22 December 2015

Mr. John J. Gibbons III
Director of Marketing / Principal
Engineering Design Services, Inc.
PO Box 986
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Slatersville, RI 02876

Project 151623 – Leakage Investigation, State Police Headquarters, 311 Danielson Pike, Scituate, RI

Dear Mr. Gibbons:

As requested, we investigated the cause(s) of leakage reported at the built-in metal gutter present at the base of the standing-seam metal panel roof at the above-named building. This letter summarizes our findings and general recommendations for repairs.

## 1. BACKGROUND AND INFORMATION PROVIDED BY OTHERS

The Rhode Island State Police Headquarters in North Scituate was constructed in 2010. From our conversations with Gilbane, the headquarters' facility staff, and occupants, it is our understanding that the building has been experiencing leaks since the building's completion in 2010. Leakage occurs at isolated locations below the built-in gutter at the edge of the standing-seam metal panel roof (Photo 1). These leaks reportedly occur at four locations above the drop ceiling of the second floor on the front elevation of the building, with the worst leaks occurring in the corner office of the Major Crimes Division. We understand that these leaks occur during most rain storms. We also understand that gutter repairs were attempted previously, e.g., re-soldering of joints in the copper gutter liner, but these repairs were not effective.

## 2. SUMMARY OF FINDINGS – FIELD OBSERVATIONS AND TESTING

Douglas R. Pac and Gregory A. Sassaman of Simpson Gumpertz & Heger Inc. (SGH) visited the site on 13 November 2015 to investigate the source(s) of the leakage at the built-in gutter. Mr. Sassaman returned to the site on 3 December 2015 to continue the investigation. We focused our efforts along the west half of the gutter on the south elevation (to the left of the large central gable when viewed from the exterior).

### 2.1 Interior and Exterior Observations

We performed a partial interior survey at the second floor, with a focus on the reported leakage locations. We observed signs of leakage, including staining and efflorescence, at four main locations along the front (south) elevation (Photos 2 and 3). The stains appear to originate from the top of the CMU wall, just below the built-in gutter, near the downspouts (Photo 4). The stains

are located in similar locations along the east and west portions of the built-in gutter (i.e., mirrored over the centerline of the building; Photo 5).

We performed a partial exterior survey of the gutter area with a focus on the locations where water stains are present at the interior (i.e., near downspouts/drains) and along the west side of the large central gable, and made the following observations.

- The built-in copper gutter is divided into two segments on each half of the building and ponds water in multiple locations (Photo 6). Ponding water appears to be due to a combination of minimal slope toward the drains and occasional debris clogging of the drains.
- Some of the solder joints within the copper gutters are cracked (Photo 7).
- There is a continuous sealant joint between the painted aluminum standing-seam panels and the copper gutter below (Photo 8).
- Many of the adhered snow guards are missing (Photo 9).
- Unpainted galvanized steel lintels/angles are present above the second floor windows. No exposed drip edges are present (Photo 10).
- An EPDM membrane patch is present at one complex corner condition (Photo 11).

### 2.2 Water Testing

We performed a series of water tests on 13 November 2015 above the corner office of the Major Crimes Division (i.e., the end of the west gutter), where the worst leakage was reported. We tested portions of the gutter, the low edge of the standing-seam roof, and some related conditions using a hand nozzle. We wet large areas during initial tests and followed up with more isolated testing of specific conditions. We generally started our testing at the low point (gutter edge) and moved up the roof slope as we proceeded with further testing. We performed water tests at the following locations.

- Base of the soldered copper gutter near the location of the downspout (Photo 12).
- Cracked soldered joint within the copper gutter (Photo 13).
- Metal fascia panel seam atop the gutter curb (Photo 14).
- Hemmed transition between the copper gutter and the painted metal fascia trim (Photo 15).
- Standing-seam panel edge, gutter and fascia – large scale test (Photo 16).
- Copper gutter end condition where EPDM patch is present (Photo 17).
- Exterior face of the dormer, with focus on open joints and transitions (Photos 18 and 19).

- West side of the dormer, with focus on open joints and transitions (Photo 20).
- Dormer roof, including the valley between the dormer roof and main roof (Photos 21 and 22).
- Main roof ridge condition (Photo 23).

