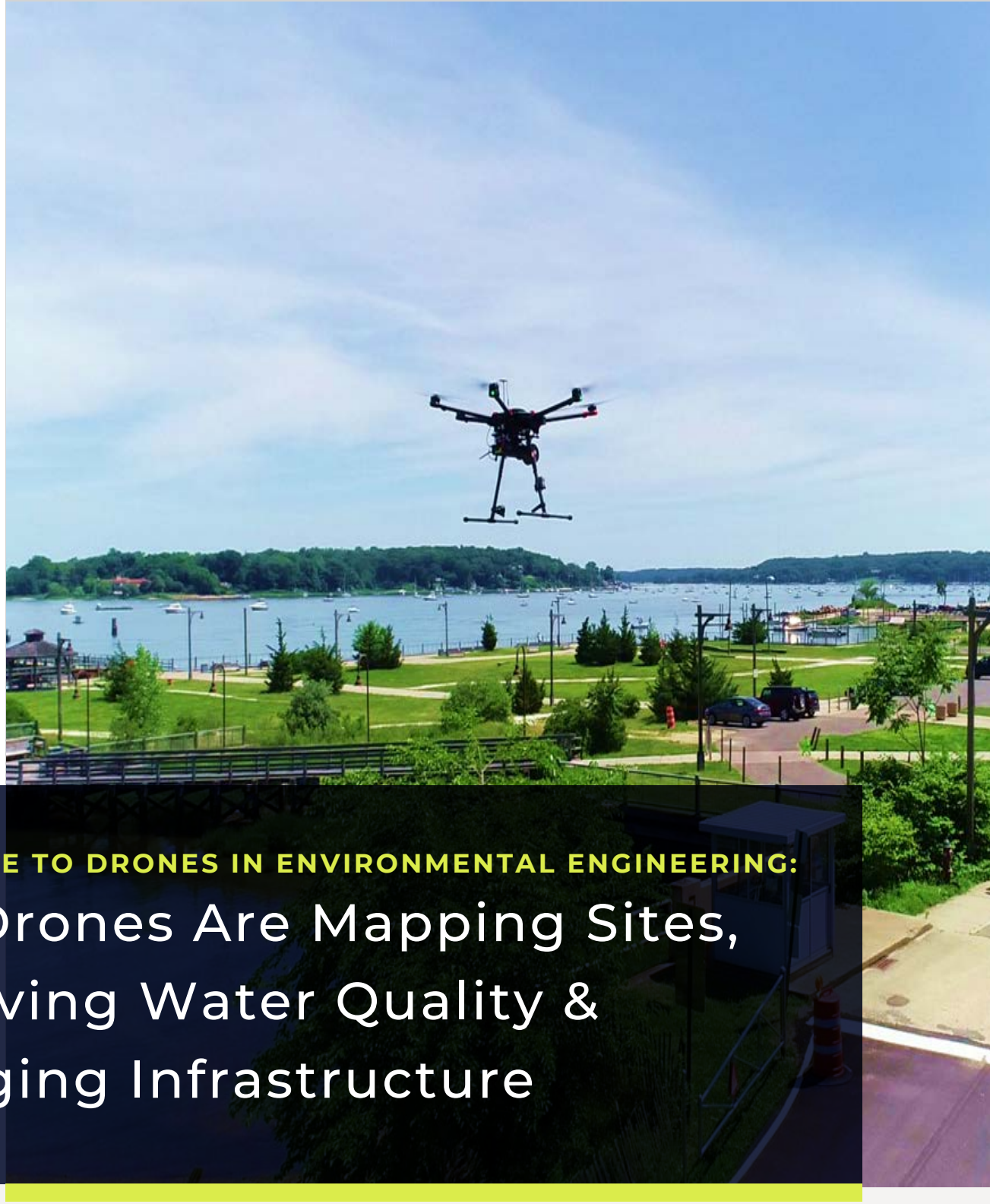


YOUR GUIDE TO DRONES IN ENVIRONMENTAL ENGINEERING:

