boxford, Massachusetts
Gale JN 833440

INFRARED SURVEY

On January 31, 2018, Gale conducted a non-destructive, visual, thermographic infrared (IR) survey of the exterior walls. The IR Survey was performed on both the interior and exterior sides of the walls. The following are observations from the IR Survey:

- Cold air infiltration at wall to roof transitions, including rake and eave edges Refer to Figure 13.

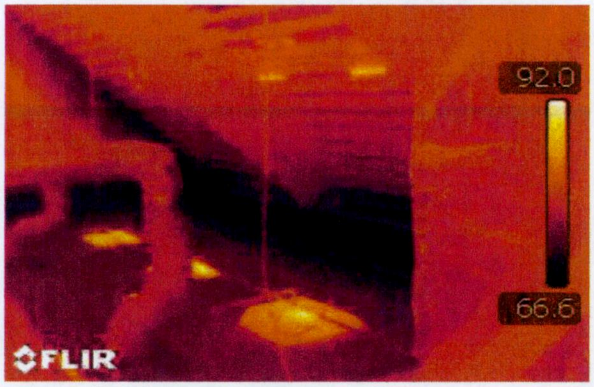


Figure 1: Thermographic image from inside the attic shows cold air infiltration at the wall to roof transition.

- Cold air infiltration at the gable wall of the roof, specifically at wall to roof transition Refer to Figure 14.

Figure 2: Thermographic image from inside the attic shows cold air infiltration at the gable wall transition to the roof ridge.

- Cold air infiltration in the field of wall at inside office spaces Refer to Figures 15.

Figure 3: Thermographic image from inside Room 222 shows cold air infiltration in the wall below and around the window.

- Cold air infiltration around window perimeters was typical. Refer to Figure 16.

Figure 4: Close-up thermographic image shows cold air infiltration occurring around a window (typical).

- Cold air infiltration at outside corners of the building and at the second-floor line. This appears to be the location at the front entrance of the building. Refer to Figure 17.

Figure 5: Thermographic image from inside Room 202 shows cold air infiltration in the wall at an outside corner and at the floor.

- Cold air infiltration occurring around exterior doors and at grade. Refer to Figure 18.

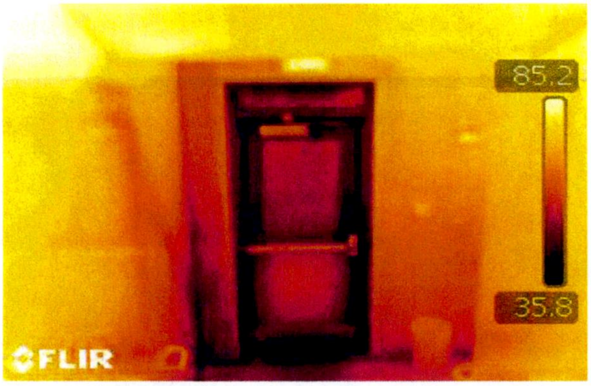


Figure 6: Thermographic image at the base of the stairwell shows cold air infiltration around the north entrance door and at grade.

- Cold air infiltration below and around windows, and in the wall area within the Assembly Room was observed. Refer to Figure 19.

Figure 7: Thermographic image from inside the Assembly Room shows cold air infiltration at many locations.

- Cold air infiltration at the wall transition to grade was observed. Refer to Figure 20.

Figure 8: Thermographic image from inside the front corridor on the 1st floor shows cold air infiltration at the wall base transition to grade.

The IR survey performed from the building exterior indicated several anomalies that are consistent with warm air exfiltration at the following representative locations:

- In the field of the wall at gable elevations Refer to Figure 21.

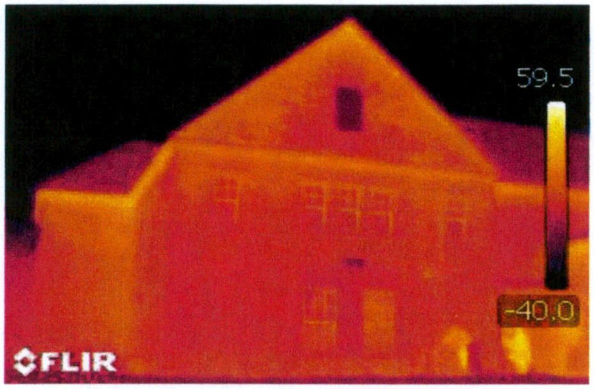


Figure 9: Exterior thermographic image shows warm air exfiltration at multiple exterior wall locations.

