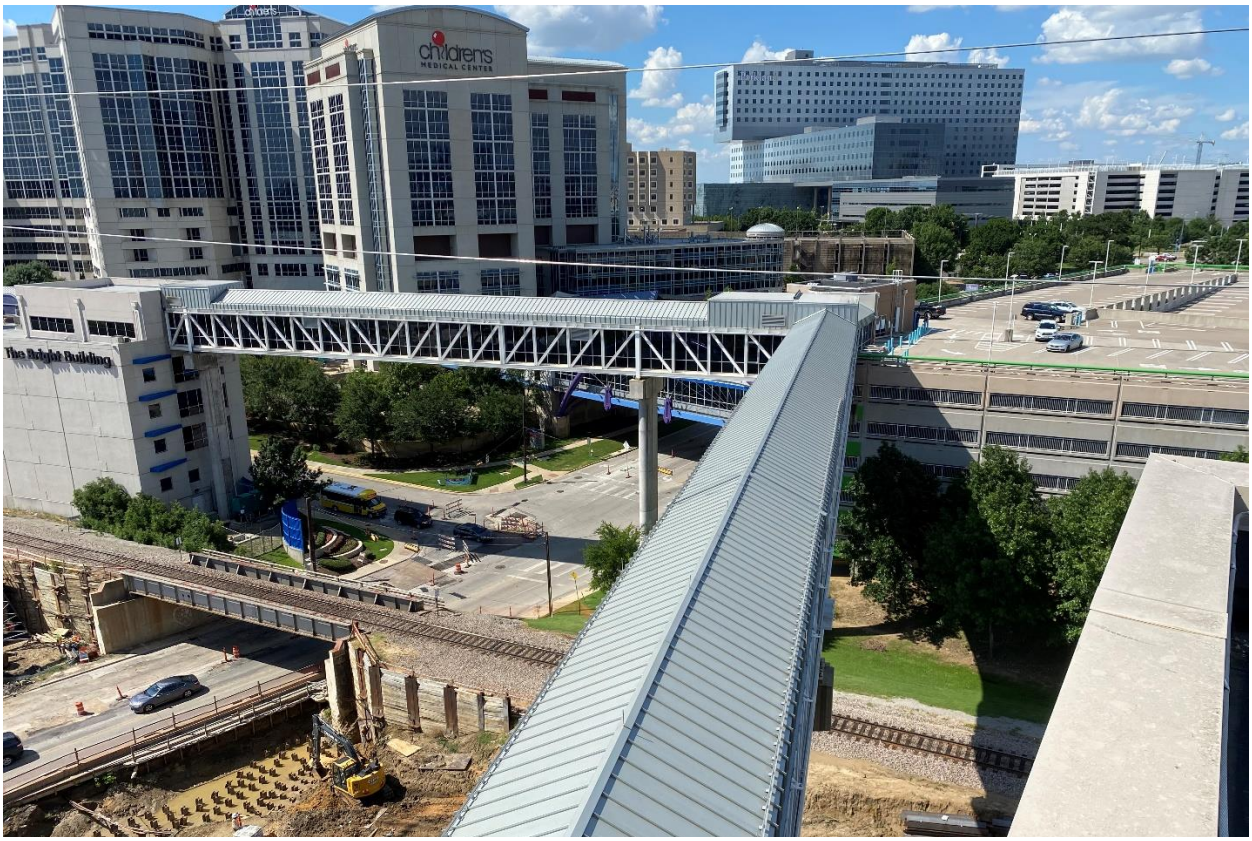
WJE

Children's Health Skybridges

Condition Assessment and Water Intrusion Investigation

1935 Medical District Drive
Dallas, Texas 75235



FINAL REPORT
August 7, 2020
WJE No. 2020.2158.0

PREPARED FOR:
Children's Health
1935 Medical District Drive
Dallas, Texas 75235

PREPARED BY:
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Texas Registered Engineering Firm F-0093

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Bryan C. Staffel
Senior Associate and Project Manager

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INTRODUCTION

As requested, Wiss, Janney, Elstner Associates, Inc. (WJE) has completed a condition assessment and investigation of water intrusion at three skybridges at the Children's Health (CH) Dallas campus located at 1935 Medical District Drive in Dallas, Texas. This report summarizes our findings and provides our conceptual recommendations for repair.

PROJECT DESCRIPTION AND BACKGROUND

In order to facilitate pedestrian foot traffic across roadways and train tracks, skybridges connect the various parking garages to different buildings within the CH complex. It was reported that several of the skybridges at CH have been subject to ongoing water intrusion issues for an unknown period of time. WJE was asked to perform a condition assessment and water intrusion investigation of the three skybridges listed below. Figure 1 shows the location of each skybridge. For reference purposes throughout this report, WJE has noted a "plan north" which will generally apply to all three skybridges.

- Skybridge A: Truss Bridge servicing the Bright Building and the Green Garage
  - Year Built: 2003
  - Orientation: East-West
  - Length: 185 feet
- Skybridge B: Truss Bridge servicing the Purple Garage and the Green Garage
  - Year Built: 2003
  - Orientation: North-South
  - Length: 240 feet
- Skybridge C: Cable Suspension Bridge servicing Tower D of the Medical Center and the Green Garage
  - Year Built: 2007
  - Orientation: Generally East-West
  - Length: 215 feet

Each bridge features aluminum framed windows and metal wall panels. The roof systems at Skybridges A and B consist of sloped standing seam metal roofs with small low slope modified bitumen roof areas at each end. The Bridge C roofing system is mostly low-slope modified bitumen with metal flashings and copings.

Figure 1. Aerial view showing locations of Skybridges. Image dated February 22, 2017, provided through Pictometry subscription. Annotations by WJE. "Plan North" indicated.

CONDITION ASSESSMENT AND WATER INTRUSION INVESTIGATION

WJE's onsite condition assessment and water intrusion investigation of the three skybridges was completed June 23, 2020 through June 25, 2020. Additional water intrusion testing was also completed at

Skybridge C on July 10, 2020. The condition assessment included both interior and exterior visual observations of each skybridge. Up-close exterior observations at Skybridges A and B were made by our Difficult Access Team (DAT) who accessed the facades using the specialty rail system (Figure 2 and Figure 3). Observations of the sloped standing seam metal roof systems on Skybridges A and B were primarily made from the adjacent garages/buildings; up close observations were limited by access.

