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Dated ….

Thermographic Report – Building, San Francisco, CA 93955

In September 2009, Agrarius LLC was commissioned to study a three story office building located at Building, San Francisco, CA. Folsom Street, street level views are provided below.

Building, San Francisco, CA

The customer reported that during a rain storm in January 2009 the building sustained a significant introduction of water inside the building while a new roof was being installed. In February a mold and spot moisture inspection was conducted to assess the impact of the water damage. The inspector documented elevated levels of mold and moisture in walls in a number of rooms. Since the January storm a new roof was installed and work on drains and downspouts was accomplished on the exterior. Inside the building some spot repairs were made, replacing heavily damaged ceiling board in a few water damaged locations. In other less heavily damaged and water stained ceilings and walls, no repairs were made. The building has been without tenants since the February inspection.

The focus of Agrarius' study was to characterize the moisture/water and other points of damage that may require attention by the remediation contractor and to also assess the state of the building shell with respect to its water tight integrity. Agrarius conducted a thermographic survey of the building interior on 2 September and 11 September 2009. On 2 September the interior was imaged to establish a dry[1] baseline of the building interior. On 11 September, to simulate a winter rain storm, the roof and exterior balconies were wet down using a garden hose. The interior was then imaged to assess the impact of the simulated rain event.

This report contains Agrarius' findings based on an examination and analysis of the September 2 and 11 imaging surveys. To facilitate our assessment the imagery was mapped to a set of building plans that were provided to Agrarius by the building owner. The report is in two segments, all loaded on a DVD. Segment 1, the summary text and

[1] National Weather Service reported that the last rain (other than trace) that fell in San Francisco prior to Agrarius' thermographic surveys was on 5 May 2009.

images contained in this document and annotated images referenced to floor plans in another file, are formatted to be printed on 8.5 X 11 paper. Segment 2 contains all raw and processed images in an electronic format that may also be examined. In the electronic version of the images referenced to the floor plan, the images are hyperlinked to the full resolution image file so that it can be viewed in detail.

Thermal Imaging - Background

Infrared Thermography, thermal imaging, or thermographic imaging is a type of infrared imaging science. The type of themographic camera used by Agrarius detects radiation in the far infrared range of the electromagnetic spectrum (roughly 8–14 µm) and produces images of that radiation, called thermograms. Since infrared radiation is emitted by all objects based on their temperatures, according to the black body radiation law, thermography makes it possible to "see" one's environment with or without visible illumination. The amount of radiation emitted by an object increases with temperature, therefore thermography allows one to see variations in temperature (hence the name). When viewed by thermographic camera, warm objects stand out well against cooler backgrounds. Figure 1 below illustrates 'seeing' in the visual and thermal parts of the electromagnetic spectrum. In the thermal view, white is warm and black is cool.

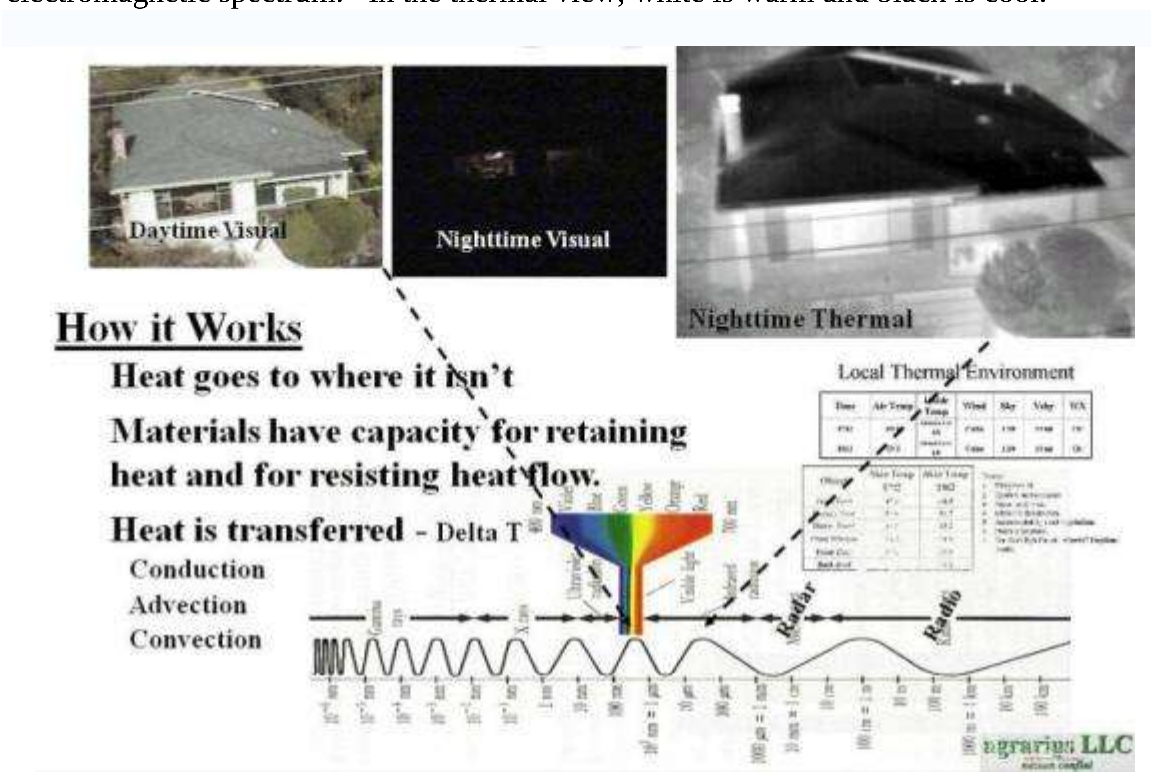

Figure 1. Energy Spectrum

Every material has a unique thermal signature. When heat, cold, moisture, and building material damaging events (such as flooding and/or insects) are introduced into a building structure the thermal signature changes. The changes can be subtle or dramatic but with thermal image scanning technology the thermal signatures are detectable where they wouldn't be able to be seen with the naked eye. Thermal image scanning technology is now being used to evaluate residential and commercial structures. As a non-invasive testing tool it can quickly help discern where there are suspected issues. This can help to limit the areas where time consuming further evaluation and destructive discovery is needed.