- In the field of the wall between the 1st and 2nd floor windows (at approximate floor line locations), and around windows. Refer to Figure 22.

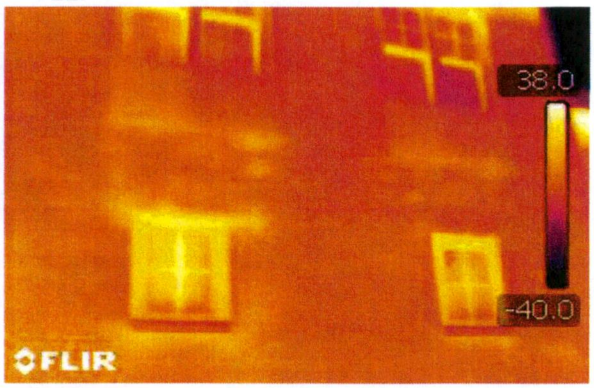


Figure 10: Exterior thermographic image shows warm air exfiltration in the field of the wall between 1st and 2nd floor windows and around the windows.

- At inside corners Refer to Figure 24.

Figure 11: Exterior thermographic image shows warm air exfiltration at inside corners of the exterior wall.

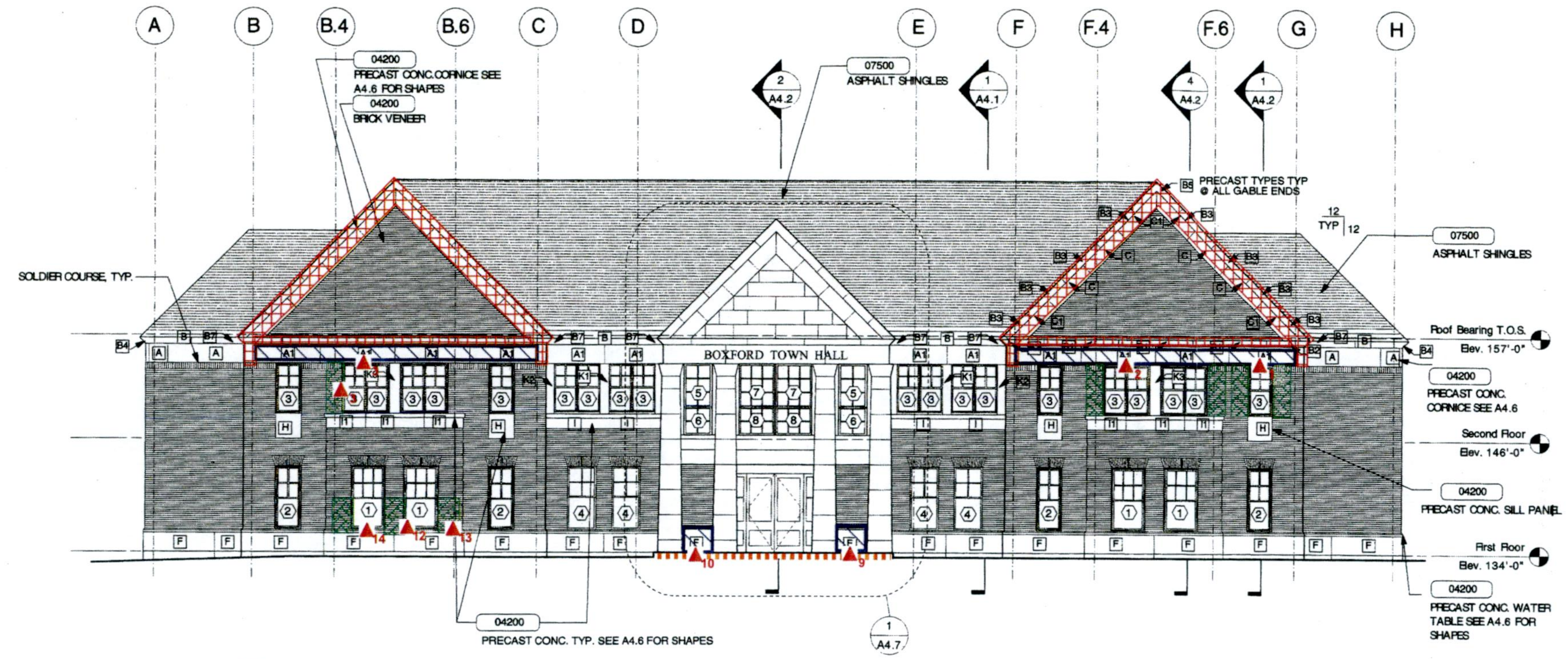
I:\833440\01 Evaluation\report\Appendix D - Infrared Survey\Appendix D Infrared Survey.docx

