



Improving District Heating Maintenance Programs w/ Drone Technology

Problem

- District heating systems are aging & leaking
- Leaks are expensive and can be hard to locate
- Traditional inspection methods are ineffective and/or expensive
- Reactive maintenance results in higher costs and unplanned energy losses



Traditional Thermal Inspection Methods



Walking

- Slow
- Lack Perspective
- Limited Data
- No GIS Info



Pickup Truck

- Still need to walk parts of system
- Limited Perspective
- Limited Data
- No GIS Info



Helicopter

- Expensive
- Disruptive
- Shaky Video
- Limited Data
- No GIS Info

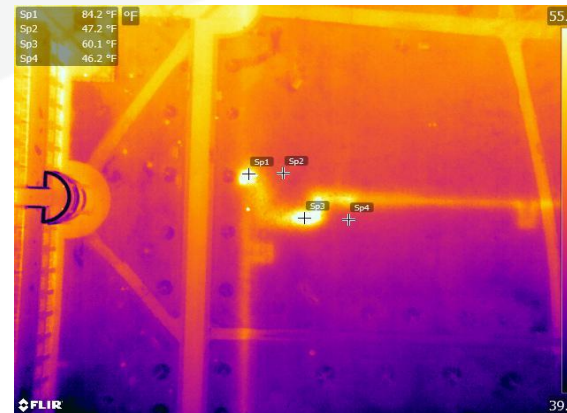


Airplane

- Expensive
- High Altitude
- Limited Data
- Lacks Detail

Drone-Enabled Inspections

- Scalable & Affordable
- Efficient
- Effective
- Safe
- Smooth Video
- High-Res Visual
- Radiometric Thermal Data
- GIS Ready



Equipment

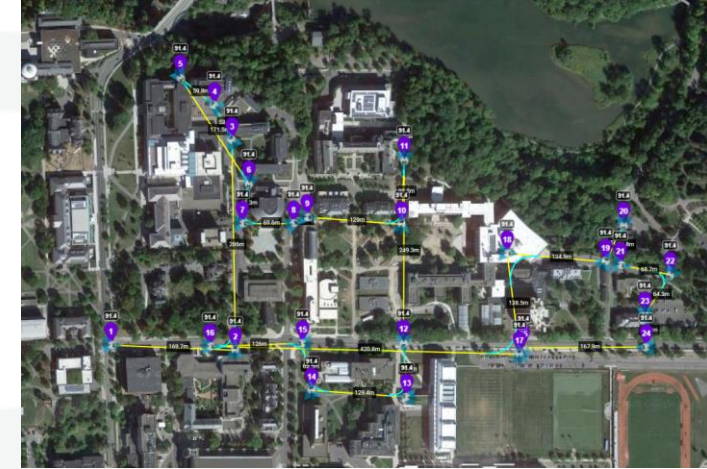
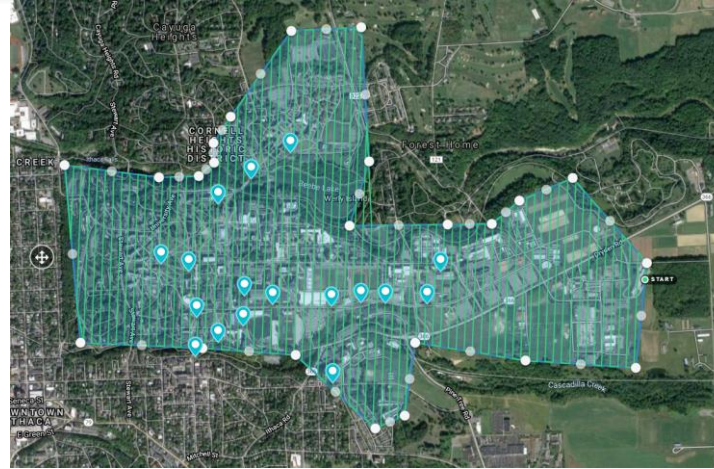


- FAA Part 107 Certified Pilots
- FAA Registered Aircraft
- Aviation Insurance \$3M - \$5M