Specifically in the case of detecting water in, or the wetness of, a material in a building, scanning for thermal discontinuities is very useful because the signature (temperature and shape) of water in building materials is very distinctive and recognizable. Water has a very high specific heat. If a material is wet, as the ambient or adjacent temperatures change, the rate of change of the wet material temperature lags behind the temperature changes in the dry material by a significant amount. This difference in temperatures is readily evident when viewed with a thermographic camera. Agrarius' thermal imaging camera detects temperature differences of less than .5° Fahrenheit.

Scope and Flow of Work

2 September 2009

On 2 September the interior was imaged to establish a dry baseline of the building interior. Infrared and visual images of all walls and floor surfaces adjacent to the walls were observed and numerous views were collected to establish the base (dry) condition of the building interior. Figure 2a and 2b are a sample composite of thermal images (figure 2a) and the companion visual (figure 2b) of a dry ceiling and joining walls in the building. Note the feature in the upper left of the images. It is a patch that was applied after the damage caused by the rain in January 2009.

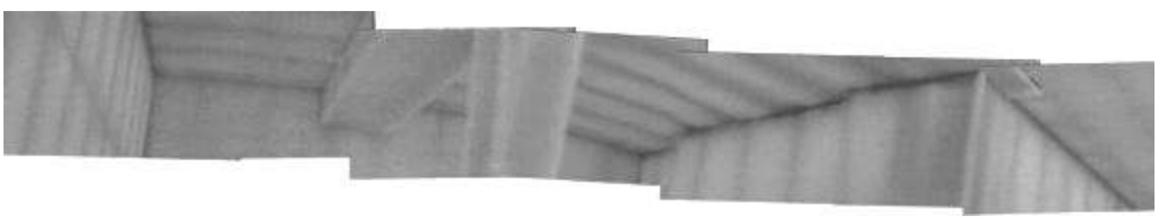

Figure 2a. Thermal Image

Figure 2b. Visual Image

Also note that the thermal image does not show the colors and color contrast that we see with our eye (visual). It only shows temperature variations (white is warm, black is cool).

Based on our analysis of the thermal character of the building, on 2 September the building interior is dry. There are several locations where damage from prior water is evident however the moisture/wetness contained in the interior is judged to be normal.

There is no evidence of persistent water in the ceiling, floors, or walls, nor are there any plumbing leaks evident.

Detailed raw and processed thermal and visual imagery are contained in the electronic files on the DVD named Building Report and Data. The electronic files and images contained in the Building Dry Imagery files are the 2 September data. The file named Building Survey Imagery-2Sep09 contains processed images thumb nailed and mapped onto the floor diagram that shows the location of a significant finding. Each floor is one page and all of the image thumbnails are hyperlinked to the full resolution image in the Building Dry Imagery files. This document is named in the DVD as Building Report.

The following set of 2 September panels (Figures 3, 4, and 6) and discussion points are provided in this document for orientation. To view the detailed imagery, open the document named Building Survey Imagery-2Sep09.