GALE

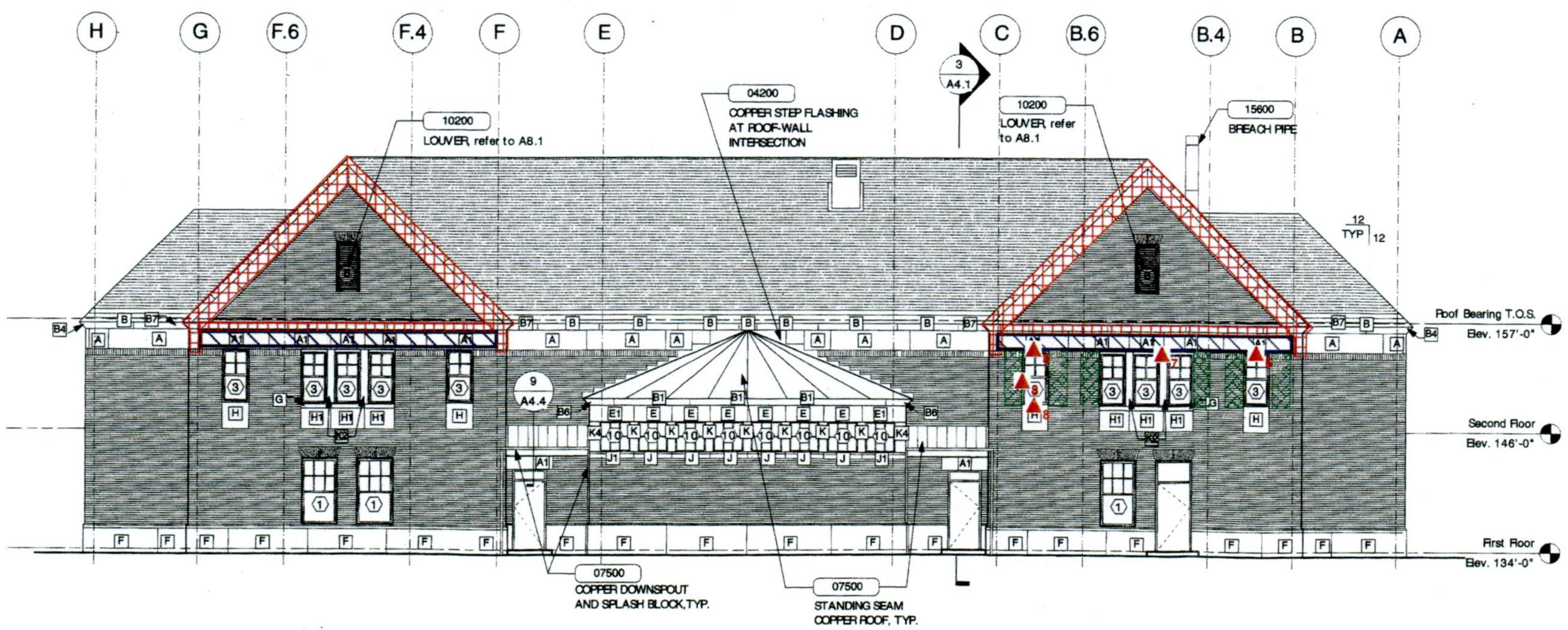
APPENDIX E

REDUCED DRAWINGS

APPENDIX E - OPTION 2 RECOMMENDED SCOPE OF WORK



1 SOUTH ELEVATION
SCALE: 1/8"=1'-0"



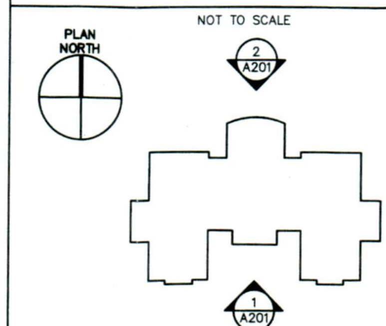
2 NORTH ELEVATION
SCALE: 1/8"=1'-0"

LEGEND

▲#	REPORTED LEAK LOCATION; REFER TO REPORT FOR # DESIGNATIONS.
(orange dotted line)	INSTALL TRAFFIC GRADE SEALANT AT BASE OF WALL.
(green hatch)	REMOVE BRICK TO INSTALL CONTINUOUS AVB AND SEAL AT WINDOW TRANSITIONS. REINSTALL BRICK AND REPLACE BACKER ROD AND SEALANT WHERE REMOVED.
(red grid)	CUTOUT MORTAR JOINTS 1" AND INSTALL SEALANT.