Process

Daytime

- Map Campus
- Capture Pre-Programmed Video



Nighttime

- Capture Pre-Programmed Thermal Video
- Capture Radiometric Thermal Images



Deliverables

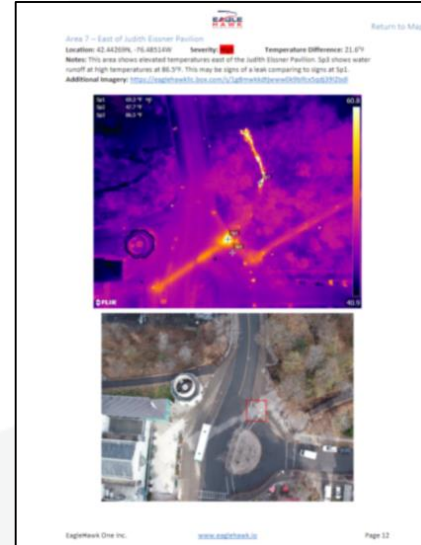
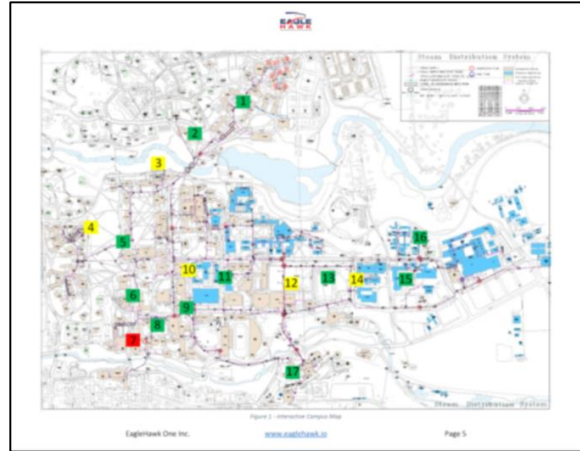
Roof Inspection Results
Date: 11/11/2023 Time: 7:00 PM Weather Conditions: Clear w/ Cooling Temp
Customer Name: Cornell University
Inspector Name: Vito Schumacher, Jacob Abright, and Andrew Schumacher
Thermal Image Type: DR Zennose V7 (208 VDC Pro, 640 x 512, 130ms)

The infrared and visual surveys were conducted via iDRONE technology. During the afternoon of the 11th, visual imagery as well as video was taken utilizing aerial cameras attached to the drone. The drone followed pre-determined flight paths which followed the steam line system, as well as generated a general campus map. The thermal inspection began at approximately 7:00 PM with cooling temperatures averaging around 35°F. The drone flew at approximately 500-600ft and were sometimes brought lower manually for better images of the steam system. Both radiometric images as well as thermal video of the steam tunnel was taken. The video was overlaid with the thermal data video to allow for better understanding of the steam system location. The radiometric images were edited to point to show both the temperature information of the problem areas, as well as provide better context of different problem locations.

Table 1 - Inspection Overview

Problem Area Number	Location	Temperature (DR, °F)	Severity
1	42.45121N, 76.47894W	20.3	Low
2	42.45182N, 76.48127W	5.6	Low
3	42.45094N, 76.48134W	17.8	Medium
4	42.44917N, 76.48173W	9	Low
5	42.44707N, 76.48162W	6.5	Low
6	42.44717N, 76.48164W	8.6	Low
7	42.44509N, 76.48118W	21.6	High
8	42.44424N, 76.48144W	9.9	Low
9	42.44417N, 76.48131W	6.5	Low
10	42.4459N, 76.4818W	19.9	Medium
11	42.4458N, 76.47972W	7.4	Low
12	42.4458N, 76.47910W	1.5	Low
13	42.4455N, 76.4794W	9.3	Medium
14	42.4454N, 76.47102W	10.8	Medium
15	42.4454N, 76.46877W	5.6	Low
16	42.4470N, 76.46709W	7	Low
17	42.4410N, 76.47133W	8.6	Low

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Comprehensive & Detailed
Interactive Report

Picture-in-Picture
Video

Picture-in-Picture Video



Map Data



Quick & easy integration with existing systems



Map Data

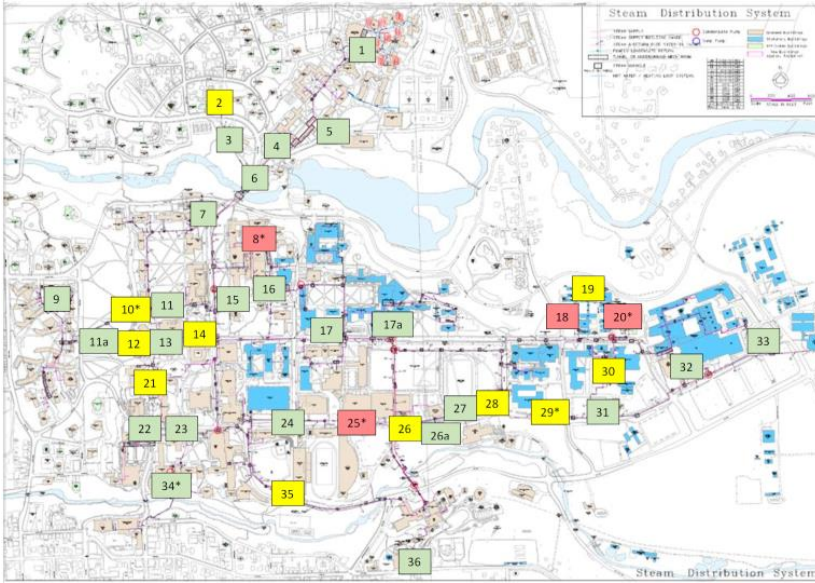


A professional drone with a camera and sensor equipment is shown in flight against a cloudy sky. The drone has four rotors and various attachments, including a camera and a sensor unit. It is positioned in the center of the frame, with its arms extended. The background features a coastal landscape with green trees, a body of water, and several wind turbines. The overall scene is bright and clear, with a mix of natural and industrial elements. The text 'Case Study 1' is overlaid on the image in a large, bold, black font. Below it, the subtitle 'The Benefits of Recurring Inspections' is also in a bold, black font, but slightly smaller. The text is centered and easy to read. There are decorative L-shaped corner brackets in the corners of the image: black in the top-left and top-right, and red in the bottom-left and bottom-right.