During several of these tests, we observed moisture (dampness) on the interior face of the CMU wall at the location where the downspout extends through the middle of the CMU wall (Photo 24). These wet areas eventually produced a few streams of liquid water that travelled down the CMU wall and dripped down where the pipe exits the wall (Photo 25).

As noted below, on 3 December 2015 we performed an additional water test of the membrane flashing condition at the drain. This water test resulted in immediate leakage to the interior.

### 2.3 Exploratory Openings

On 3 December 2015, we made an exploratory opening in the roof edge with the assistance of Apollo Roofing to investigate the concealed construction beneath and surrounding the copper gutter by the location of the drain that aligns with the corner office of the Major Crimes Division. See Appendix 1 for a hand sketched section detail of the as-built condition of the roof edge and gutter.

When reviewing the concealed conditions, we observed a Carlisle self-adhering membrane beneath the copper gutter, beginning at the top face of the wooden curb beneath the fascia trim and terminating approximately two inches onto the deck of the sloped roof (Photo 26). We observed existing water ponding on top of the Carlisle membrane at the bottom of the gutter (Photo 27). Where the Carlisle membrane on top of the curb meets the hemmed edge of the copper gutter, we observed a bead of sealant/mastic that was cracked along the length of the joint and noticeably wet (Photo 28).

At our direction, Apollo peeled back one of the standing-seam metal roof panels below the snow guard so that we could observe the construction beneath (Photos 29 and 30). We observed that the copper gutter extends up the sloped deck approximately 8 in., terminates on top of a black membrane, and is stripped in with a W. R. Meadows membrane. This W. R. Meadows membrane begins on top of a cleat for the metal roof panel (approximately 4 in. up the sloped deck) and extends towards the ridge as far as could be observed in the opening. We observed a building paper between the W. R. Meadows membrane and the metal roof panels. We did not observe water or signs of water infiltration in this location on the sloped roof.

Apollo made two small openings into the curb of the gutter. They made one opening in the gypsum sheathing on the outside face of the curb beneath the metal fascia panels (Photo 31). When looking into this opening we observed rigid insulation outboard of the CMU wall (Photo 32). Apollo made a second opening into the plywood of the sloped portion of the gutter (Photo 33). We observed a membrane adhered to the exterior of the CMU wall behind the insulation (Photo 34). This membrane did not connect to the Carlisle membrane within the gutter but instead terminated beneath the plywood bottom of the gutter. Therefore, the air and water barrier is discontinuous at this location. Refer to Appendix 1 for a sketch showing this condition.

We directed Apollo to remove the copper around the drain in order to observe the metal and membrane terminations into the drain. After cutting a perimeter of copper around the drain, Apollo was unable to lift the copper out of the drain as it was well secured to the structure (Photo 35). We observed that the Carlisle membrane terminates short of the copper drain pipe (Photos 36 and 37). SGH did not observe any termination seal or lap onto the copper at this transition. Upon peeling back the Carlisle membrane, SGH observe wet plywood (Photo 37).

We performed a water test by applying a film of water at the termination of the Carlisle membrane at the copper drain pipe (Photo 38). We immediately observed water draining to the exterior through the metal architectural panels due to the breach between the gutter membrane and the wall membrane that we describe above (Photo 39). When we arrived at the corner office of the Major Crimes Division, we observed water leakage originating from over the top of the CMU wall by the downspout (Photo 40). This water leakage proceeded to run down the wall and drip at the head of the window opening.

## 3. CONCLUSIONS

Water penetrates into the building at the drains within the built-in gutters. Water reaches the membrane underlayment below the copper gutter liner, likely through cracked solder joints, unsealed joints in the metal panels, and other avenues. Water collects on the membrane due to lack of positive slope toward drains and lack of any drainage medium at the membrane level. Water eventually reaches the building interior at drain locations due to lack of integration between the membrane gutter liner and the drain pipes. Once inside the building, water travels laterally through and around the plywood layer and reaches the interior face of the CMU wall, where it becomes visible from the interior.

Reliable repairs should include remedying the fundamental problems, such as lack of drainage provisions at the membrane level and lack of integration between the membrane underlayment and the drains.

## 4. REPAIR RECOMMENDATIONS

Below we present general recommendations for repairing the leakage problems discussed above. Please note that these repairs are conceptual in nature; additional exploratory work and design development is warranted prior to execution of any repairs.