(blue diagonal hatch)	REMOVE PRECAST CONCRETE STONE. CUT INSULATION TO INSTALL THROUGH WALL FLASHING WITH END DAMS. INSTALL CONTINUOUS AVB AND NEW INSULATION. REINSTALL PRECAST ELEMENTS.

KEY PLAN

NOT TO SCALE



GALE
Gale Associates, Inc.
Engineers and Planners
163 LIBBEY PARKWAY | WEYMOUTH, MA 02189
P 781.335.6465 F 781.335.6467 www.gainc.com
Boston Baltimore Orlando Hartford

EVALUATION

PROJECT
EXTERIOR WALL/WINDOW EVALUATION AT THE BOXFORD TOWN HALL/LIBRARY BOXFORD, MASSACHESETTS

OWNER
TOWN OF BOXFORD
7B SPOFFORD ROAD
BOXFORD, MA 01921

NO.	DATE	DESCRIPTION	BY

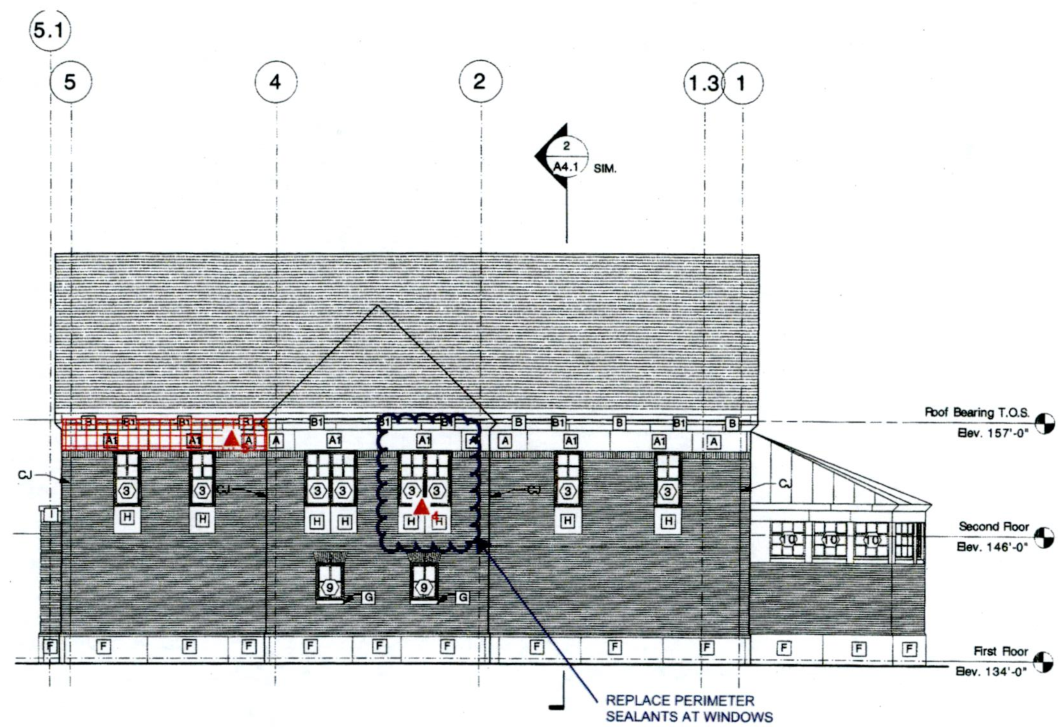
PROJECT NO.	
CADD FILE	833440 A100s
DESIGNED BY	
DRAWN BY	
CHECKED BY	
DATE	
DRAWING SCALE	1/8"=1'-0"