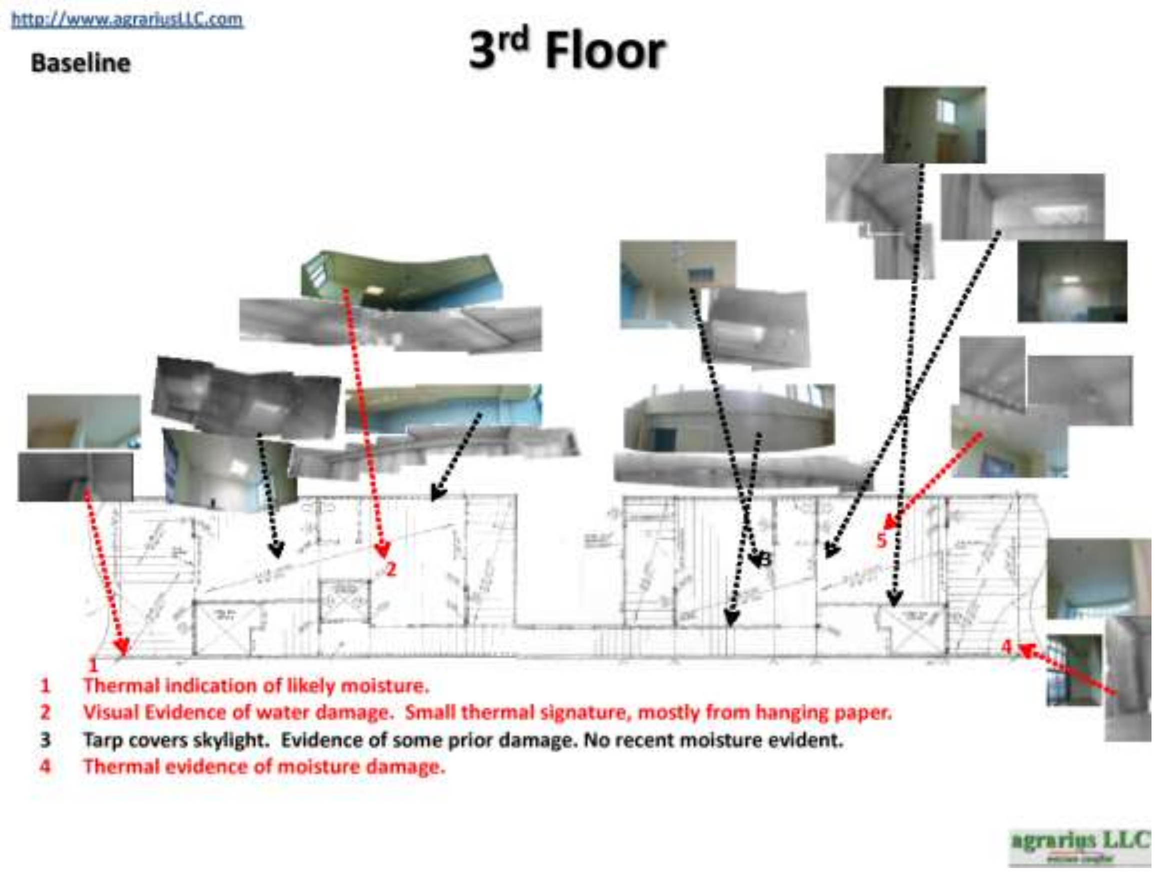

Figure 3 3rd Floor, 2 Sept

The 3rd Floor imaging shows a number of damaged points in the ceiling. Some are seen in the visual images as stained locations and torn paper. Others are only detectable in the thermal images (see Building Survey Imagery-2Sep09). However, there are no significant thermal indications of moisture present.

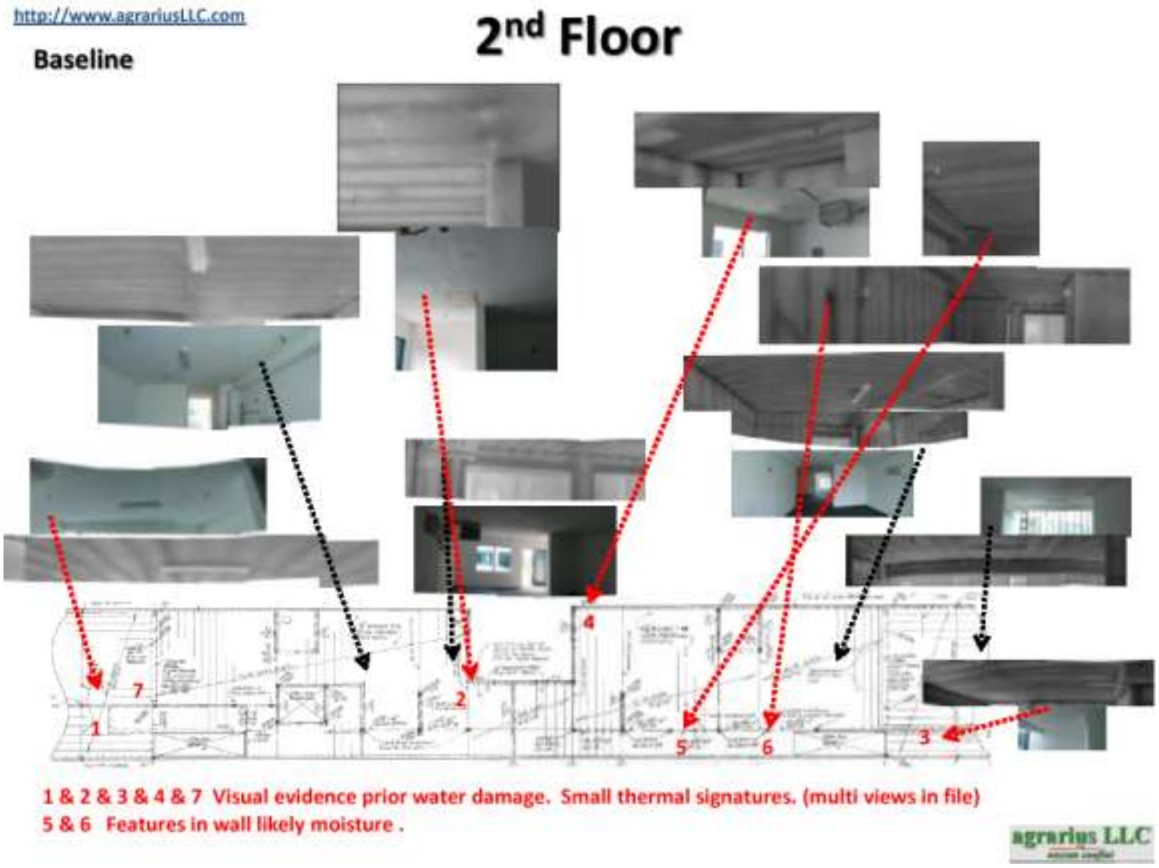

Figure 4 2nd Floor, 2 Sept

The 2nd Floor imaging shows damaged points in the ceiling and wall. Some are seen in the visual images as stained locations and torn paper. Others are only visible in the thermal images (see Building Survey Imagery-2Sep09). On the second floor, damage at locations 1 and 3 line-up under damaged locations 1 and 4 on the third floor. Note that at some of the locations where damage is visible in the visual picture (water stains and torn paper), very little is evident in the thermal view because the ceiling board has completely dried and no major damage to the ceiling board material was sustained. For example, figure 5, below demonstrates a view of a fully dried section of ceiling.

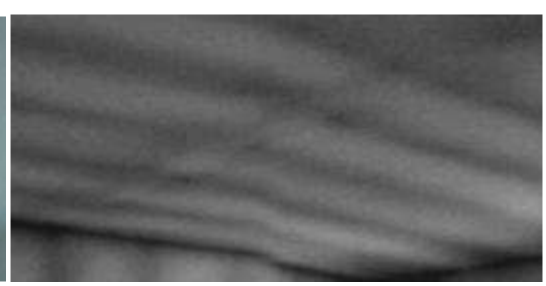

Figure 5a Visual 'scar' Figure 5b Thermal ‘scar’

On the 1st Floor (Figure 6) although there are a few locations where there is visual evidence of prior damage there are no significant thermal indications of moisture present.