- Remove and dispose of the existing copper gutter, self-adhering membrane underlayment, and painted metal fascia (salvage metal fascia panels for reinstallation if desired).

- Install new sloped plywood substrate and a new continuous self-adhering membrane system, including fully wrapping the gutter curb, integrating new membrane with existing membrane underlayment at sloped roof, and flashing all penetrations and end conditions. Removal of a portion of the adjacent standing-seam metal panels may be needed to achieve a reliable connection between the new gutter underlayment and the existing roof underlayment.

- Install new drain bowls at the membrane level (custom formed soldered copper drain bowl), including integration with self-adhering membrane.

- Perform a flood test of the new membrane system.

- Install a new soldered copper gutter that slopes toward drains, including providing separation (drainage medium) between copper and self-adhering membrane. Integrate the new copper liner with existing standing-seam metal roof panels and (re)install the painted metal fascia panels. Seal all joints in fascia metal using flexible membrane and metal cover plates.

- Provide weeps in the continuous sealant joint at base of the standing-seam metal panels to allow water that bypasses the roof panels to drain into the gutter.

- Perform additional water/flood tests.

If a less expensive repair approach is desired, you could consider repairing only the drain locations, though this approach may be less effective, particularly over the long term. Limitations of this option include the inability to slope gutters, provide a drainage medium, identify and replace any deteriorated plywood, or address any other undiscovered defects that might be uncovered during reconstruction of the full gutter assembly.

Thank you for the opportunity to assist you with this project. We would be happy to participate in a conference call or meeting to discuss our findings further. We would also be happy to assist with development of design documents for bidding and executing the repair work, if desired. If you have any questions or require additional information, please feel free to contact us.

Sincerely yours,

Douglas R. Pac
Senior Staff I – Building Technology

Gregory A. Sassaman
Staff I – Building Technology

Derek B. McCowan, P.E.
Senior Project Manager
RI License No. 9401

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**Photo 1**

Location of built-in gutters with reported leakage.

**Photo 2**

Location of reported leakage in the corner office of the Major Crimes division.

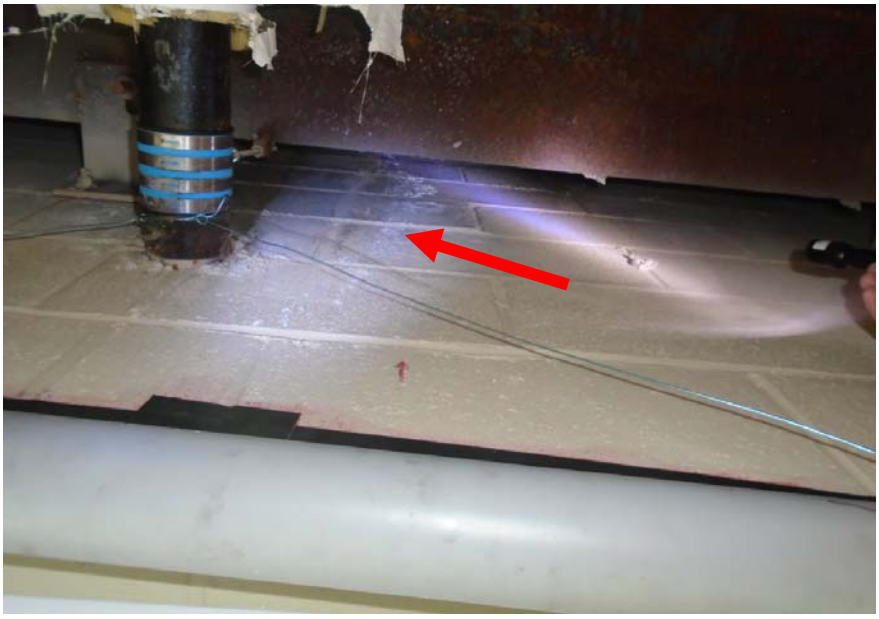

**Photo 3**

Staining and efflorescence on the CMU wall above the window.

**Photo 4**

Staining and efflorescence extending to the top of the CMU wall.

**Photo 5**

Mirrored reported leakage locations.