GRAPHIC SCALE
0 4' 8' 16'

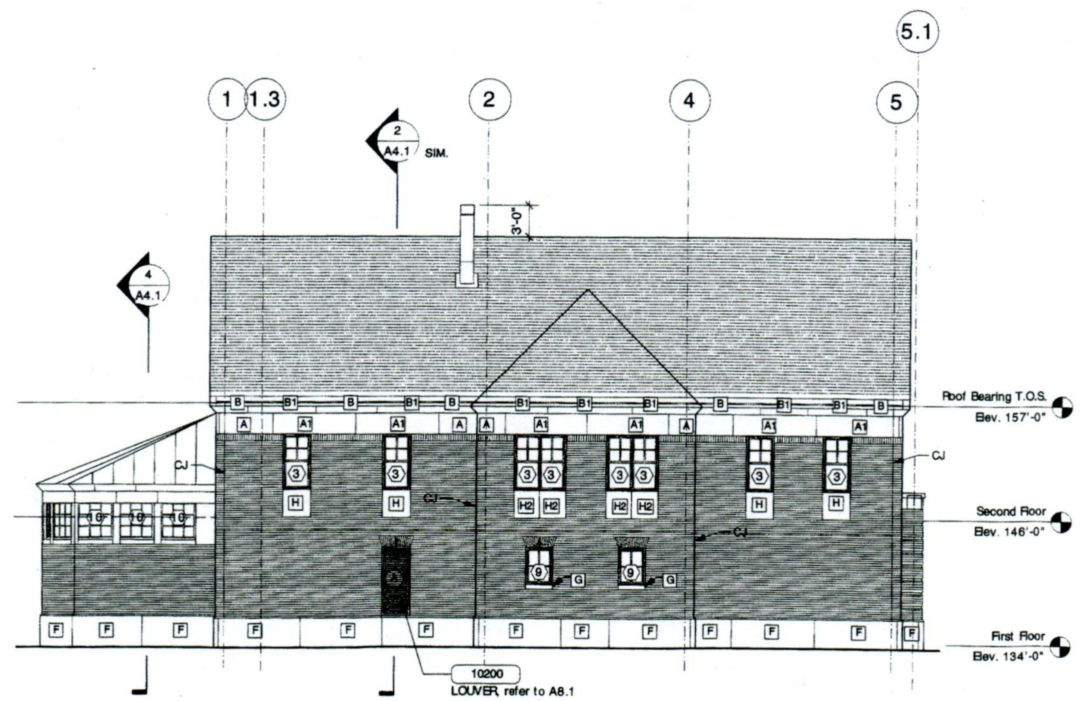
SHEET TITLE
NORTH & SOUTH ELEVATIONS

DRAWING NO.
A201

APPENDIX E - OPTION 2 RECOMMENDED SCOPE OF WORK



1 EAST ELEVATION
SCALE: 1/8"=1'-0"



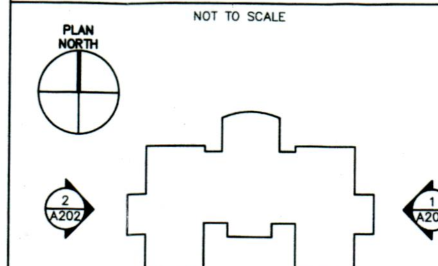
2 WEST ELEVATION
SCALE: 1/8"=1'-0"

LEGEND

REPORTED LEAK LOCATION; REFER TO REPORT FOR # DESIGNATIONS.