Figure 2. Up-close observation of skybridges by WJE's difficult access team.


Figure 3. Up-close observation of skybridges by WJE's difficult access team.

Water intrusion testing was conducted in general accordance with ASTM E2128 *Standard Guide for Evaluating Water Leakage of Building Walls*. WJE used a calibrated spray rack in general accordance with ASTM E1105 *Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, By Uniform or Cyclic Static Air Pressure Difference* (no differential pressure was used) and a calibrated spray nozzle in general accordance with AAMA 501.2 (3) *Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems*. As our testing was diagnostic in nature, testing outside of the methods specified by these standards was employed in some instances. WJE used various water pressures and test durations as determined appropriate for the component or material being tested. At each test area, WJE started at the lowest applicable component and proceeded upward as necessary.

Based on discussions with maintenance staff, water intrusion was generally reported at both ends of Skybridges A and B and at the east end of Skybridge C where it intersects with the Green Garage. Locations of water testing were selected based on accessibility and access to water sources at the time of our investigation. The following sections summarize our observations and water intrusion testing at each skybridge. Representative photos are also included.

Skybridge A: Bright Building to Green Garage

Observations

- Water stains and peeling paint were observed on the interior steel framing and drywall finishes below the sidewall-to-roof transition near the west end of the skybridge (Figure 4).
- Water stains were observed along the sill of both smoke exhaust louvers within the window wall on the south facade (Figure 5).

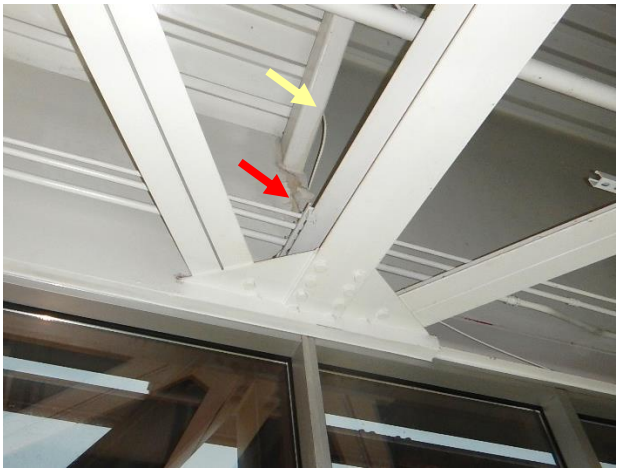

Figure 4. Water stains on steel framing (yellow arrow) and peeling paint on drywall (red arrow) below sidewall roof transition.

Figure 5. Water stains below louvers within window wall.

- Gasket shrinkage (between approximately 1/8 inch to 1/2 inch) was observed at several of the window lites on the south facade (Figure 6 and Figure 7). Little to no gasket shrinkage was observed on the north facade.

Figure 6. Gasket shrinkage at horizontal mullion.

Figure 7. Gasket shrinkage at sill of window wall.

- Two louvers were glazed into the window wall on the south facade (Figure 8). Sheet metal infill panels were observed on each side of the louvers. The flange around the perimeter of the louvers appeared

to have been set in sealant against the infill panels and the window framing at the horizontal mullion and head. Sealant was not consistently observed around the perimeter of the flange.

- At the east louver within the window wall, weep holes were observed at the bottom of the west infill panel (Figure 9). No other weeps were observed within the other infill panels.

Figure 8. Louver set into window wall. Sealant around perimeter not consistently observed (arrow).

Figure 9. Weep holes observed at bottom on infill panel adjacent to east louver on the south facade.

- Weeps were observed within the perimeter sealant joint along the sill of the window wall (Figure 10 and Figure 11). Weeps appear to be drilled through the sill receiver but were not consistently spaced. Dirt build-up and organic growth was present along the sealant joint around the weep holes. Similar dirt build-up and organic growth was observed along the upper edge of the sill receiver. Continuity of the sealant joint behind the steel columns at bents could not be verified.

Figure 10. Dirt build-up and organic growth around weep in perimeter sealant joint at sill and along top edge of sill receiver. Photo shows probe inserted into weep hole within sill receiver.

Figure 11. Dirt build-up and organic growth around weep in perimeter sealant joint at sill and along top edge of sill receiver. Photo shows probe inserted into weep behind steel column. Condition of sealant joint behind column could not be observed.

- Sealant was observed to be inconsistently applied at the butt joints in the perimeter steel plates at the floor slab (Figure 12 and Figure 13). Corrosion was observed at some of the joints on the north facade where the sealant was discontinuous (Figure 13).

Figure 12. Butt joint in perimeter steel plate for the floor slab. Sealant inconsistently applied at joint.

Figure 13. Corrosion at butt joint in the perimeter steel plate for the floor slab.

- A black flexible sheet membrane was observed at the intersection of the steel wide flange beams for Skybridges A and B (Figure 14). It is unknown to WJE whether this was part of the original construction or a remedial attempt. Two different applications of sealant were observed around the perimeter of the membrane. Sealant deterioration ("alligatoring") was observed within the lighter colored sealant (Figure 15).

Figure 14. Black flexible membrane at steel beam intersection for Skybridges A and B.

Figure 15. Two different applications of sealant were observed. Sealant deterioration ("alligatoring") was observed within the underlying whiter sealant.

- Black flexible sheet membrane was observed along the south vertical termination of the metal wall panels and the cladding of the Bright Building (Figure 16 and Figure 17). The sealant was observed to be poorly installed and smeared along the edges of the membrane.

Figure 16. Black flexible membrane at west termination of skybridge. Edges of membrane sealed with sealant.

Figure 17. Black flexible membrane at west termination of skybridge. Edges of membrane sealed with sealant.

- The gabled metal panel roof transitions to a low slope modified bitumen roofing at each end of the skybridge (Figure 18). Signs of aging, including granule loss and alligator cracking, were observed throughout the modified bitumen roof membrane (Figure 19).