How Drones Are Mapping Sites, Improving Water Quality & Managing Infrastructure

WALDEN ENVIRONMENTAL ENGINEERING

Introduction

Your Guide to UAVs in Environmental Engineering

Unmanned Aerial Vehicles (UAVs, also known as drones) can be a helpful tool for many companies, government agencies and other organizations. They may be considered cutting-edge technology, but their use has been around for longer than most might realize. Use of small drones in the commercial space formally began almost 10 years ago, when the FAA Modernization and Reform Act of 2012 created a process known as a Section 333 Exemption. Using this exemption, businesses were able to petition the FAA to deploy drones for specific cases. While limited, Section 333 provided many organizations their first legal pathway to pilot drone programs, integrating high resolution cameras with the first generations of mass-produced small drone hardware to use in inspection, mapping, photography, and more. In 2016, the commercial drone industry received a major boost when the FAA created 14 CFR Part 107, which formally codified commercial drone usage and further outlined safety, operating, and licensing criteria. Under Part 107, obtaining a drone pilot's license became considerably easier, and with it, industry adoption skyrocketed. As of 2018, there were more than one million drones registered with the FAA, and over 100,000 people in the US have received their Part 107 remote pilot license to engage in commercial drone work.

CHAPTER ONE:

Mapping Outfalls, Coastlines, Streams, Rivers and Facilities

Why have drones increased in demand and usage in such a short timespan? The reasons are many, but in this guide, we'll focus on a specific use case: How Walden Environmental Engineering and Harkin Aerial have developed ways to use drones to improve water quality, map water infrastructure, and detect/locate issues in drinking water and stormwater utility infrastructure.

Why use a drone in the first place?

There are several key reasons why drones are very effective for analyzing stormwater issues. First, they are able to cover a large area quickly, but in great detail - a single drone can easily map a 50 acre space in well under an hour, including setup and breakdown. Doing the same on foot could easily take days depending on terrain and environment, while manned aircraft are typically too costly and the operation too complex for areas under a few hundred acres.

Satellite imagery, while often free, generally provides a resolution of 1-2 feet per pixel. By comparison, drone imagery can achieve < 1 inch per pixel - up to 30X higher resolution. While satellite imagery is ideal for analyzing large areas of land (over 500 acres), most sites fall into the category where drones win out - not just on resolution, but in acquisition time. On-request satellite imagery is generally provided on a yearly or quarterly basis and the premium to obtain more recent data is extremely high. A drone can easily be deployed on a daily or weekly basis with little increase in costs.

Additionally, costs are saved compared to the labor required to do the same work on the ground. Drones are able to carry a large variety of payloads, from thermal cameras, to high resolution photography cameras, to LIDAR, and more. Drone payloads are often very versatile, offering multiple cameras in one unit, or the ability to quickly swap out payloads in the field to use on separate flights to capture the required data.

With water management specifically, aerial thermography, aerial photography, and aerial photogrammetry are especially well-suited to closely inspecting infrastructure, revealing unseen water temperature changes, obtaining 3D terrain data to use for hydrology, and GIS mapping of assets and features. This guide provides specific examples of how Walden and Harken are using drones to manage and improve water infrastructure.