CUTOUT MORTAR JOINTS 1" AND INSTALL SEALANT.

KEY PLAN
NOT TO SCALE



GALE
Gale Associates, Inc.
Engineers and Planners
163 LIBBEY PARKWAY | WEYMOUTH, MA 02189
781.335.6465 / 781.335.6467 www.gainc.com
Boston Baltimore Orlando Hartford

EVALUATION

PROJECT
EXTERIOR WALL/WINDOW EVALUATION
AT THE BOXFORD TOWN HALL/LIBRARY
BOXFORD, MASSACHESETTS

OWNER
TOWN OF BOXFORD
7B SPOFFORD ROAD
BOXFORD, MA 01921

NO.	DATE	DESCRIPTION	BY

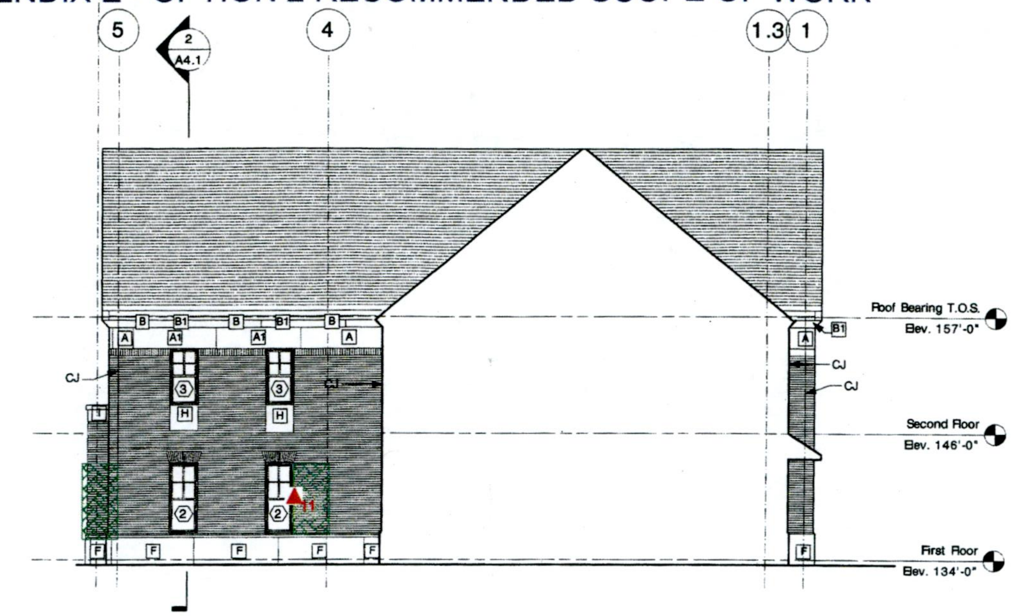
PROJECT NO.	
CADD FILE	833440 A100s
DESIGNED BY	
DRAWN BY	
CHECKED BY	
DATE	
DRAWING SCALE	1/8"=1'-0"

GRAPHIC SCALE
0 4' 8' 16'