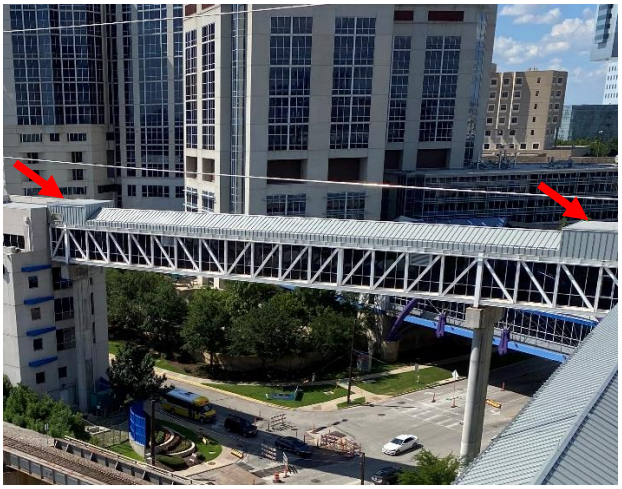

Figure 18. Low-slope roof areas at each end of the skybridge.

Figure 19. Typical granule loss observed at the roof membrane at the low-slope roof areas.

- A piece of counterflashing was observed to be missing at the west sidewall metal panel roof transition (Figure 20). Insulation and framing were visible behind the section of missing counterflashing (Figure 21).

Figure 20. Section of missing counterflashing along sidewall roof transition.

Figure 21. Insulation and framing observed behind section of missing counterflashing.

Water Intrusion Testing

Water intrusion testing was completed at two locations (Location 1 and 2) on the west end of Skybridge A near the intersection with the Bright Building.

Location 1 - Sidewall Transition

Location 1 included the sidewall transition between the gabled metal panel roof and the vertical metal sidewall panels. As noted above, a piece of sidewall counterflashing was observed to be missing near the ridge (Figure 20). Staining was observed on the interior framing components below this transition indicative of previous water intrusion (Figure 4). WJE used a spray nozzle to test along the sidewall transition at both sides of the gable. WJE started at the eave and sprayed up to the ridge. Water intrusion was observed below both sides of the gable when testing near the upper half of the sidewall transitions where the counterflashing was missing (Figure 22 through Figure 25). Water was observed on the interior running off of the ends of the steel deck flutes and also out from behind the interior drywall at the exterior walls. No additional water intrusion was observed when testing the adjacent metal roof panels, wall panels, or coping metal along this sidewall transition.

Figure 22. Water spray testing sidewall transition with missing counterflashing along south half of gabled roof. Water intrusion observed after 2 minutes.

Figure 23. Water intrusion running out from behind drywall at south exterior wall when testing sidewall transition above.

Figure 24. Water spray testing sidewall transition with missing counterflashing near ridge. Water intrusion observed after 5 minutes.

Figure 25. Water running out of metal deck flutes directly below sidewall transition.

Location 2 - South Window Wall

WJE tested the window wall framing surrounding two vision lites near the west end of the south facade of Skybridge A (Figure 26). An infrared camera was used to detect water infiltration behind the short wall in front of the spandrel glass. No water intrusion was observed when testing the horizontal or vertical mullions at each lite. However, water intrusion was observed when testing along the head of both vision lites. (Figure 27). Water was observed at the gasket intersections at the bottom corners of the vision lites (Figure 28). WJE removed a portion of the gasketing at the head and observed that the top of the glass lite was roughly in line with the edge of the day light opening of the curtain wall framing (Figure 29). In addition, it was observed that the interior vertical gasketing was run in between the horizontal gasketing.

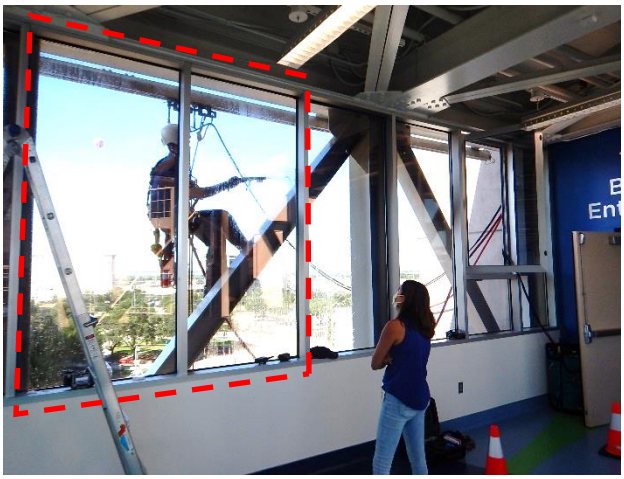

Figure 26. Water testing two lites within the south window wall using a spray nozzle.

Figure 27. Water spray testing along window head.

Figure 28. Water intrusion observed at gasket intersection at horizontal mullion below the test area.

Figure 29. Removal of interior head gasket revealed that the top of the glass was in line with the daylight opening of the frame.

Skybridge B: Purple Garage to Green Garage

Observations

- Water stains were observed below a louver in the metal wall panels on the west facade near the Purple Garage (Figure 30). Water stains were also observed below the louvers within the window wall on the west facade (Figure 31).

Figure 30. Water staining observed below intersection of duct work and exterior wall behind louver within the metal wall panels on the west facade.

Figure 31. Water stains below louvers within window wall.

- Observations behind the louver grille showed an internal joint along the base of the louver that appeared unsealed (Figure 32 and Figure 33).

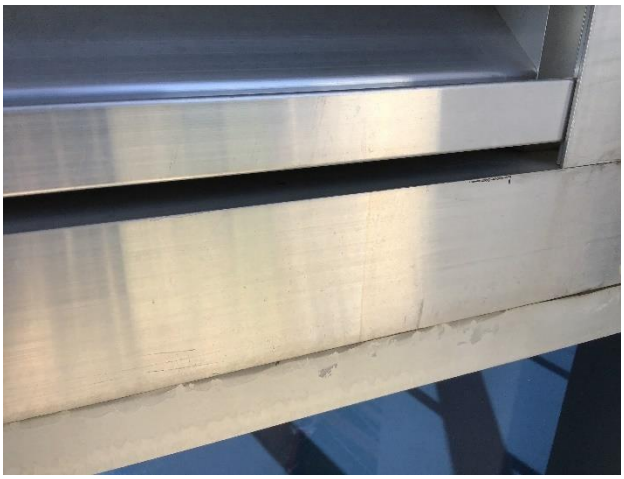

Figure 32. Base of louver within window wall.