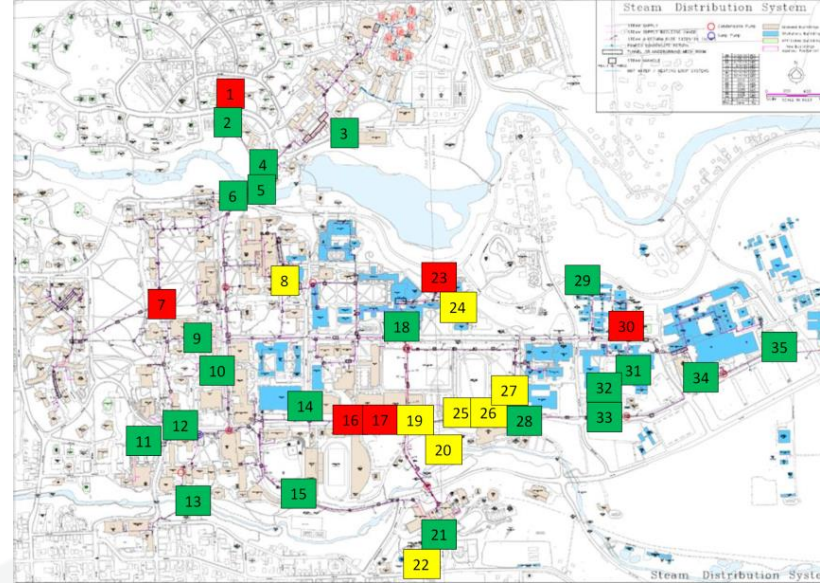
Case Study 1

The Benefits of Recurring Inspections

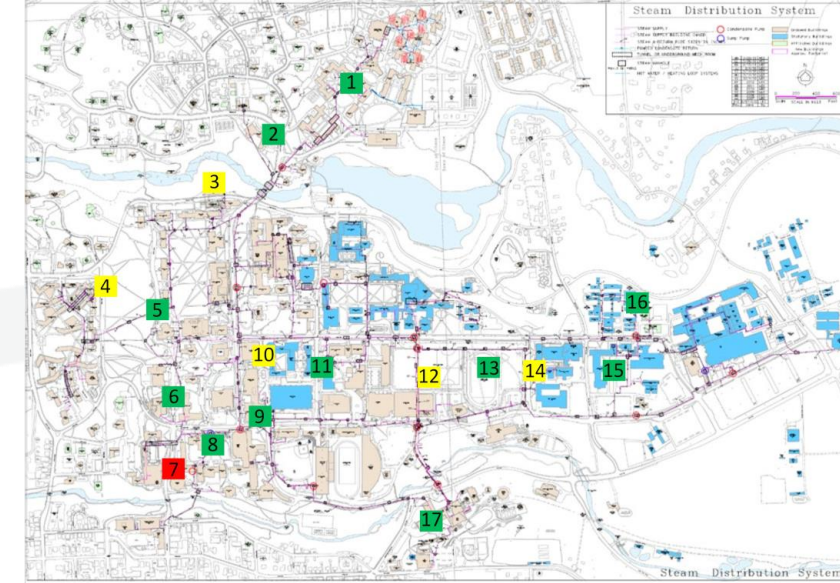
Case Study 1 – Ivy League School #1



April 2018

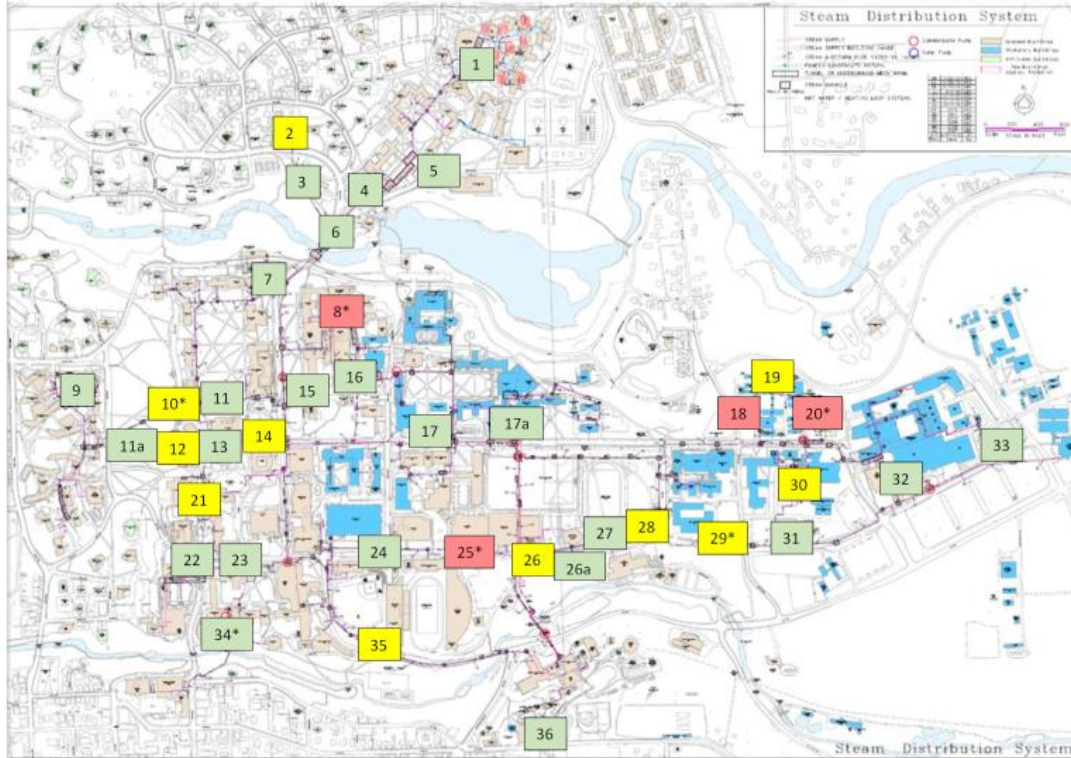


Dec 2018

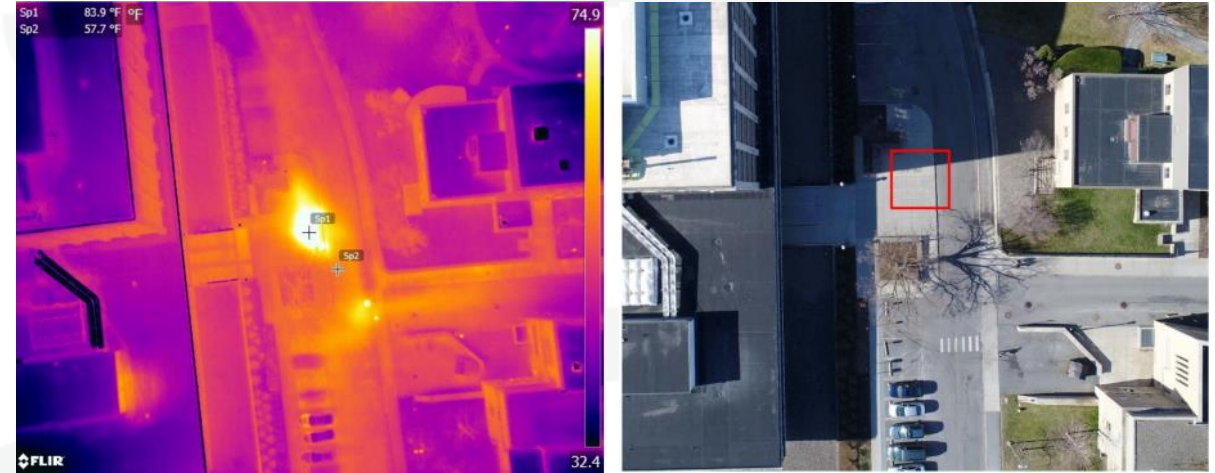


Nov 2019

Case Study 1 – First Inspection



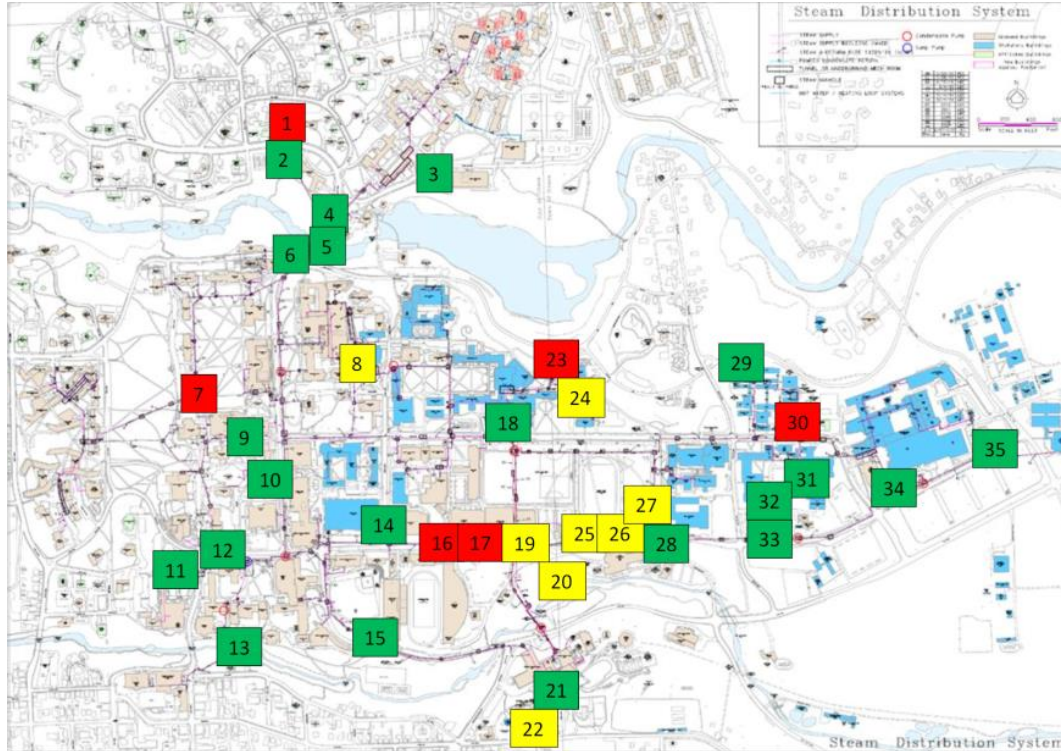
April 2018



39 Areas of Concern:

- 4 Major
- 11 Minor
- 24 Monitor

Case Study 1 – Second Inspection



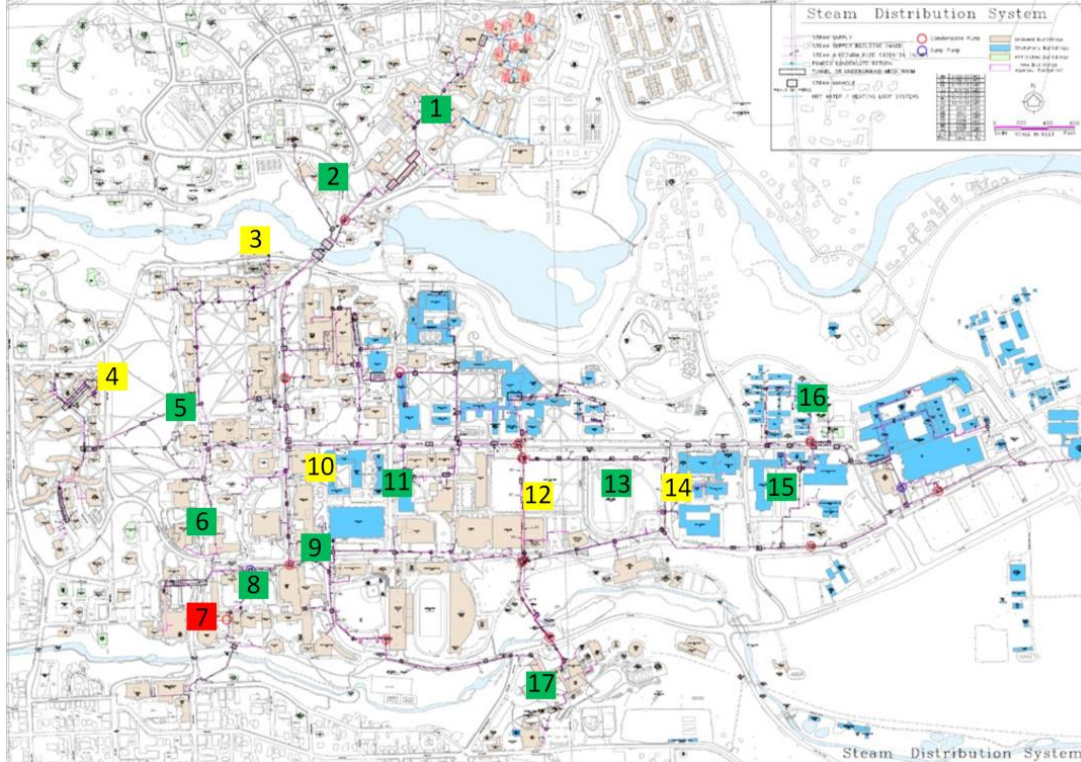
Dec 2018