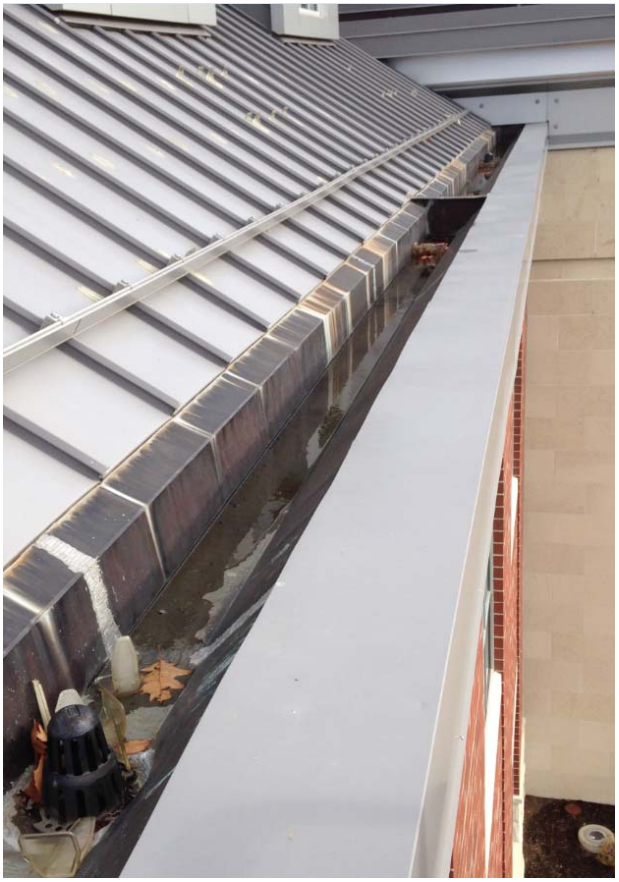

**Photo 6**

Metal gutter divided into two segments. Water ponding within gutter.

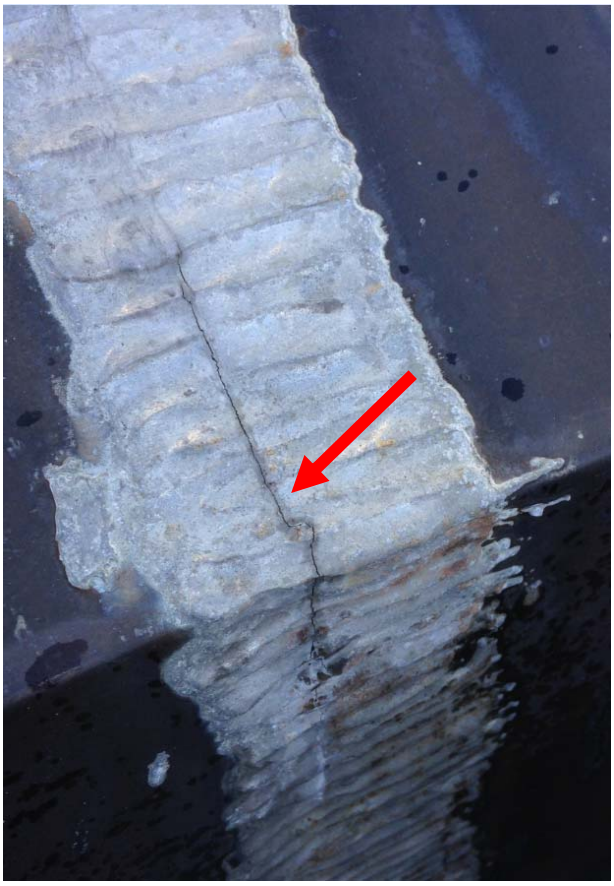

**Photo 7**

Cracked solder joint within copper gutter.

**Photo 8**

Continuous sealant joint between standing-seam metal panels and copper gutter.

**Photo 9**

Many adhered snow guards are missing.

**Photo 10**

Unpainted galvanized steel lintels without through-wall flashing.

**Photo 11**

Membrane adhered to the top of the painted metal fascia trim at gutter end.

**Photo 12**

Water testing of the soldered copper gutter and drain.

**Photo 13**

Water testing of cracked soldered joint.