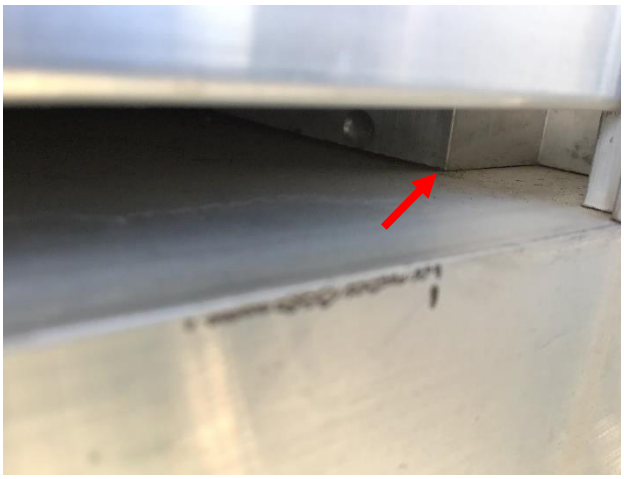

Figure 33. Open joint observed inside louver.

- Water staining was observed above the head of a window in line with the west steel column of the northern bent (Figure 34). Sheet metal cap flashings were observed at the top of these columns that were cut into the standing seam roof panels. Some of these cap flashings were observed to be sealed along the top and sides; however, the majority were not, including this location where water staining

was observed below (Figure 35). No other issues were observed within the standing seam roof panels at this location.

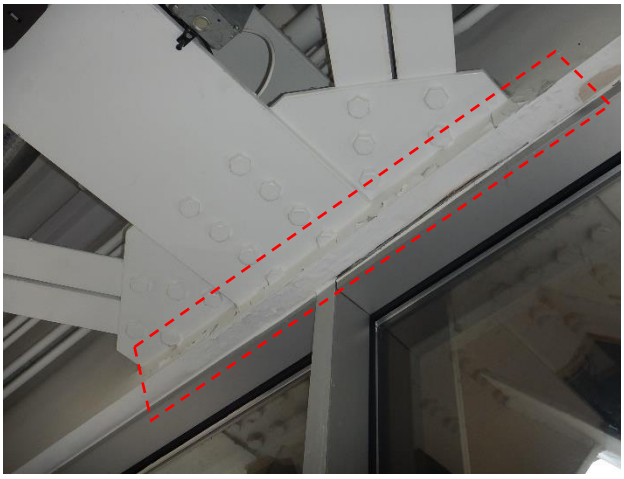

Figure 34. Interior water staining below sheet metal cap on north end of the west facade.

Figure 35. Sheet metal cap above steel column. Perimeter of cap not sealed at this location.

- Gasket shrinkage was observed on the east and west window walls in multiple locations (Figure 36).
- A missing sealant joint was observed around the perimeter of an inset operable window frame near the center of the skybridge on the west facade (Figure 37).

Figure 36. Gasket shrinkage on east facade.

Figure 37.Unsealed joint between window wall frame and inset operable window frame.

- One of the spandrel lites on the east facade was observed to be shattered with portions of the glass missing (Figure 38 and Figure 39). The lite was located above the railroad track. Spandrel insulation was observed behind the broken lite.

Figure 38. Broken spandrel lite on east facade above rail road track.

Figure 39. Broken spandrel lite on east facade above rail road track.

- Evidence of a failed perimeter seal within one of the insulated glass units (IGUs) was observed on the east facade (Figure 40 and Figure 41).

Figure 40. Haze/fogging of glass lite observed indicative of a failed perimeter seal within the IGU.

Figure 41. Deficiency observed within perimeter IGU seal.

- Similar issues regarding the perimeter sealant joint along the sill at Skybridge A were also observed at Skybridge B.
- No missing counterflashing or other visible deficiencies were observed in the sidewall roof transitions at either end of the skybridge (Figure 42).
- The modified roof membrane at the low slope roofs on both sides of Skybridge B showed similar signs of aging as those on Skybridge A (Figure 43).


Figure 42. Sidewall transition at north end of Skybridge B.


Figure 43. Low-slope roof at south end of Skybridge B.

- Several of the sealant joints within the precast panels of the Purple Garage adjacent to the south end of the Skybridge were observed to be deteriorated ("alligatoring"). An adhesive failure was observed in a vertical sealant joint within the elevator tower above the skybridge.

Water Intrusion Testing

Water intrusion testing was completed at five locations (Location 3 through 7) on the south end of Skybridge B near the intersection with the Purple Garage.

Location 3 - Sidewall Transition

WJE tested the sidewall transition between the gabled metal panel roof and the vertical metal wall panels. No notable staining was observed at the interior framing prior to testing. No water intrusion was observed when testing the sidewall with a spray nozzle on each side of the gable (Figure 44 and Figure 45).


Figure 44. Water spray testing along sidewall transition at west side of gabled metal panel roof. No water intrusion observed.


Figure 45. Water spray testing along sidewall transition at east side of gabled metal panel roof. No water intrusion observed.

Location 4 - Louver Vents

WJE tested two louver vents, one on each side of the south end of the skybridge. Prior to testing, staining was observed below the west louver indicative of previous water intrusion (Figure 30). WJE used a spray nozzle to sheet water down each of the louvers from the flat roof above (Figure 46 and Figure 47). No water intrusion was observed when spraying the louvers from the roof above. WJE repositioned testing and horizontally sprayed the west louver from the top deck of the Purple Garage (Figure 48). Water intrusion was observed after approximately 2 minutes leaking from the joint between the duct work and the wall (Figure 49). Additional water intrusion was observed dripping from a joint in the mechanical duct work near the east louver.

Figure 46. Water spray testing down onto the east facade louver near the Purple Garage. No water intrusion observed.

Figure 47. Water spray testing down onto the west facade louver near the Purple Garage. No water intrusion observed.

Figure 48. Water spray testing perpendicular to the west facade louver near the Purple Garage. Water intrusion observed after 2 minutes.

Figure 49. Water intrusion observed running out of the bottom joint between the louver duct work and the wall.

Location 5 - Vertical Expansion Joint

WJE tested the vertical expansion joint on the west facade that separates the skybridge and the Purple Garage. Prior to testing, staining was observed on the precast panel adjacent to the joint. WJE started testing with a spray nozzle at the bottom of the joint and proceeded upward. Water intrusion was observed within 2 minutes when spraying near the mid-height of the joint at a ledge in the adjacent precast panel (Figure 50 and Figure 51).