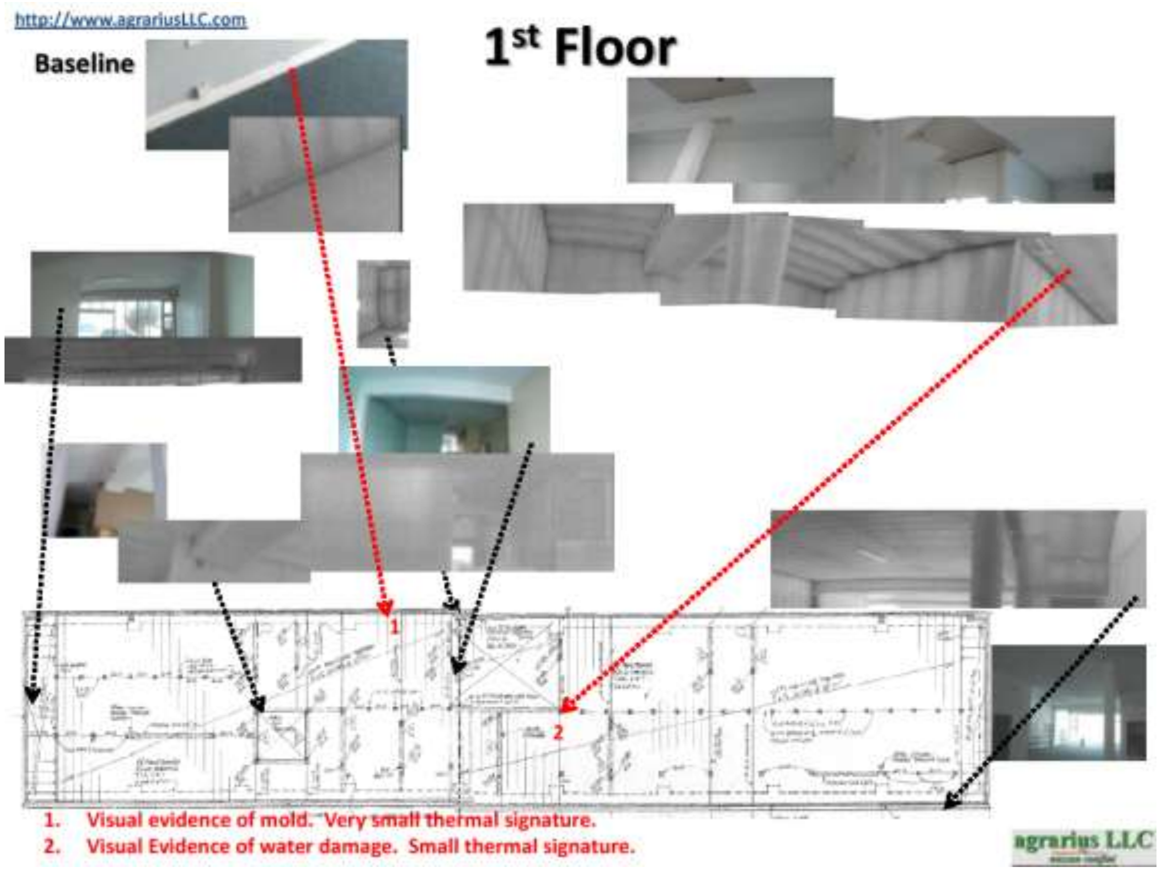

Figure 6 1st Floor, 2 Sept

11 September 2009

On 11 September, to simulate a winter rain storm, the roof and exterior balconies were wet down using a garden hose. The interior was then imaged to assess the impact of the simulated rain event.

Detailed raw and processed thermal and visual imagery are contained in the electronic files on the DVD named Building Report and Data. The electronic files and images contained in the Building Wet Imagery files are the 11 September data. The file named Building Survey Imagery-11Sep09 contains processed images thumb nailed and mapped onto the floor diagram that shows the location of a significant finding. Each floor is one page and all of the image thumbnails are hyperlinked to the full resolution image in the Building Wet Imagery files. This document is named in the DVD as Building Report.

The following set of 11 September panels and discussion points are provided in this document for orientation. To view the detailed imagery, open the document named Building Survey Imagery-11Sep09.