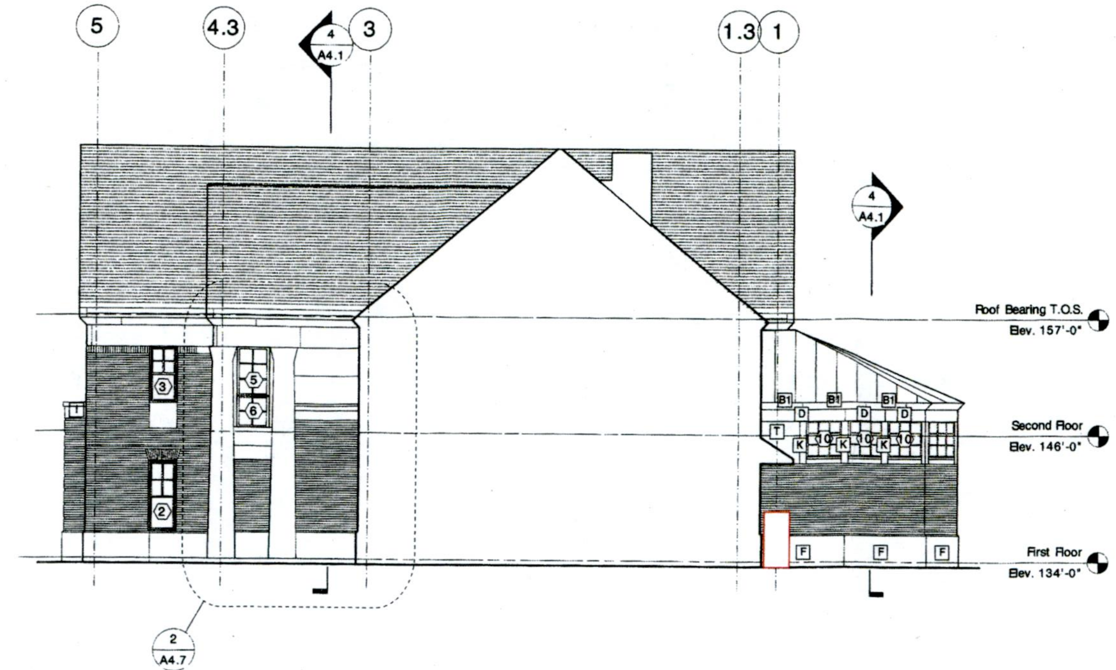
SHEET TITLE
EAST & WEST ELEVATIONS

DRAWING NO.
A202

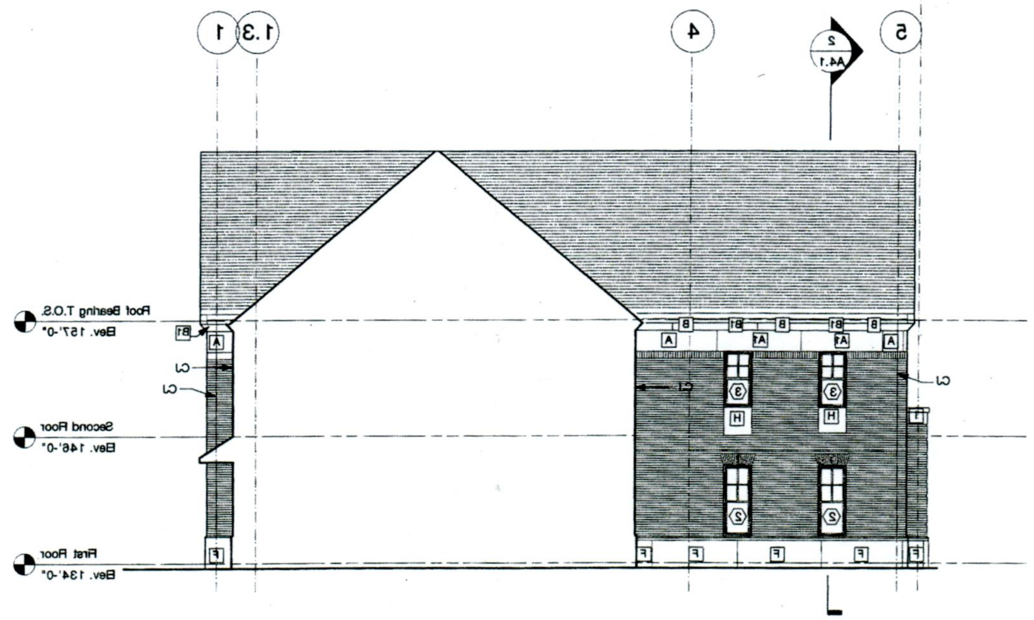
APPENDIX E - OPTION 2 RECOMMENDED SCOPE OF WORK