Figure 50. Vertical expansion joint between the skybridge and the Purple Garage. Water intrusion observed when spray testing the adjacent precast ledge after approximately 2 minutes.

Figure 51. Water intrusion observed on top of precast ledge.

Location 6 - Roof-to-Tower Transition

WJE tested the transition between the flat roof at the south end of the skybridge and the precast elevator tower at the Purple Garage. No water intrusion was observed when testing along the roof-to-wall transition flashing (Figure 52 and Figure 53). An adhesive sealant failure was observed within a precast panel joint further up the wall. Water intrusion was observed when testing this failed sealant joint after approximately 4 minutes (Figure 54). Water intrusion was observed below the south end of the roof-to-wall transition within the skybridge (Figure 55).

Figure 52. Water spray testing north end of roof-to-wall transition at the elevator tower for the Purple Garage. No water intrusion observed.

Figure 53. Water spray testing south end of roof-to-wall transition at the elevator tower for the Purple Garage. No water intrusion observed.

Figure 54. Water spray testing vertical sealant joint with adhesive failure above roof-to-wall transition at the elevator tower. Water intrusion observed after 4 minutes.

Figure 55. Water intrusion observed running down precast panel within the skybridge below roof-to-wall transition at the Purple Garage elevator tower.

Location 7 - West Window Wall

WJE tested the window wall framing surrounding one vision lite near the south end of the west facade of Skybridge B. An infrared camera was used to detect water infiltration behind the short wall in front of the spandrel glass. No water intrusion was observed when testing the perimeter of the lite with a spray nozzle (Figure 56 and Figure 57).

Figure 56. Water spray testing the horizontal intermediate of a vision lite on the west facade of the skybridge near the Purple Garage. No water intrusion observed.

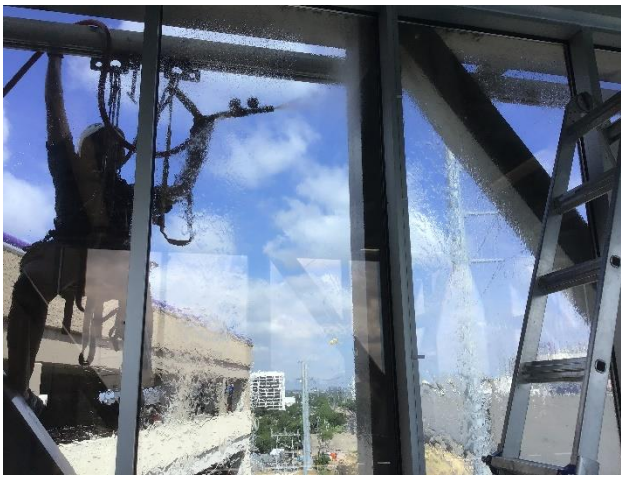

Figure 57. Water spray testing the vertical intermediate of a vision lite on the west facade of the skybridge near the Purple Garage. No water intrusion observed.

Skybridge C: Green Garage to Tower D

Observations

- No adhesion loss or discontinuities were observed within the vertical expansion joints at the east end of the skybridge (Figure 58).
- The observed sealant joints around the perimeter of the window system and between metal panels had consistent profiles with no notable areas of deterioration or adhesion loss (Figure 58 and Figure 59).
- Little to no gasket shrinkage was observed within the window systems.

Figure 58. Vertical expansion joint at east end of Skybridge C. Photo also shows orientation of window system and metal panels below

Figure 59. Window system and metal panels along north facade of Skybridge C.

- Deteriorated sealants with cohesive and adhesive failures were observed along the expansion joint flashing at the roof-to-wall transition where the skybridge meets the Green Garage (Figure 60 and Figure 61). Multiple layers of remedial sealant were observed along this joint.

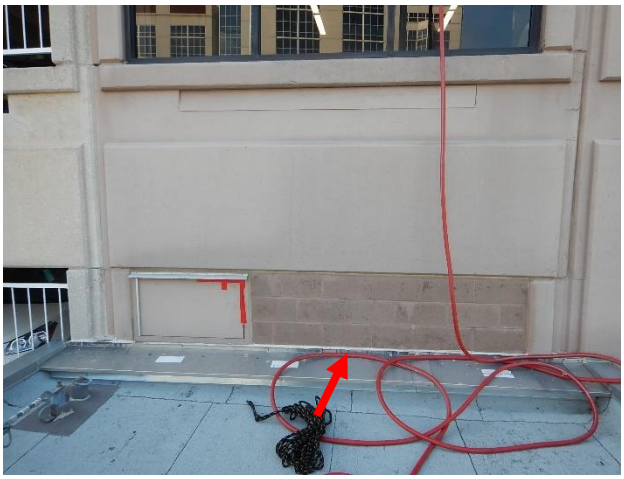

Figure 60. Roof-to-transition at the Green Garage. Metal expansion joint flashing sealed to precast panels and CMU infill (arrow).

Figure 61. Deteriorated remedial sealant joint along top of expansion joint flashing.

- The CMU infill directly above the expansion joint flashing was observed to be coated. Cracks/ separations were observed within the mortar joints of the CMU that propagated through the exterior coating (Figure 62). Efflorescence and water stains were observed on the back of the CMU (Figure 63).

Figure 62. Separation/cracking of mortar joint within CMU infill above roof flashing.

Figure 63. Efflorescence and water staining on back of CMU infill.

- Additional deficiencies/discontinuities were observed within the precast-to-precast and window perimeter sealant joints higher up the precast wall for the Green Garage (Figure 64 and Figure 65).

Figure 64. Cohesive failures of precast-to-precast sealant joint.

Figure 65. Daylight observed at corner of 2nd floor window sill above the roof-to-wall transition of the skybridge.

- Granule loss and alligator cracking was observed within the modified bitumen roof membrane (Figure 66 and Figure 67). Various roof sealants were also observed to be deteriorated.