35 Areas of Concern:

- 6 Major
- 8 Minor
- 21 Monitor

Case Study 1 – Third Inspection



Dec 2019



17 Areas of Concern:

- 1 Major
- 5 Minor
- 11 Monitor

Case Study 1 – Summary

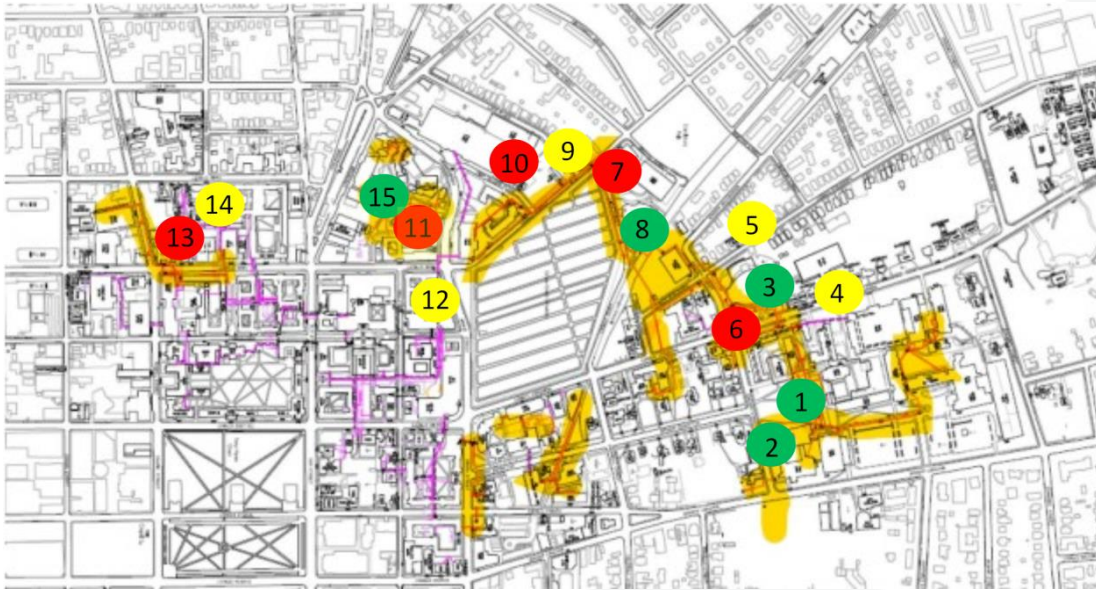
- Established annual inspection program
 - Previously done every 3 years
- Data used to make effective repairs & improvements
 - Reduced the number of areas of concern over 3 years
- Early detection of major issues
 - Cost savings in reducing energy and condensate losses