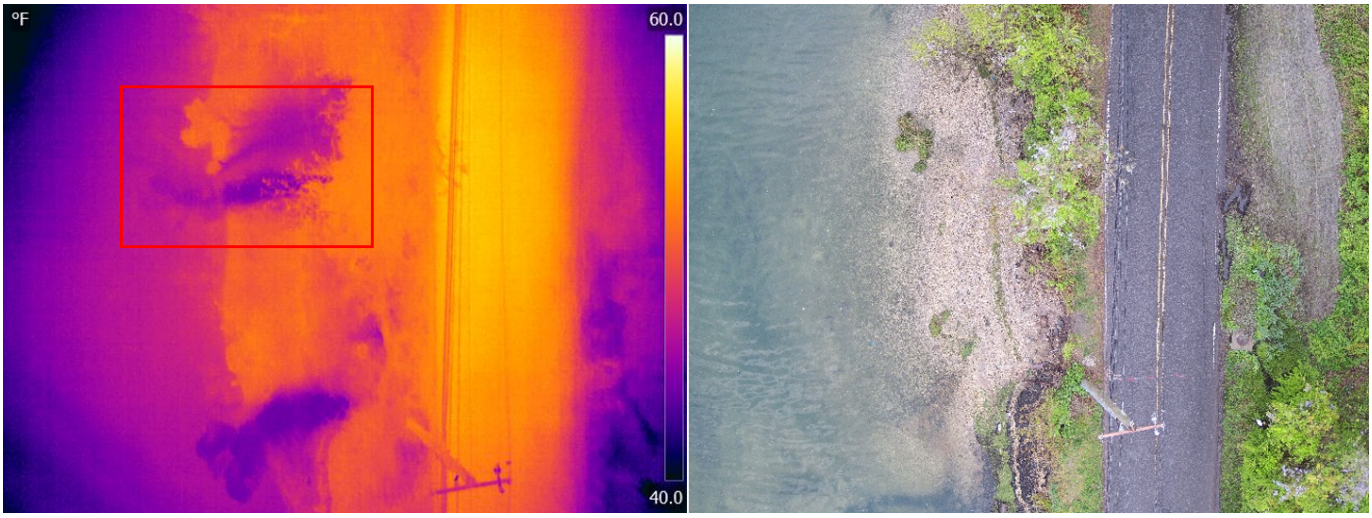
CHAPTER TWO:

Using Aerial Thermography to Spot Water Quality Issues, Leaks, and Other Discrepancies

Recent developments in drone thermal imaging have proven to be especially effective at identifying water quality issues. Walden and Harkin have undertaken multiple case studies which show, under proper conditions, that many illicit discharges (sources of potential pollution) produce a measurable change in temperature that can be seen with a thermal drone. By flying in ideal conditions (usually nighttime or early morning), drones can cover large areas of land. By looking at hotspots that "light up" in a thermal image and comparing them with aerial images from visible light cameras, discharges can be pinpointed and logged. Since anomalies typically have the highest temperature difference at the point source of the discharge, a drone operator who is well versed in thermal imaging can "hunt down" issues - by methodically guiding the drone to the warmest apparent locations in a given scene. Just like drone mapping, all data is georeferenced. As the drone snaps a photo of a thermal anomaly, the GPS location is tagged so that the site can be investigated on foot as a follow-up action. This method is extremely useful for locations where water quality issues are known, but illicit discharge sources are difficult to pinpoint due to rough terrain, or an area too large to easily cover on foot.

In some conditions, it is possible to identify leaks in drinking water mains using drone thermal imaging, if the leak comes to the surface and creates a measurable temperature difference. It is especially useful to detect issues in areas or features where the main is not deeply buried, such as curb valve boxes. A leaking curb valve will change the temperature of the surrounding area, and this can be picked up easily on thermal. Shallow buried sanitary piping can also generate a thermal signature strong enough to show up on the surface pavement. If the signature is "clean," i.e. it shows the straight pipe run and nothing else, it is a good indicator that there are no issues. If the thermal signature shows a more organic shape around the pipe, this is a good indicator that there may be a leak or similar issue requiring follow up action or repair.

Lastly, unexpected stormwater patterns can be tracked and traced from thermal photos after a rainfall event. In the imagery on the next page, traces of both expected and unexpected runoff can be seen from rainfall that had occurred overnight. Long after the visible traces are gone, runoff leaves behind "thermal fingerprints" that show both the runoff pattern and point source. In this scenario, it was determined that the roadway had insufficient drainage.



In this side-by-side comparison of thermal and visible photography, runoff from the night prior was not visible to the naked eye. However, a "thermal fingerprint" is left behind. In the thermal photo, multiple plumes from discharge can be seen. The plumes in the lower part of the photo were determined to be normal stormwater drainage. The plumes in the upper part, boxed in red, were determined to be from runoff due to poor drainage.

Image of a water main curb valve leak taken at an intersection in the early morning (before sunrise). The bright area shown in thermal is considerably larger than the visible leak during the day, making for easy detection.