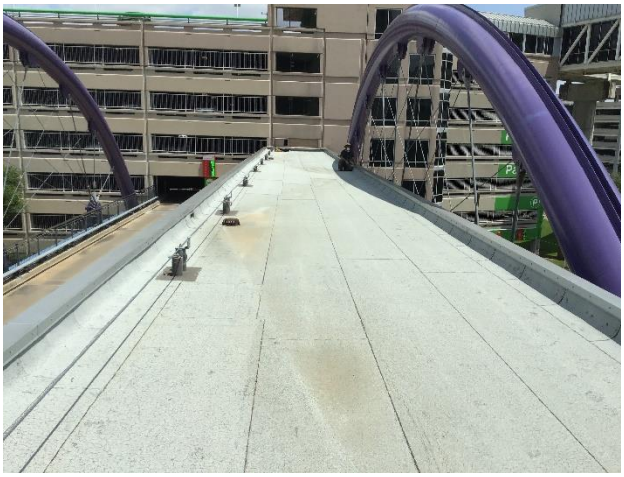

Figure 66. Low-slope roof across Skybridge C.

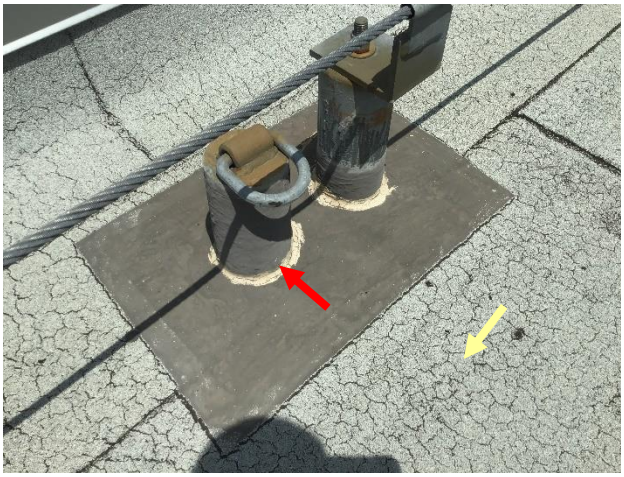

Figure 67. Alligator cracking of roof membrane from UV exposure (yellow arrow). Sealant deterioration observed around tie back anchors (red arrow).

Water Intrusion Testing

Water intrusion testing was completed at two locations (Location 8 and 9) on the south end of Skybridge C near the intersection with the Green Garage. Water intrusion was reported at the ceiling below the roof/wall transition and along the base of the wall at the south end of the north facade.

Location 8 - Roof-to-Wall Transition

WJE tested the roof-to-wall transition at the east end of the skybridge at the Green Garage. WJE started at the roof-to-wall expansion joint flashing and proceeded upward. No water intrusion was observed when spraying the metal roof-to-wall expansion joint flashing. Water intrusion was observed when spraying the

painted CMU infill wall directly above the metal roof-to-wall flashing. Further diagnostic testing revealed that water was primarily migrating through separations in the mortar joints. Water was observed running out below the south vertical joint between the precast and the CMU. Water pooled on the garage floor and migrated into a core hole for a conduit penetration within the concrete slab.

Figure 68. Separation/cracks were tested within the CMU infill above the roof-to-wall transition.

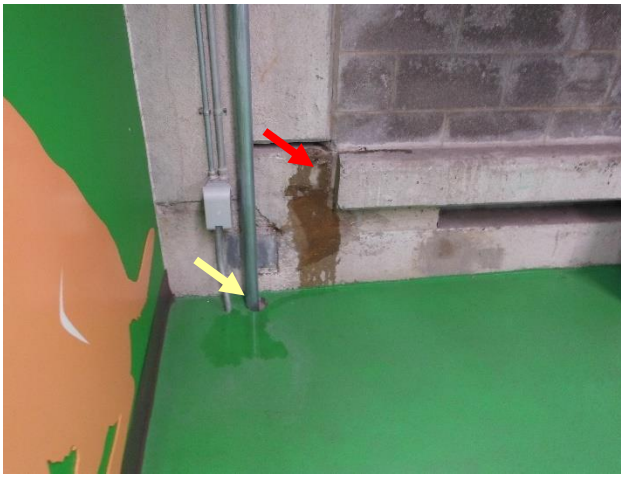

Figure 69. Water intrusion (red arrow) observed when spraying cracks/separations within the CMU infill above the roof-to-wall transition. Water migrated down through conduit penetrations within the garage floor (yellow arrow).

Water intrusion was also observed when spraying the small metal access door to the skybridge roof (Figure 70). Water was observed running down the CMU below the door jamb after approximately 30 seconds of testing (Figure 71).

Figure 70. Water testing metal access door above roof-to-wall transition.

Figure 71. Water intrusion observed after 30 seconds of testing the metal access door.

WJE continued testing up the garage wall above the skybridge roof. Water intrusion was immediately observed when testing the perimeter of the punched window on the second floor of the garage (Figure 72 and Figure 73). Discontinuities within the perimeter sealant joint allowed water intrusion.

Figure 72. Water testing perimeter of 2nd floor window sill within Green Garage above roof-to-wall transition.

Figure 73. Immediate water intrusion observed due to large discontinuity in perimeter sealant at the corner of the window.

Location 9 - North Window Wall

WJE used a spray rack to test the window wall on the north facade of the skybridge behind the location of interior drywall distress at the base of the wall. At this location, the window wall is covered with framing and interior drywall. No interior drywall was able to be removed at the time of our testing. WJE started testing by spraying the middle of the curtain wall. No water intrusion was observed after 45 minutes. WJE moved the spray rack up to test the upper half of the curtain wall and perimeter head sealant joint (Figure 74). Water intrusion was observed after 10 minutes pooling along the base of the wall (Figure 75).

Figure 74. Spray rack testing of windows on north facade.

Figure 75. Water intrusion observed at base of wall behind windows.

WJE attempted to perform additional diagnostic testing to further pinpoint the source of the water intrusion; however, the interior drywall covering the back of the windows prevents any further identification of the specific path of water intrusion through/around the window system.

DISCUSSION AND CONCLUSIONS

Window Walls at Skybridges A and B

The window walls on each side of Skybridges A and B were originally set and glazed from the interior and were set into receivers at the head and the sill. The window system is designed to collect incidental water that gets into the glazing pockets, internally drain the water down to the sill, and then redirect the water back to the exterior through weeps within the sill receiver. Most of the rainwater is deflected by the exterior gaskets; however, water can infiltrate the gaskets during high wind events or as gaskets deteriorate and/or shrink with UV exposure. Maintaining gaskets is necessary as excessive water within the glazing pocket has the potential to overwhelm the internal water management system.