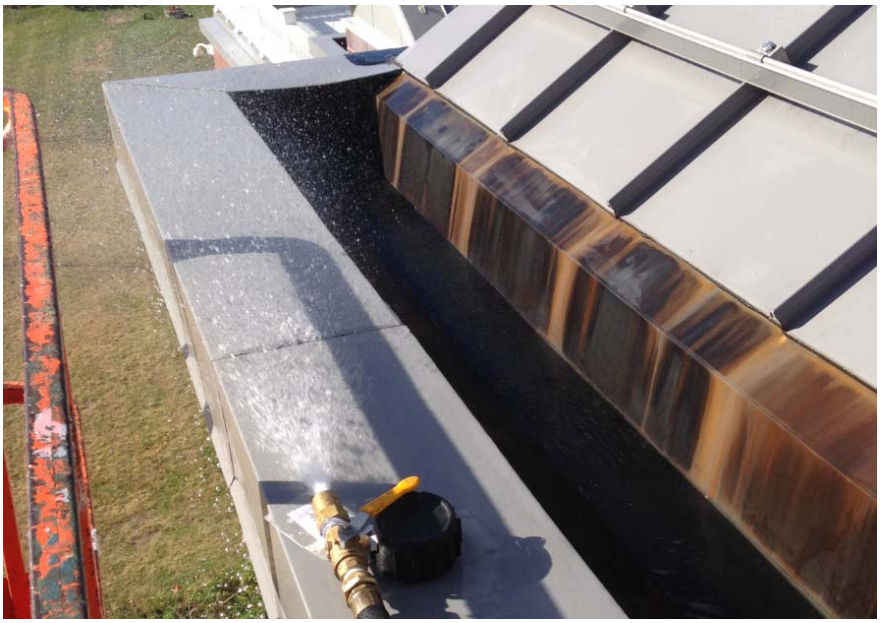

**Photo 14**

Water testing of joint in painted metal fascia trim.

**Photo 15**

Location of water testing of transition from hemmed fascia trim to copper gutter.

**Photo 16**

Water testing from snow guards to roof edge.

**Photo 17**

Water testing of adhered membrane on top of fascia trim.

**Photo 18**

Water testing at dormer.

**Photo 19**

Water testing at dormer.

**Photo 20**

Water testing the side of the dormer.

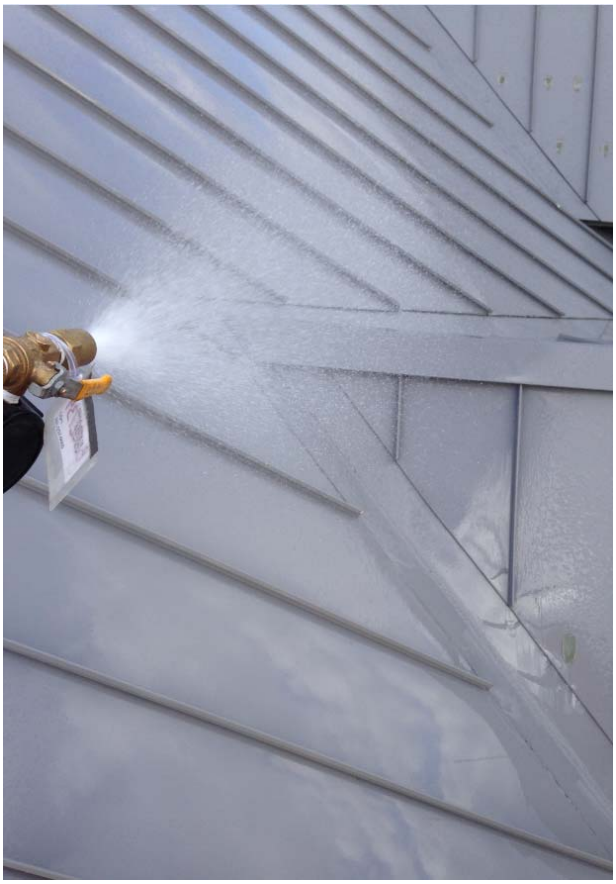

**Photo 21**

Water testing the ridge of the dormer.

**Photo 22**

Water testing the dormer and main roof valley.

**Photo 23**

Water testing the top of the main roof by the ridge cap.

**Photo 24**

Water/moisture on interior face of CMU wall by downspout.

**Photo 25**

Water dripping from bottom of drainage pipe.

**Photo 26**

Carlisle self-adhering membrane beneath copper gutter.