A professional drone with a camera and sensor equipment is shown in flight against a cloudy sky. The drone is positioned in the upper half of the frame, with its arms and propellers visible. Below the drone, a coastal landscape is visible, featuring green trees, buildings, and wind turbines in the distance. The text "Case Study 2" is overlaid on the image in a large, bold, black font.

Case Study 2

The Benefits of Recurring Inspections

Case Study 2 – Ivy League School #2

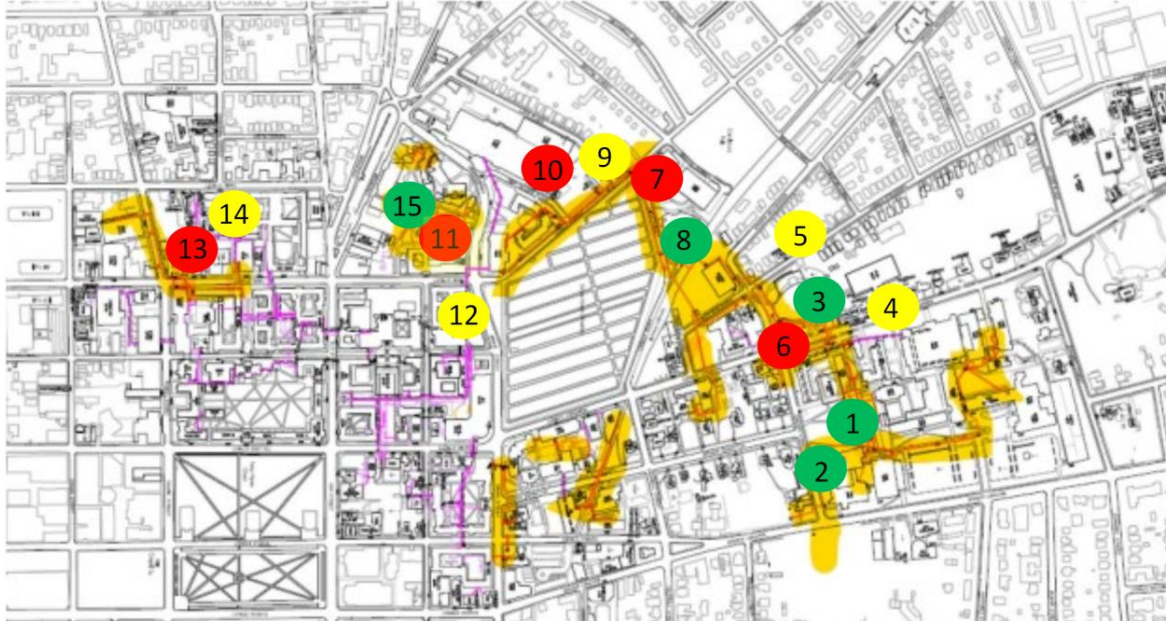


Mar 2019



Dec 2019

Case Study 2 – First Inspection



Mar 2019



15 Areas of Concern:

- 5 Major
- 5 Minor
- 5 Monitor

Case Study 2 – Second Inspection



Dec 2019



19 Areas of Concern:

- 1 Major
- 5 Minor
- 13 Monitor

Case Study 2 – Summary

- Established annual inspection program
 - Previously no formal aerial inspection program
- Data used to make effective repairs & improvements
 - Reduced the number of major areas of concern over 3 years
- Early detection of major issues
 - Cost savings in reducing energy and condensate losses