The presence of dirt build-up and mildew along the sill receiver and around the weeps at Skybridges A and B may indicate that the sill receiver does not drain efficiently, and that water may build up within the system. WJE was not able to determine if any staining or water intrusion has occurred on the interior of the sill receiver since the base of the window wall is covered by a short wall. No distress was observed on the interior drywall finishes and no water intrusion was observed with the infrared camera at the base of the wall during spray testing of the window walls at Skybridges A and B. WJE understands that the flooring, which runs up the base of the wall to act as a base moulding, was recently replaced which may have covered up any drywall distress or water staining at the base of the wall.

Water intrusion was observed during spray testing of the head framing of two vision lites at Skybridge A. Removal of an interior head gasket revealed that the top of the glass lite was not properly positioned up into the glazing pocket. This may be a result of improper installation of setting blocks or improperly sized glazing for the opening. As a result, some of the head gaskets may not have a tight seal against the glass. During our spray testing, water was infiltrating past the head gasket and was able to migrate over the top of the glass lite and onto the interior gaskets. This water travelled down the back of the interior gasket at the jamb and out of the glazing pocket at the discontinuous intersection of the vertical and horizontal interior gaskets. This source of water intrusion is typically prevented by sealing the intersection of the interior gaskets; this was not observed at these window walls. Given the overhang above the window heads created by the steel beams and a lack of previously reported water intrusion at windows, water intrusion at these gasket intersections would not be common during a typical rain event. In addition, if water intrusion did occur, only a small amount of water would be expected to pool on the mullion and would not likely warrant remediation efforts.

At two locations on the east facade of Skybridge B, deficiencies were observed in the IGUs including a broken spandrel lite and a failed IGU seal. Failures within the perimeter seal of an IGU will allow moisture vapor within the airspace resulting in the fogged/hazy appearance observed onsite.

In addition to the spandrel and vision lites of glass within the window wall, louvers and operable windows were also glazed into the window framing. The condition of the louvers is addressed in a subsequent section. The operable windows were installed in order to gain access to the specialty rail system on the outside of the skybridges. No issues were observed regarding the internal water management of the operable frames, and no evidence of water staining or water intrusion was observed. However, a missing sealant joint was observed around the perimeter of one of the inset operable window frames on the west facade of Skybridge B.

Proper integration of the window walls with the adjacent envelope/structural components around the perimeters is also necessary for a watertight system. During testing at Location 5, water intrusion was able to migrate around the vertical expansion joint at the south perimeter through an unsealed joint in the adjacent precast.

Window System at Skybridge C

The windows at skybridge C are also drainable window systems, with the ability to manage incidental water within a glazing pocket and then redirect/weep it back out to the exterior. These windows manage water within "zones" which are created for each IGU in the system. For a given zone, incidental water that infiltrates past the exterior gaskets is captured within the glazing pocket and drained into the next horizontal mullion or sill member. Weep holes within the pressure bar and face cap allow water to exit the horizontal glazing pocket. When functioning properly, water within the glazing pocket is not able to migrate to an adjacent zone or inboard of the glazing pocket.

At Test Location 9, when spraying the window system at the east end of the north facade, water intrusion was recreated at the base of the wall; however, the specific source of the water intrusion was inconclusive. WJE believes the water intrusion is likely occurring through internal deficiencies within the window system but without removal of the interior drywall or deglazing the window, the origination of the water intrusion could not be confirmed. This window issue appears to be a unique condition as no other distress to interior finishes was observed within Skybridge C.

The observed sealants and gaskets, across the rest of the window and wall system, were in good condition with no notable deterioration, adhesion issues, or shrinkage.

Louvers

Two different configurations of louvers for the HVAC systems were observed within Skybridges A and B. Louvers are designed to take in or expel air but also need to be able to resist, manage, and weep out water that blows past the louver grille. The first set of louvers were observed within the vertical metal panels at the ends of the skybridges where a low-slope roof area is raised up to house the HVAC equipment. The louvers are fresh air intakes and are tied into duct work. Water intrusion was observed when testing one of these louvers at Location 4; however, the water intrusion only occurred when spraying the louver head on. This testing indicates that this water intrusion is related to an internal issue and likely only occurs during a wind-driven rain event. Apparent deficiencies/discontinuities within the water management system behind the louver grille are allowing water intrusion. WJE did not access this louver for close-up review.

The second set of louvers were glazed into the window wall framing at four locations (two on the south facade of Skybridge A and two on the west facade of Skybridge B). These appear to be smoke exhaust fans for the skybridges. Due to water access limitations at the time of our investigation, none of these louvers were water tested. However, based on the staining observed below several of these louvers, it is likely that similar internal deficiencies/discontinuities exist within the water management system behind these louver grilles as well.

Metal Panel Roofing and Walls

Standing seam metal roof and wall panels typically have a long service life (approximately 50 years) and generally require little maintenance. Where the roof/wall systems transition or terminate, continuity between the systems needs to be provided to ensure proper water management.

The sloped standing seam roof panels were observed to be in good condition. Based on the lack of visible staining below the field of the roof panels or along the ridge, it appears that the majority of metal roof panels are performing well and are not contributing to the reported water intrusion within the skybridges. However, water staining was observed, and water intrusion was recreated, at the sidewall transition at the west end of Skybridge A. At this location, a piece of missing sidewall counterflashing was identified as the source of the water intrusion. Based on a lack of any weather barrier and/or flexible flashing behind this transition, the continuity of the counterflashing is critical to preventing water intrusion at these sidewall transitions.

The only other observed interruptions in the roof panels were the sheet metal cap flashings at the steel columns above the skybridge bents. Due to water source limitations, we were not able to water test these conditions during our assessment. These cap flashings need to be properly lapped and sealed under the roof panels to prevent water intrusion at these locations. Based on the water staining observed below one of these cap flashings and the observation that only some of these cap flashings were sealed, it is likely that some deficiencies/discontinuities exist around these cap flashings that either have, or are, currently contributing to water intrusion.

The metal wall panels at the ends of the skybridges were also observed to be in good condition with no evidence of water intrusion issues. The black transition membrane used to seal the wall panels to the cladding at the Bight Building was poorly applied with inconsistent sealant application; however, the membrane appears to be performing. It is unknown if the membrane and the adjacent sealants are original or if these were installed as repairs after the construction of the skybridge. Exposed transition membranes need to be diligently maintained and inspected to ensure a water tight assembly.