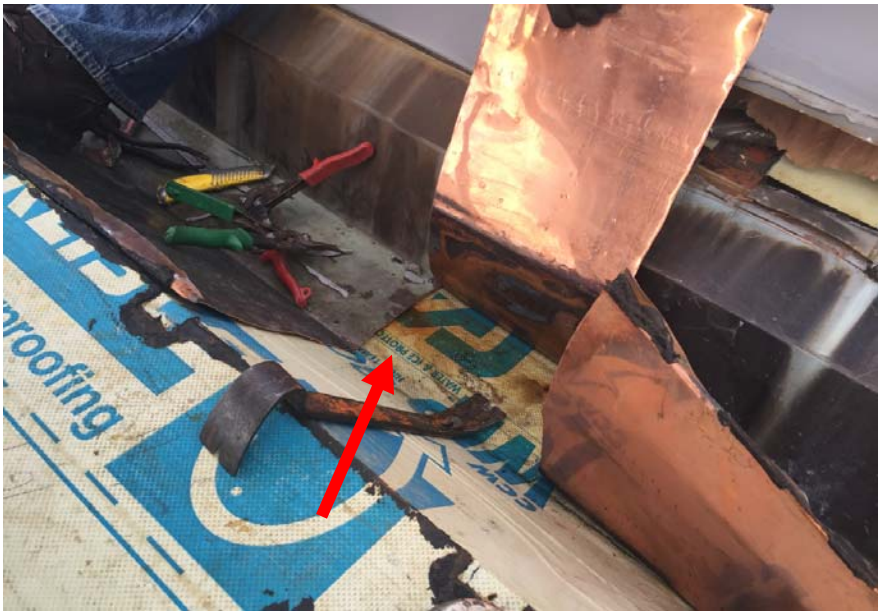

**Photo 27**

Water ponding on top of the Carlisle membrane.

**Photo 28**

Cracked sealant/mastic on Carlisle membrane.

**Photo 29**

Location of opening of metal roof panel.

**Photo 30**

Peeled back metal roof panel and layers beneath.

**Photo 31**

Opening in gypsum sheathing beneath metal fascia trim.

**Photo 32**

Insulation outboard of CMU wall when looking into opening in gypsum sheathing.

**Photo 33**

Opening in plywood on sloped portion of gutter.

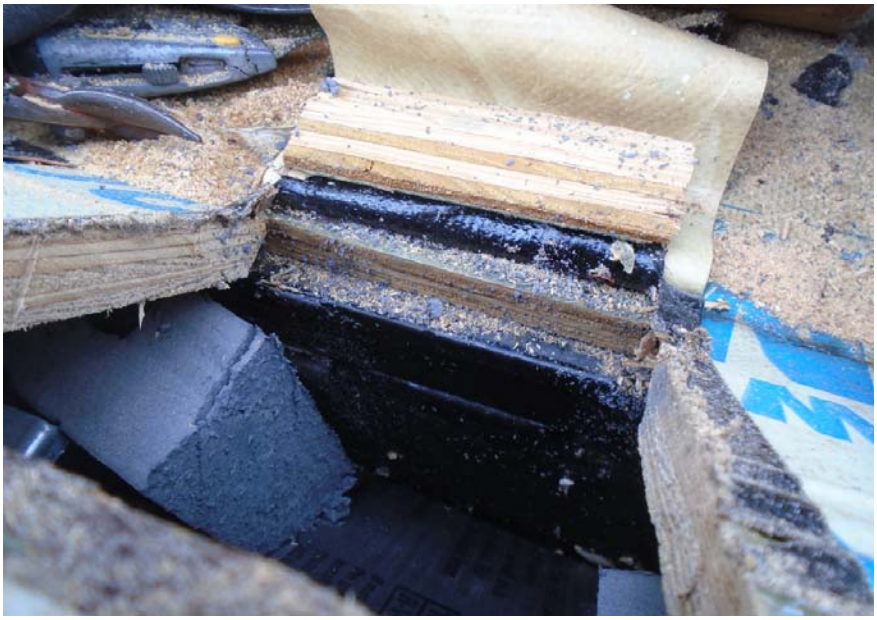

**Photo 34**

Wall membrane behind insulation board turning beneath plywood at base of gutter.

**Photo 35**

Cut perimeter of copper gutter around drain.

**Photo 36**

Location of Carlisle membrane termination at drain.