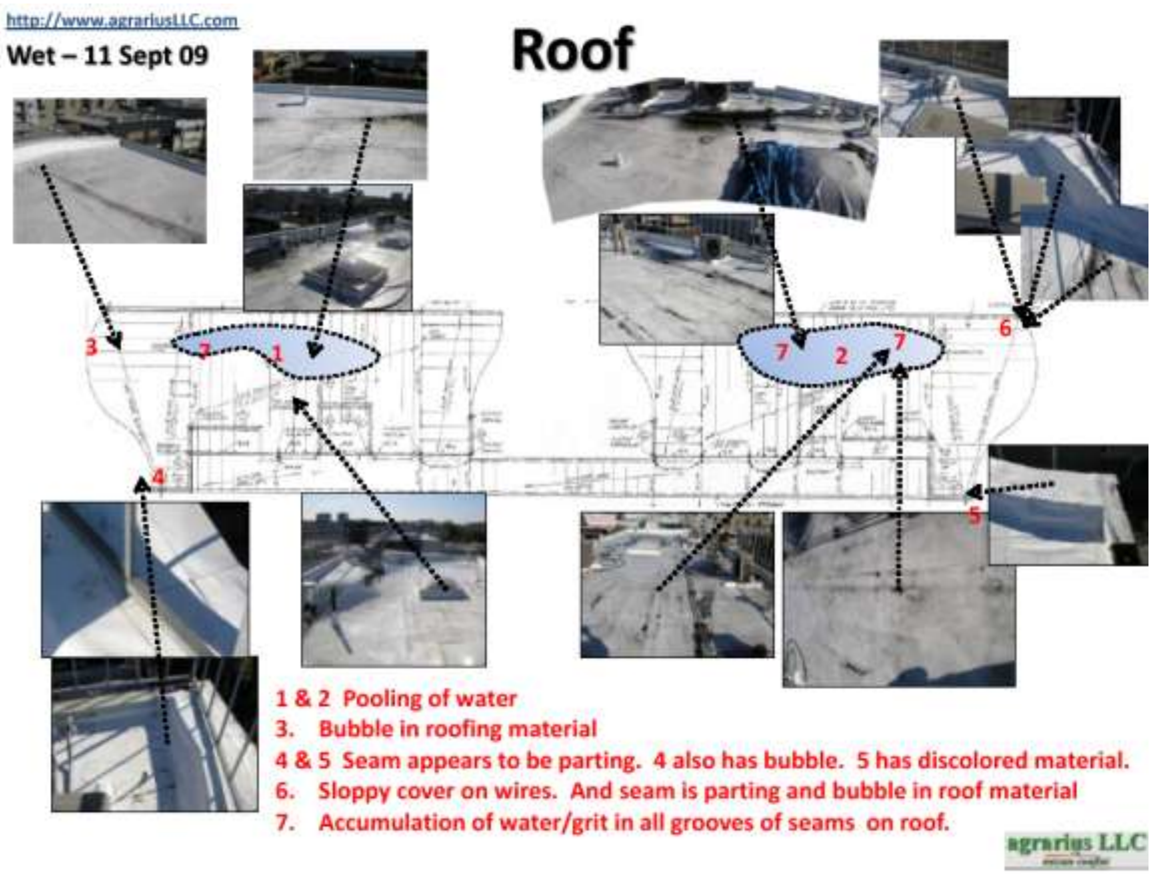

Figure 7 Roof, 11 Sept

In the annotated Roof (Figure 7) panel it is important to note that after wetting the roof, both north and south roofs had large puddles that were as deep as 2 inches at the centroids. There are also a number of locations (4, 5, and 6) where the seam appears to be pulling apart.

Moving to the floors below (3rd Floor, 2nd Floor, 1st Floor), it is seen that the defects pointed to on the Roof are highly location correlated to the locations on the floors below where water/moisture is evident. The following set of images illustrates this at one location. The ceiling in room 304 was dry on 2 September and then after wetting the roof on 11 September it is wet.

Note that Figure 8 shows a puddle formed on the south roof top. Also note the character of the seams joining the roofing material. This pattern in the roofing material, exposed seams, is typical of all the seams that join long 5 ft wide strips of roofing material on the flat roof. Where there are puddles, the seams are covered by water.

Figure 8 Water puddle on south roof and detail of roofing material seam

Then a visual view of the room below the roof puddle.

Figure 9 Visual view of room 304 ceiling

The following image (Figure 10a and 10b) is the thermal view of the ceiling on 2 September when the ceiling was dry. Note the two spots where there was visible damage from the winter rains. Figure 10a corresponds to the location where the light fixture joins to the ceiling and figure 10b corresponds to the location where the paper ceiling cover is seen to be peeling and hanging.

Figure 10a Thermal of light fixture joining ceiling

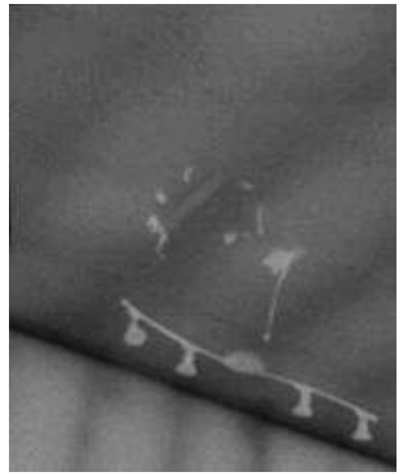

Figure 10b Thermal of paper peeling

Figure 11 is the thermal view of the ceiling after the roof above was wet on 11 September and a puddle formed on the roof above.