Low Slope Roofing and Adjacent Cladding

The condition of the low slope roofing at the ends of Skybridge A and B and across the entirety of Skybridge C was consistent with the deterioration and wear expected of similarly aged modified bitumen roof membranes. No evidence of trapped moisture or water intrusion was observed within the field of the roofing. Given the estimated dates of construction, these roof membranes are approximately 13 to 17 years old. Modified bitumen membranes have a typical service life of 20-25 years.

At the east end of Skybridge C, the source of the reported water intrusion below the roof-to-wall transition was determined to be related to the CMU infill above the roof expansion joint flashing. Cracks and separations within the mortar joints above the metal roof flashing are allowing water infiltration into the CMU cells where water is eventually able to migrate down into the entrance of the skybridge below. The water infiltration within the CMU has also resulted in the efflorescence observed on the backside of the CMU within the garage. In addition to the CMU, water intrusion was also observed within the garage when testing the roof access door and at discontinuous perimeter sealants around windows. The majority of the sealants and coatings on the Green Garage above the roof of Skybridge C appear to have exceeded their useful service life.

At the south end of Skybridge B, no water intrusion was observed when testing the low-slope roofing of the metal transition flashing with the elevator tower. However, similar to the east end of Skybridge C, deficiencies with the cladding components above this roof-to-wall transition, in this case a failed precast sealant joint, are allowing water intrusion into the skybridge.

RECOMMENDATIONS

Based on our observations and water intrusion testing, WJE has developed the following recommendations regarding the three skybridges. Due to similar issues and construction, recommendations for Skybridges A and B are grouped together. Recommendations are also grouped into short term and long term considerations; however, given the difficultly/expense of access at Skybridges A and B, it may be prudent to address the majority of issues at one time.

Skybridges A and B

Short Term Considerations

1. **Sidewall Transitions.** At the sidewall transition on the west end of Skybridge A (Test Location 1), WJE recommends that the existing sidewall detail be modified to mitigate the current water intrusion issue and ensure a more watertight assembly along this transition. This would involve removal of the counterflashing along the entire sidewall, installation of a new flexible flashing membrane behind the counterflashing, and then reinstallation/replacement of the counterflashing. Consideration should be given to completing this recommendation at all similar locations at Skybridges A and B.
2. **Louvers.** At all louvers, both for the HVAC intake and the Smoke Exhaust vents, WJE recommends that joints within the bottom pan behind the louver grille be inspected and sealed. This would likely require partial removal of the louver grille for access. In lieu of internal modifications, consideration could be given to installing a hood over the louvers to limit exposure to rain.
3. **Column Cap Flashings.** All column cap flashings should be sealed along the top and sides.
4. **Missing Sealant.** Install a new sealant joint, where missing, around the operable window on the west facade of Skybridge B.
5. **Broken Spandrel Glass**. Remove and replace the broken spandrel glass on the east facade of Skybridge B. Access will need to be provided through an opening in the drywall behind the spandrel lites.
6. **Failed IGU.** Remove and replace the failed IGU on the east facade of Skybridge B.
7. **Expansion Joint.** Install a new sealant joint along the precast ledge adjacent to the south expansion joint at the Purple Garage (Test Location 5).
8. **Precast-to-Precast Joints.** Remove and replace the failed sealant within the precast-to-precast joint (Test Location 6). WJE recommends that all other sealants within the precast elevator tower above the roof of the skybridge be inspected and repaired as necessary.

Long Term Considerations

1. **Window Sills.** It was undetermined if the sill receivers along the base of the window walls were contributing to water intrusion. WJE recommends that the sills be monitored, in particular the condition of the interior drywall and flooring along the base of the walls. If interior finish distress occurs, additional investigation would be warranted which would likely include openings within the

drywall to inspect the interior condition of the window sills and observation for evidence of water intrusion.

2. **Window heads.** The water intrusion observed at Test Location 2 is not believed to be a systemic or commonly reoccurring issue and as such, repairs are not likely warranted. WJE recommends that these areas be monitored during/after future weather events for similar water intrusion. As a preventative measure, the intersections of the interior gaskets can be sealed to limit the possibility of water intrusion as observed during our testing.
3. **Window Gaskets.** In order to limit the amount of water within the window wall systems, WJE recommends that the gaskets be removed and replaced where gasket shrinkage has occurred. Alternatively, sealant can be added to the gaps as long as care is taken not to clog or impede the glazing pocket. A final option is to wet glaze the window perimeters. This option may be more cost effective than gasket replacement and would provide approximately 20 years of performance.
4. **Mod Bit Roofing**. Given the age and condition of the modified bitumen roofing at the ends of the skybridges, low-slope roof replacement should be considered in approximately 3-5 years.

Skybridge C

Short Term Considerations

1. **Roof-to-Wall Transition.** Repairs are needed to prevent water from getting behind the CMU infill, precast panels, access doors, and window systems above the roof-to-wall transition at the east side of the skybridge (Test Location 8). WJE recommends that the following repairs be completed:
    a. Route the existing mortar joint, install new sealant around the perimeter of the CMU infill, and apply an elastomeric coating of the CMU infill.
    b. Remove and replace the sealant joint along the top of the metal expansion joint flashing.
    c. Seal the interior joinery within the metal access door and install a new surface mounted drip edge above the door.
    d. Remove and replace all deteriorated precast-to-precast sealant joints at all garage levels above the skybridge.
    e. Remove and replace perimeter window sealants where deteriorated or missing at all garage levels above the skybridge.
2. **Water Intrusion Behind Window.** A portion of the window system will likely need to be wet sealed (Test Location 9). However, WJE recommends that additional water testing be completed after removal of the drywall from the interior wall in order to further pinpoint and diagnose the specific source of water intrusion at this location. Additional testing could be completed during construction, prior to implementation of a repair.

Long Term Considerations

1. **Mod Bit Roofing**. Given the age and condition of the modified bitumen roofing across the roof, roof replacement and all associated sealants should be considered in approximately 3-5 years.

CLOSING

Thank you for giving Wiss, Janney, Elstner Associates, Inc. the opportunity to help you with this assessment. If you have any questions concerning this report or need further clarification, please do not hesitate to contact WJE.