CHAPTER THREE:

Close Inspection of Assets Such as Elevated Water Tanks, Reservoirs, and Facilities

Drones have an exceptional ability to get into hard to reach and tight locations easily. Whether it is the rooftop on a water treatment plant or the envelope of an elevated water tank, drones combined with high powered zoom lenses are able to quickly inspect issues close-up. In the photo below, a drone was able to take off, circle the water tower, and take a photo of the area of concern in under 20 minutes. Compare that against the time it takes to have an inspector set up proper rigging and climb the side of a tower, which can take hours depending on the size of the structure. Additionally, by using drones instead of climbers, the liability associated with the operation is considerably lower. It is an unfortunate but relevant statistic that falls from height continue to be the largest single cause of on-site worker fatalities according to OSHA statistics. By using a drone for any inspections that do not require a "hands-on" component, this category of risk is eliminated entirely.

Using zoom lenses on a drone, extreme close-up photos of water tanks can be taken to inspect the exterior of the tank, down to the paint job. Details as small as 1/2" can be picked up by flying close and zooming in. In this example, the photo on the left was taken to ensure that installed patching tape was still in place as the tank was undergoing repairs. By removing the need for a rigger/climber, the inspection is considerably quicker and safer.

ALL FLYING, NO CONTACT

With recent restrictions due to COVID-19, drones are also an excellent way to investigate an entire site in a contact-free manner. All setup and piloting involves surfaces that need only be touched by a single person, and a typical drone flight crew can carry out a site survey without any physical contact. Measurements are passive and require no contact between the drone and the subject of analysis. The drone itself is cleaned after each flight as part of its maintenance schedule, and all controls are wiped down between flights.

EXPERIENCE MATTERS, COVERAGE MATTERS

It is important to understand that drones and associated services vary considerably in size, cost, and complexity. Firms that offer drone services also vary in their specific skills and areas of expertise, so when hiring any team, be sure to ask about their previous experience in your type of project. A professional firm will send over resumes, qualifications, previous projects, and examples of similar work to demonstrate their level of familiarity and give you confidence that they are able to complete the work. Lastly, a great drone operator may be able to fly the aircraft, but you should be clear about who is analyzing and collecting the data, if required. For example, for the thermal work discussed, the project should be completed by at least an ITC Level 1 Thermographer, who is qualified to properly analyze thermal images. As mentioned, payloads vary significantly and experience with the drone does not always equate to experience with the payload or data collection workflow.

Additionally, the firm should have sufficient insurance liability policies in force while the drone is operated on your site. You should ask any firm you hire to provide proof of a specific unmanned aviation liability policy in addition your organization's standard insurance requirements: general and professional policies liability do not typically extend to the use of drones.

WAIVERS, OTHER PAYLOADS, AND MORE

As you continue to take advantage of drone data, you may encounter scenarios where additional operational waivers are required from the FAA. For example, night flying is prohibited by the FAA for commercial uses by default, but drone-savvy firms, including Walden and Harkin, have obtained a 107.29 Daylight Waiver from the FAA, allowing operation at night anywhere across the continental US. This is vital to thermal imaging, where sunlight adversely affects results. In the future, regulatory guidance is expected to enable flying Beyond Visual Line of Sight (BVLOS), which will allow drones to be deployed on long-range missions such as long water main runs, pipelines, or electrical transmission/distribution lines.

Additionally, LIDAR is becoming a more viable option for obtaining elevation data in heavily forested zones, due to decreasing hardware costs. Using a properly trained LIDAR technician and drone pilot, an area that may be impossible to measure via traditional surveying can now be easily scanned from the air. Unlike photogrammetry mapping, LIDAR is an active sensor that can operate even in low-light conditions. This powerful technology has been used even to uncover previously lost ancient cities. Other technologies are quickly becoming readily available as well, such as methane detection, and aerial Ground Penetrating Radar. Walden and Harkin are continually testing new payloads and work-flows to offer new modes of data collection and increased efficiency on site.

Conclusion

Drones are still a nascent technology, and the market is still maturing.

Hardware quickly becomes obsolete and the laws governing drone use are continually changing. By utilizing firms that have experience in navigating the complex regulatory and technical challenges of the drone industry, a site manager can reap the benefits of this technology while avoiding the significant start-up costs associated with acquiring and operating drones.

WANT TO USE DRONES TO IMPROVE YOUR SITUATION? **GET IN TOUCH TODAY.**