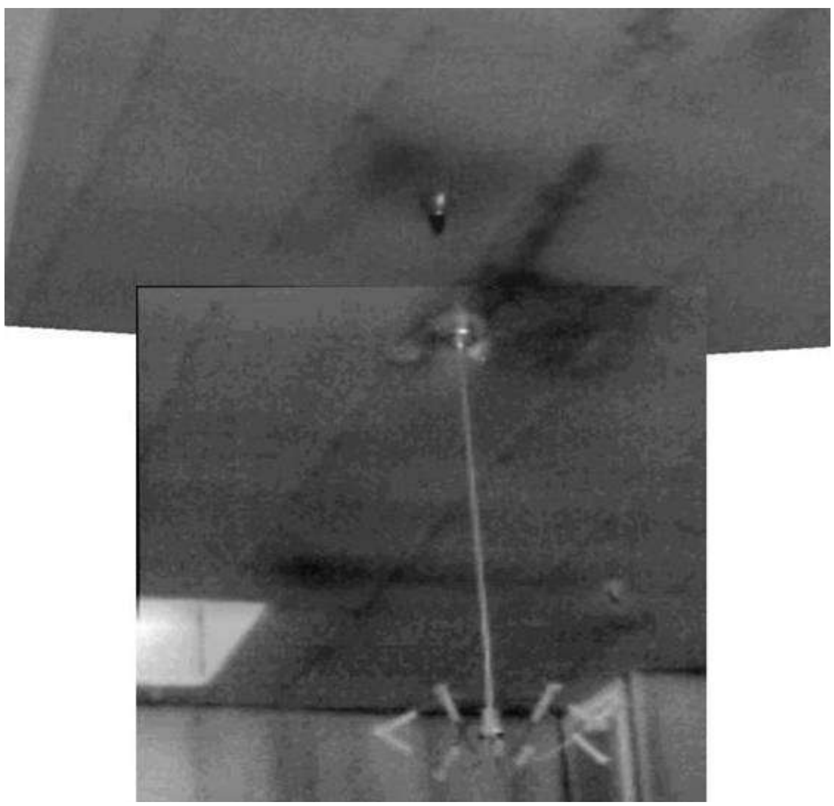

Figure 11 Thermal of ceiling in room 304

The dark (cool) shading is the thermal signature of water/moisture that has been introduced into the ceiling.

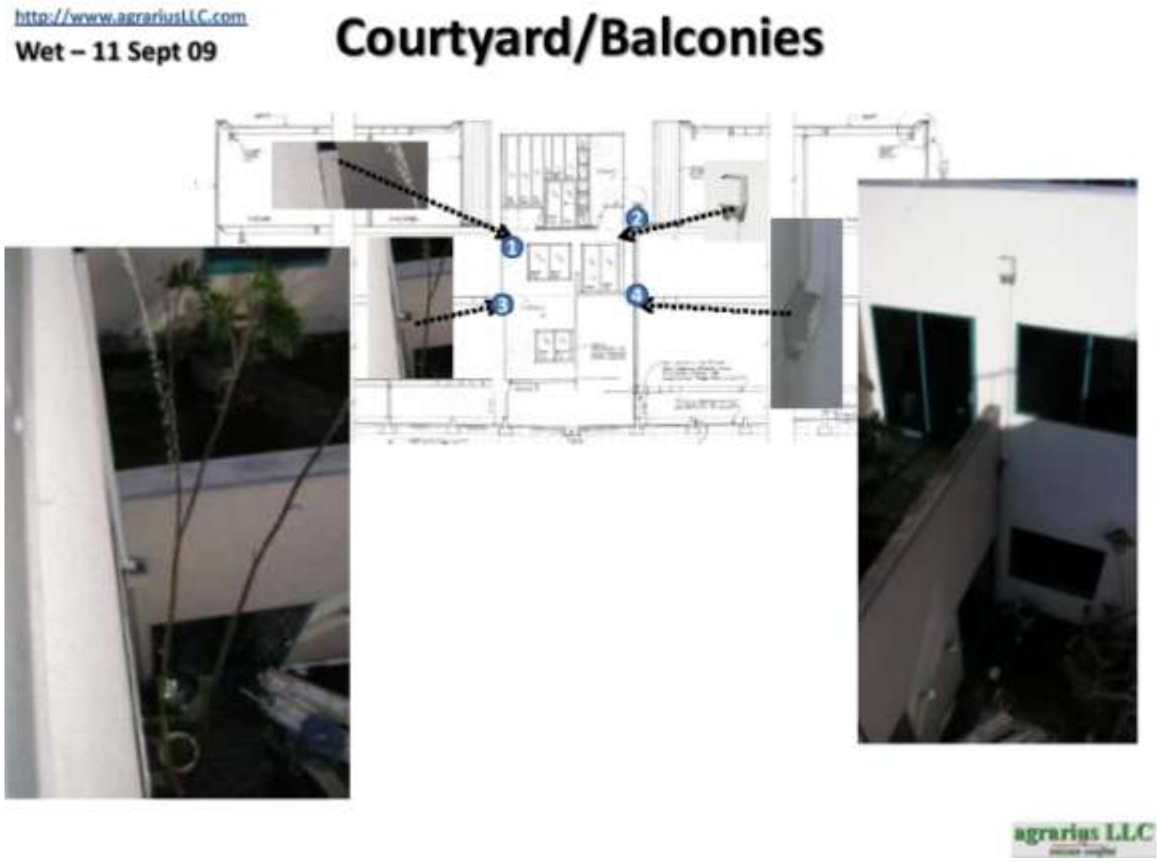

Figure 12 Courtyard/Balconies, 11 Sept

In the annotated Courtyard/Balconies panel (Figure 12) it is important to note that after wetting the balconies the drainage of water through the drains and down spouts is faulty. The balconies did not drain well and it is evident in the visual imagery that both the north and south balcony drains and scuppers do not fit onto the down spots drains. Note that the down spots disperse the water onto (and maybe into) the building rather than down the spouts and away from the building.

On all floors it is seen (Figures 13, 14, and 15) that the defects pointed to on the Courtyard/Balconies are adjacent to and below the locations noted where new water/moisture is evident.

In the next set of 3 panels (one per floor) note the locations of the water/moisture that is called out in the panels. These are all new wet spots; meaning that although there may have been visual indication that some of these spots were wet after the winter storm season ended, they had dried out (2 September imaging confirmed this). On 11 September, the rain simulation test helped to establish that the defects on the roof and in the drains on the courtyard balconies are all correlated with the new wet spots in the building.