**Photo 37**

Carlisle membrane termination at drain pipe. Wet plywood beneath peeled back membrane.

**Photo 38**

Water testing membrane termination at drain pipe.

**Photo 39**

Water draining through architectural panels above windows during water test.

**Photo 40**

Water leakage originating at the top of the CMU wall.

Figure 1

SGH Sketch
22 December 2015
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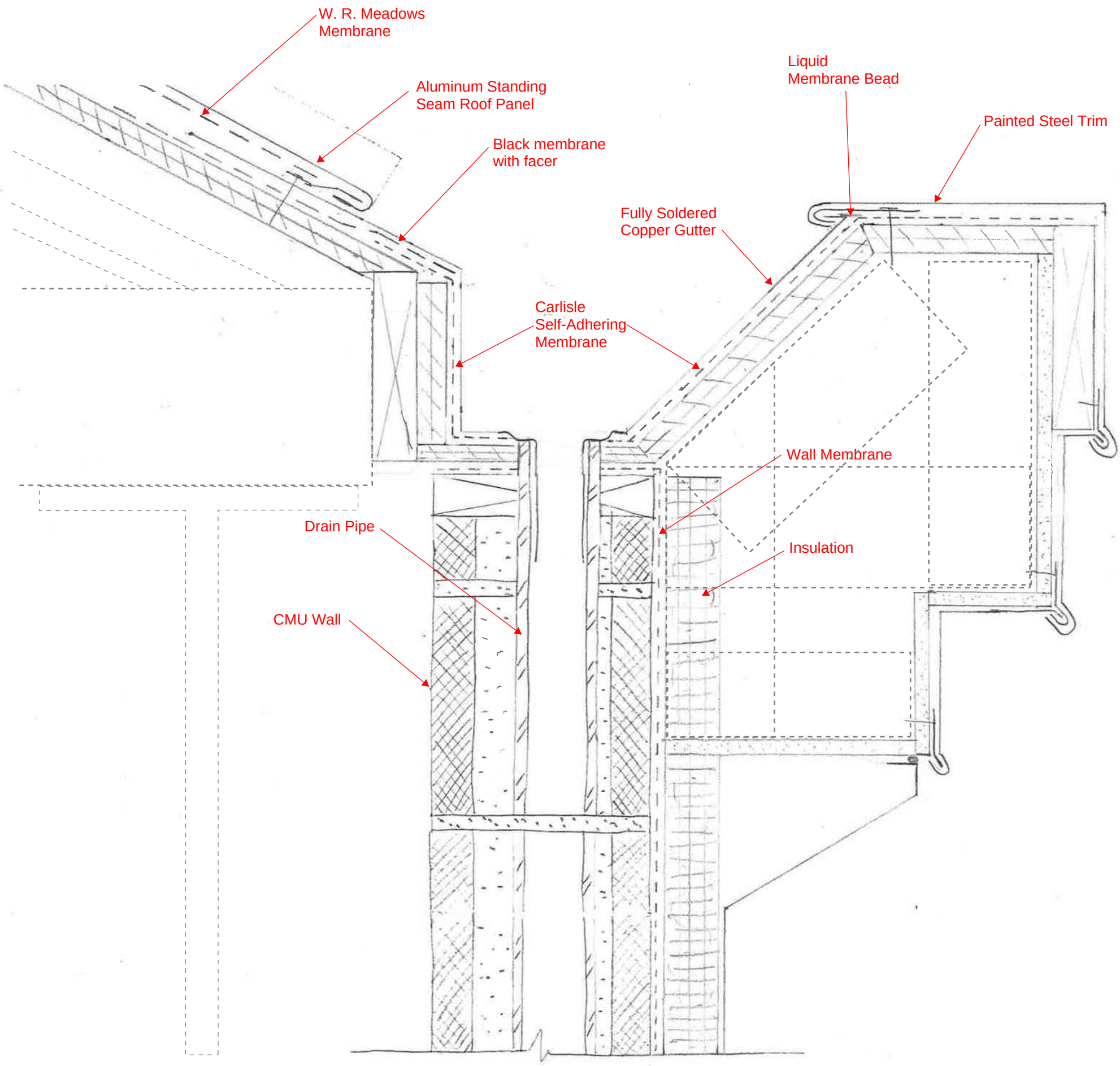


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