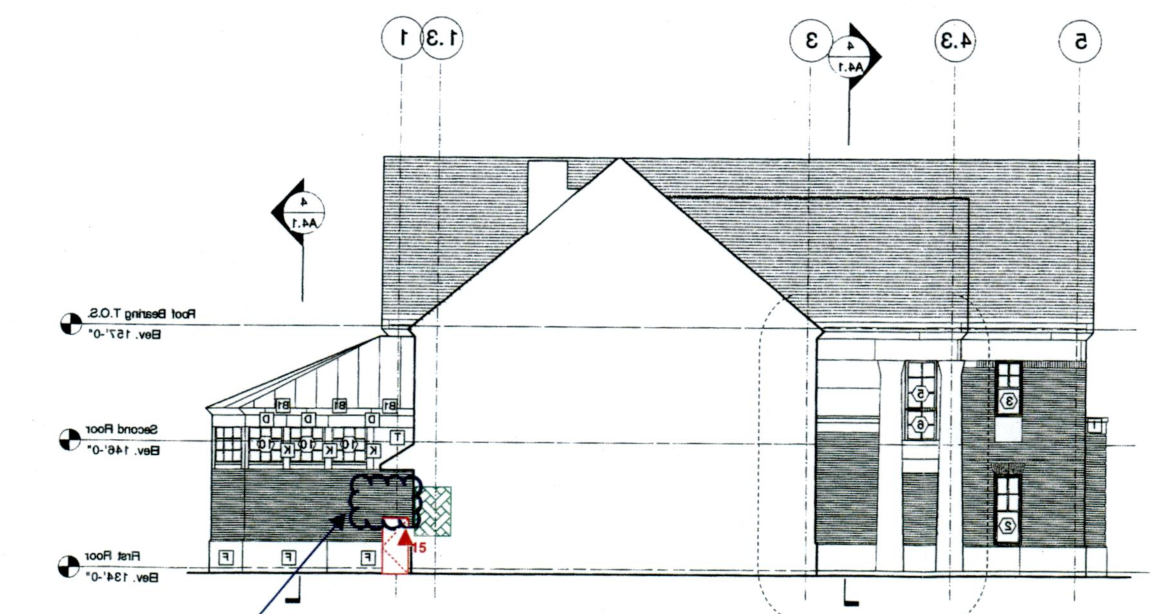
1 PARTIAL EAST ELEVATION
SCALE: 1/8"=1'-0"



2 PARTIAL EAST ELEVATION
SCALE: 1/8"=1'-0"



3 PARTIAL WEST ELEVATION
SCALE: 1/8"=1'-0"



REPLACE LINTEL AND INSTALL THROUGH WALL FLASHING.

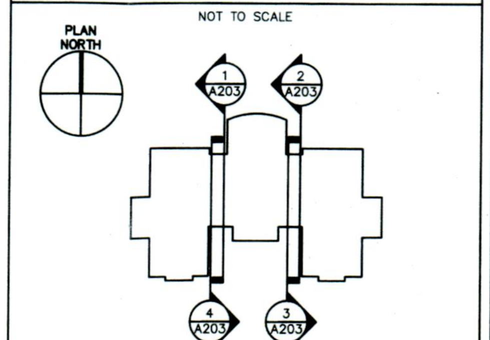
4 PARTIAL WEST ELEVATION
SCALE: 1/8"=1'-0"

LEGEND

REPORTED LEAK LOCATION; REFER TO REPORT FOR # DESIGNATIONS.

REMOVE BRICK TO INSTALL CONTINUOUS AVB AND SEAL AT WINDOW TRANSITIONS. REINSTALL BRICK AND REPLACE BACKER ROD AND SEALANT WHERE REMOVED.

KEY PLAN
NOT TO SCALE



GALE

Gale Associates, Inc.
Engineers and Planners
163 LIBBEY PARKWAY | WEYMOUTH, MA 02189
781.335.6465 | 781.335.6467 www.gainc.com
Boston Baltimore Orlando Hartford

EVALUATION

PROJECT
EXTERIOR WALL/WINDOW EVALUATION AT THE BOXFORD TOWN HALL/LIBRARY BOXFORD, MASSACHESETTS

OWNER
TOWN OF BOXFORD
7B SPOFFORD ROAD
BOXFORD, MA 01921

NO.	DATE	DESCRIPTION	BY

PROJECT NO.	
CADD FILE	833440 A100s
DESIGNED BY	
DRAWN BY	
CHECKED BY	
DATE	
DRAWING SCALE	1/8"=1'-0"

GRAPHIC SCALE
0 4' 8' 16'

SHEET TITLE
PARTIAL EAST & WEST ELEVATIONS

DRAWING NO.
A203