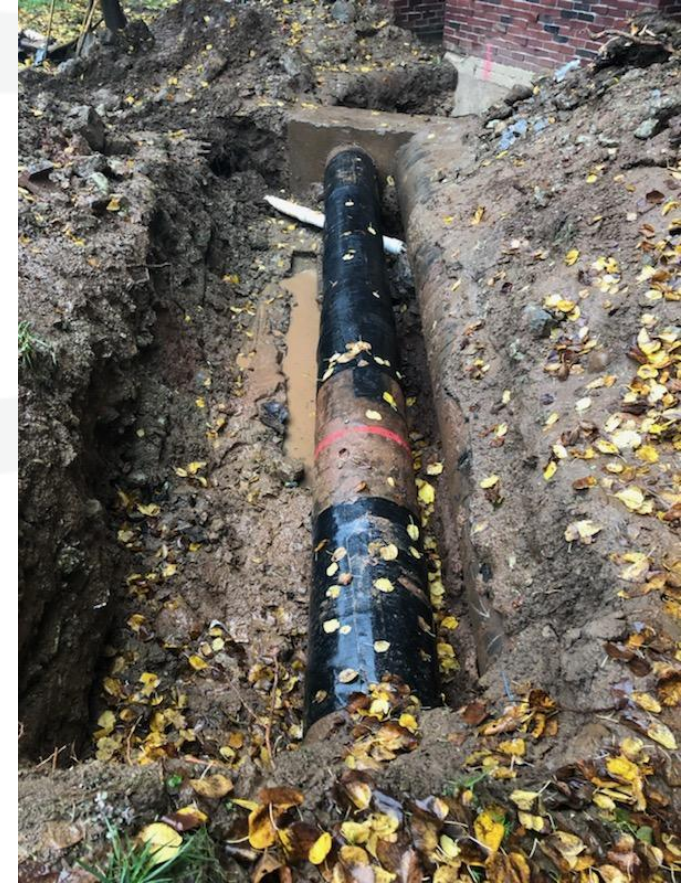
Case Study 3

Pre & Post Repair Inspection Results

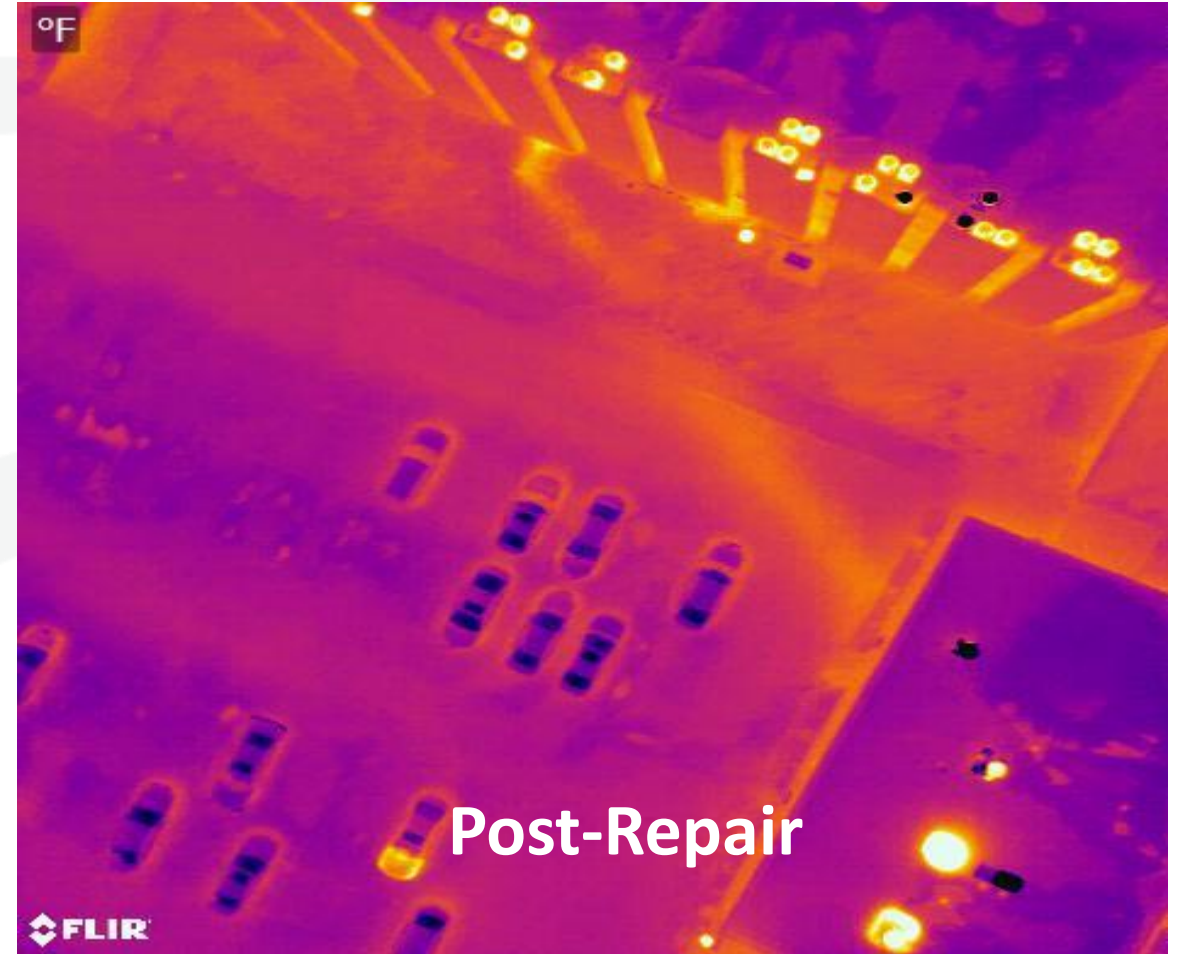
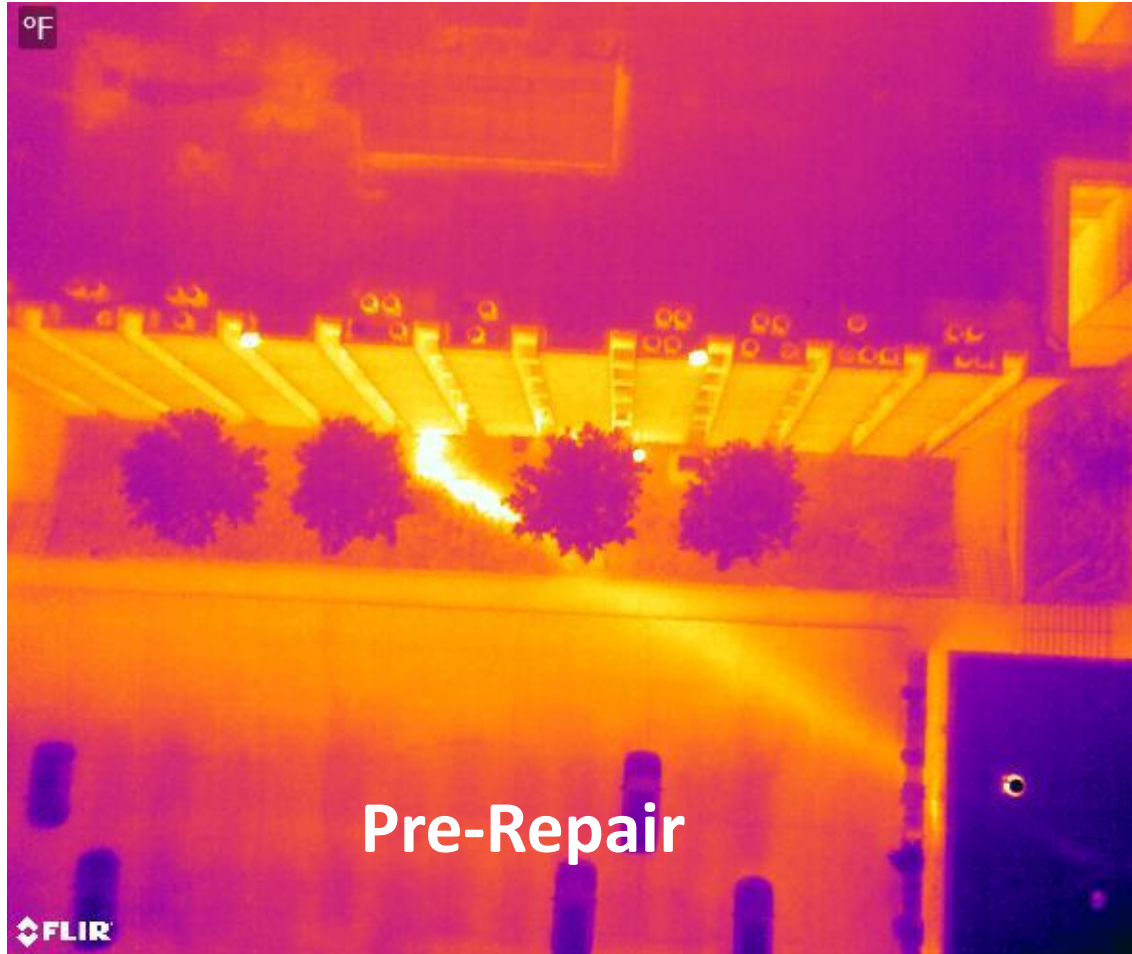
Case Study 3 – Pre-Repair Inspection



Case Study 3 – Repair



Case Study 3 – Post-Repair Inspection



Case Study 3 – Summary

- Pinpointed the location of the leak
- Reduced digging and making expensive holes
- Helped save 30 – 40 % in total project costs

Lessons Learned

- Preventative maintenance and early detection works!
 - Reduce costs and energy losses
 - Proven ROI
- Drone-enabled inspections are more effective and affordable.
 - Enabling annual inspection programs
 - First inspection helps create a baseline and roadmap
- Good data makes a facilities manager's life easier!



Questions?

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