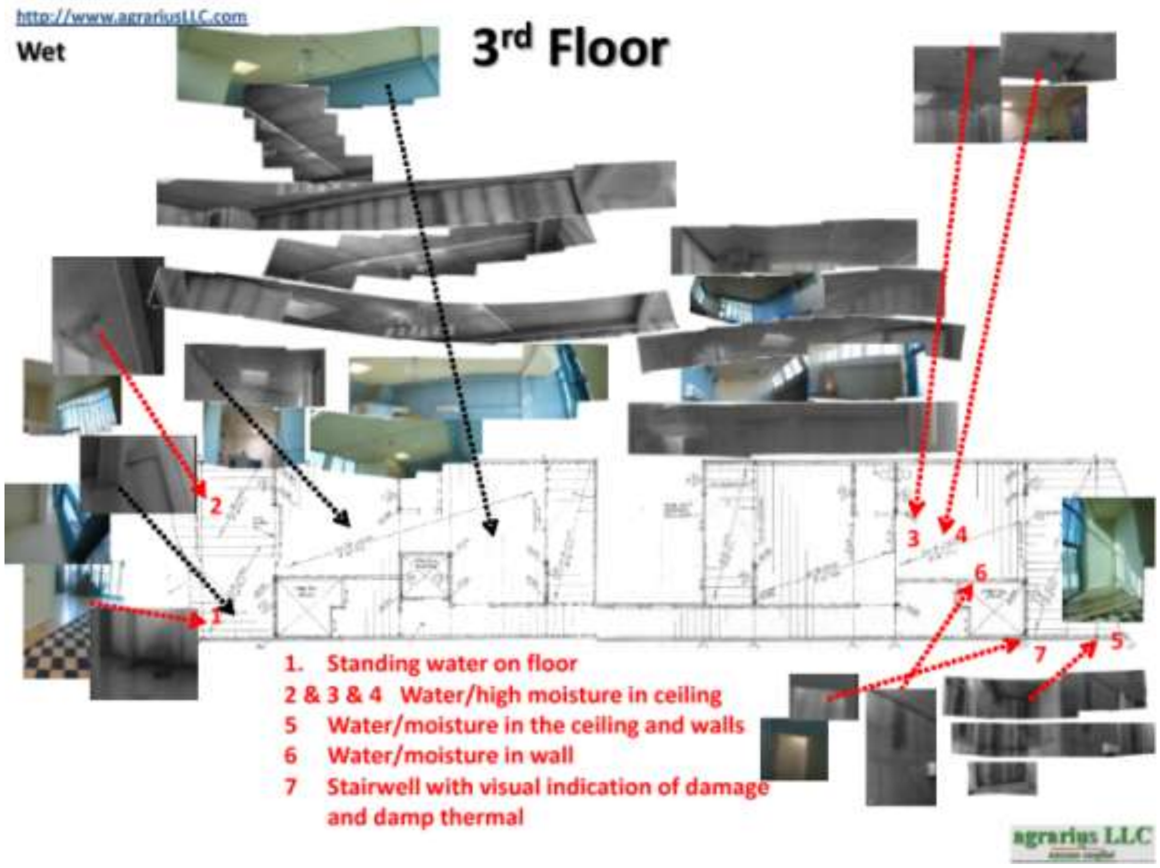

Figure 13 3rd Floor, 11 Sept

Note that the locations of water/moisture at 1, 5 and 7 are directly below locations 4 and 5 from Figure 7 (Roof). Location 2 is below location 3 from Figure 7 (Roof) and the other 3rd floor water/moisture locations noted in the ceiling are in proximity to the water puddles on the roof.

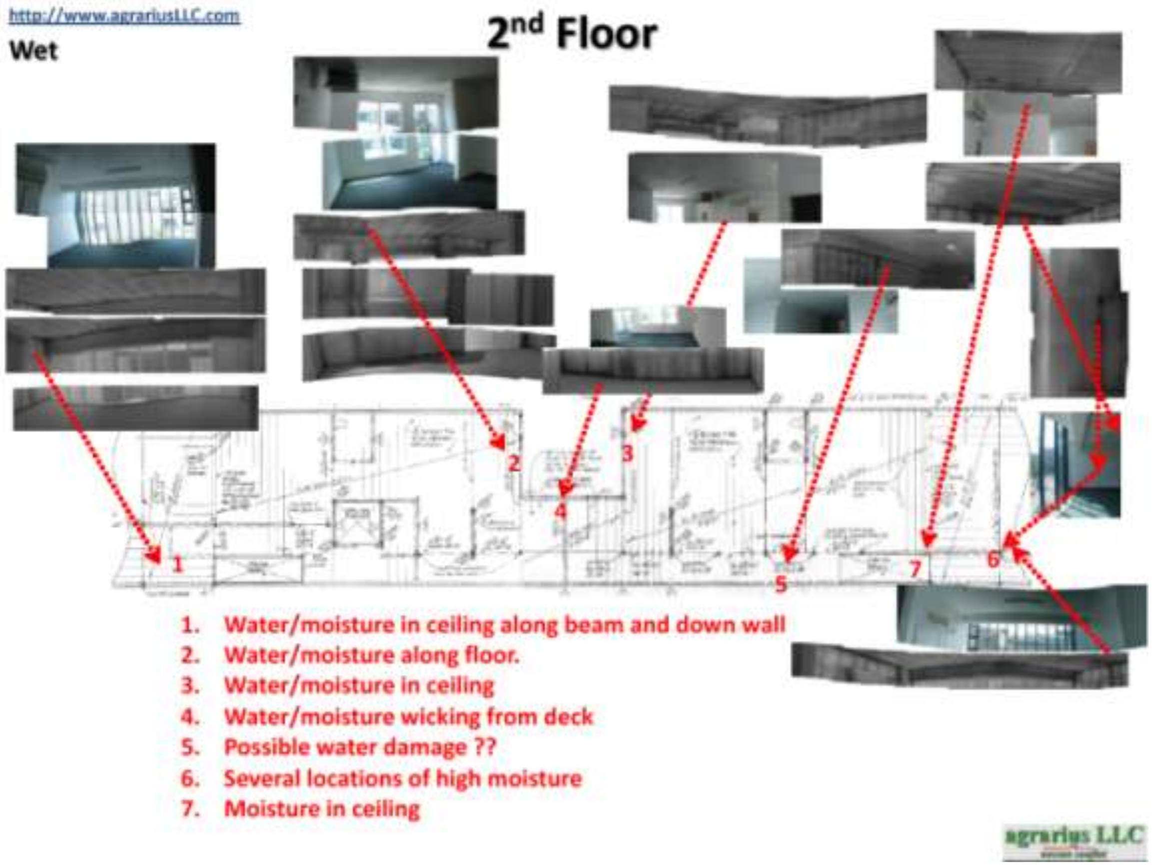

Figure 14 2nd Floor, 11 Sept

Note that the locations of water/moisture at 1, 6 and 7 are directly below locations 4 and 5 from Figure 7 (Roof), and Locations 1, 5 and 7 in Figure 13 (Courtyard/Balconies). Location 2, 3, and 4 are all in proximity to the balcony on the 3rd floor above.

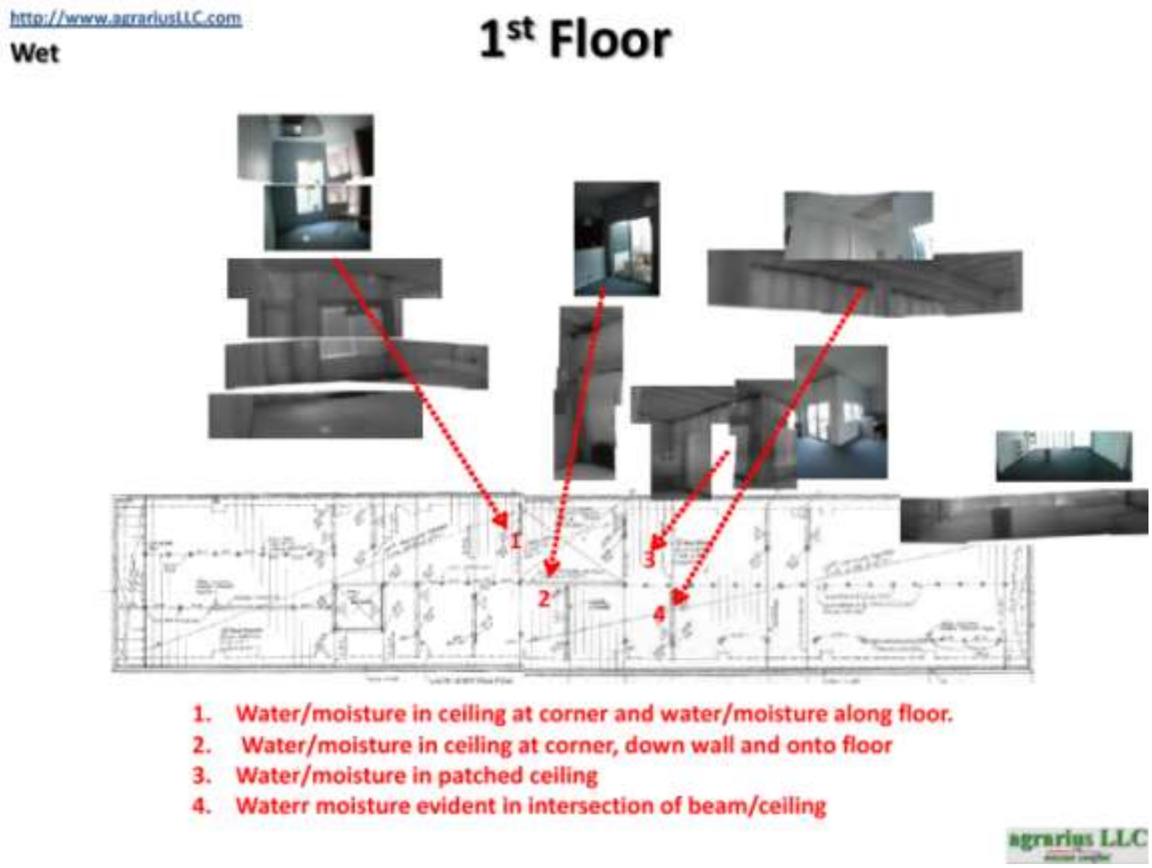

Figure 15 1st Floor, 11 Sept

Note that the locations of water/moisture at 1, 2, 3 and 4 are below the damaged areas pointed out on the 2nd floor in proximity to the balconies.

Summary of Findings

From our discussions with the building owner and the custodial engineer we understand that the roof was being installed during the January storm noted here-in, and that the work was completed before the February mold and moisture inspection. We were also informed that drains and downspouts were put in place by the same roofing contractor that installed the roof.

On 2 September 2009, we found numerous locations in the building where there is visual evidence of water damage to the ceilings and walls. The thermal indication of water damage at those locations was very small and in Agrarius' opinion all of those locations are dry. There is no evidence of any persistent water from plumbing leaks or recent (within one month) water that is introduced from sources external to the building.

On 11 September 2009, after simulating a winter rain by wetting the roof and balconies with a garden house, there is evidence of water introduced into the building that was not evident on 2 September. It is Agrarius' opinion that the 'new' water/moisture was introduced into the building from the defects at the locations annotated on the data collated into the 11 September "Roof" page and the "Courtyard/Balconies" page in the file named "Building Survey Imagery-11Sep09" (also shown in Figures 7 and 12).

Based on our examination of the roof, the exterior balconies, and a complete thermal and visual inspection of the building interior on 2 September and 11 September, Agrarius concludes that there are defects in the roof and the drainage of the balconies that will cause the building at Building to become water logged and flooded when the winter rains begin again later in 2009.

Report Submitted by:

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