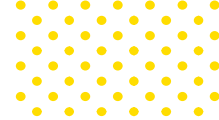# DRONES FOR CONSTRUCTION

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THE BEGINNER'S GUIDE

SO YOU WANT TO USE A DRONE ON YOUR SITE?

Advances in technology have made the drone an affordable tool for worksites. While they may seem like fancy pieces of equipment, drones have become no more commonplace than a GPS rover, but just as vital in recent years.

Unlike traditional surveying equipment, however, you don't need tons of special training and a degree to use it.

Used correctly, drones enable faster, more affordable and higher-resolution surveying, without sacrificing on accuracy. A successful drone program gets your business accurate, up-to-date information on your site's progress and productivity, so you can produce high-quality work, minimize operational risks, and streamline costs.

Collecting and processing your data is only half the story—the truth is, collection is only the beginning to a much greater, more powerful analysis workflow. You get these analytics from web-based platforms that can translate your raw data into real-world measurements (*think progress, cut-fill, distance, and elevation*).

Take our own Propeller Platform: it takes your data and transforms it into an interactive, 3D survey of your site. Fully navigable. Fully measurable. It's run in your browser, so you can forget about the clunky and complex desktop software of the past.

KEY COMPONENTS OF A SUCCESSFUL DRONE PROGRAM

To get started, you'll need the right hardware, the right software, and the right licenses (if applicable). We'll go through these one by one further down.

It's not unusual for organizations to invest a lot of money in research and experimental drone programs. The tendency is to put the emphasis on hardware. This often overcomplicates things, and leads to building custom drones or signing up for long-term drone leases.

But after the test phase has finished, some companies' inability to scale becomes apparent. They can't effectively train their people to reproduce the test-phase success on other sites.

For a successful drone program, remember to keep it simple, scalable, and economically efficient. Basically, choose your program with overall ROI at top of mind.

CHECK YOUR LOCAL AVIATION REGULATIONS
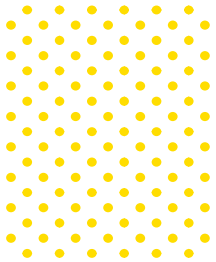
As you might imagine, drones are regulated differently depending on where you are located. You must abide by the flight laws in your location or risk fines and other repercussions. Do your research. What kind of airspace is your site located in? Is it restricted in some way? Do you need a special license?

We'll go over some locations here, but if your area isn't on the list, there are a few ways you can check on regulations. Some websites catalogue regulations by country, like the Global Drone Regulations Database. There are also apps, like the B4YouFly app for the US that gives you information based on your location.

Usually, all unmanned aerial vehicles (UAVs) are overseen by the country's aviation regulator, so check out your country's website if you're not finding information elsewhere. Here are a few examples.

USA

Drones are regulated by the FAA. You need a license to fly. Flying drones 55lbs and under for commercial purposes (meaning during daylight hours, within line of sight, under 400ft and under 100mph) is allowed after passing a UAV-specific aeronautical exam (FAA Part 107).

CANADA

You need a special flight operations certificate (SFOC) to fly commercially and if your drone is over 25kg. If your drone is under 25kg, you might qualify for official exemptions, but check out the civil aviation site to learn more.

AUSTRALIA

Thanks to recent changes in legislation, anyone can fly a drone under 4.5lbs (2kg) commercially without a licence, but you'll still need to register for an ARN before flying for commercial purposes. You can register here.

> **In general, keep in mind that some areas have tighter restrictions. If you're near airports, helipads, etc., you may need to get special authorization—or a licensed operator—to fly there or fly below a certain altitude.**
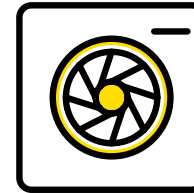
CHOOSE THE OPTIMAL HARDWARE FOR YOUR WORKSITE

There are many drones to choose from, but to pick the one that's right for your needs you should consider a few factors.
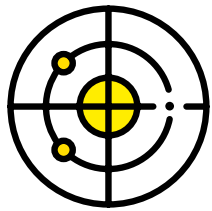
How big is your survey area?

What's your budget?

What's the best camera for your surveying purposes?

DRONE TYPE

BUDGET   Cost, of course, plays a big factor in this choice.

If your area is less than 200 hectares (about 500 acres), it can be done comfortably with a multicopter. If it's larger, you may want to consider either more than one multicopter or a fixed-wing UAV.

(But remember, if you are operating in a restricted area or a busy place near moving equipment, you may not be able to use fixed-wing aircraft due to their weight and the need for a vacant "runway" strip of land.)

MULTICOPTER

Typically, multicopters (especially those made by DJI) are mass produced and can be purchased easily and cheaply.

FIXED-WING

Fixed-wing UAVs are still made in limited quantities, meaning units are significantly more expensive— sometimes up to a hundred times more pricey.

AVAILABILITY AND EASE OF MAINTENANCE

Along with sticker price, keep in mind the added cost of maintenance and the availability of parts and replacements.

It's best to stick with simple options that are available at local stores. As with any other worksite tool, it's best to avoid providers who cannot guarantee quick repairs or replacements. You don't want to postpone your surveys because you're waiting on a replacement drone or part.

A great example of the value of availability in action comes from what would usually be a highly unfortunate event: crashing your drone. Recently, one of our partners was flying a site and crashed his drone, due to a combination of high winds and, probably, mechanical failure. But, because he was flying a DJI drone—a widely stocked craft—he was able to purchase a replacement at a local store and start flying again two hours later.

A RTK/PPK-ENABLED CRAFT

With the release of DJI's Phantom 4 RTK, one of the first affordable RTK crafts to hit the market, getting uniform, survey-grade accuracy across your site is not only possible, but the new standard.

Real-time kinematic (RTK) processing on a drone records GPS information and geotags images as they're captured. An active base station on the ground sends raw GPS data to the drone, which it combines with its own data to accurately determine position.

During flight, the RTK drone must stay connected to the base station while gathering data. Signal loss can occasionally occur. If this happens, data can be lost while the signal finds a lock again.

You've probably heard of another kind of drone surveying:PPK. The difference between PPK and RTK is where things get tricky because we're not strictly comparing apples to apples. PPK isn't hardware; it's a different processing workflow using an RTK drone.

PPK stands for "post-processing kinematic." With PPK, the drone geotags X,Y,Z coordinates to each image based on its GPS unit. While this happens, a base records the positional information on the ground, but with much more accurate triangulation.

After the flight, those two sets of GPS data are matched up using the photo timestamp. The drone's initial GPS data is corrected, giving precise geotags for the imagery. Those images are then used to build your site survey.

Propeller's own solution, Propeller PPK, allows you to achieve 1/10ft accuracy site-wide with only one AeroPoint and DJI's Phantom 4 RTK in a PPK workflow.
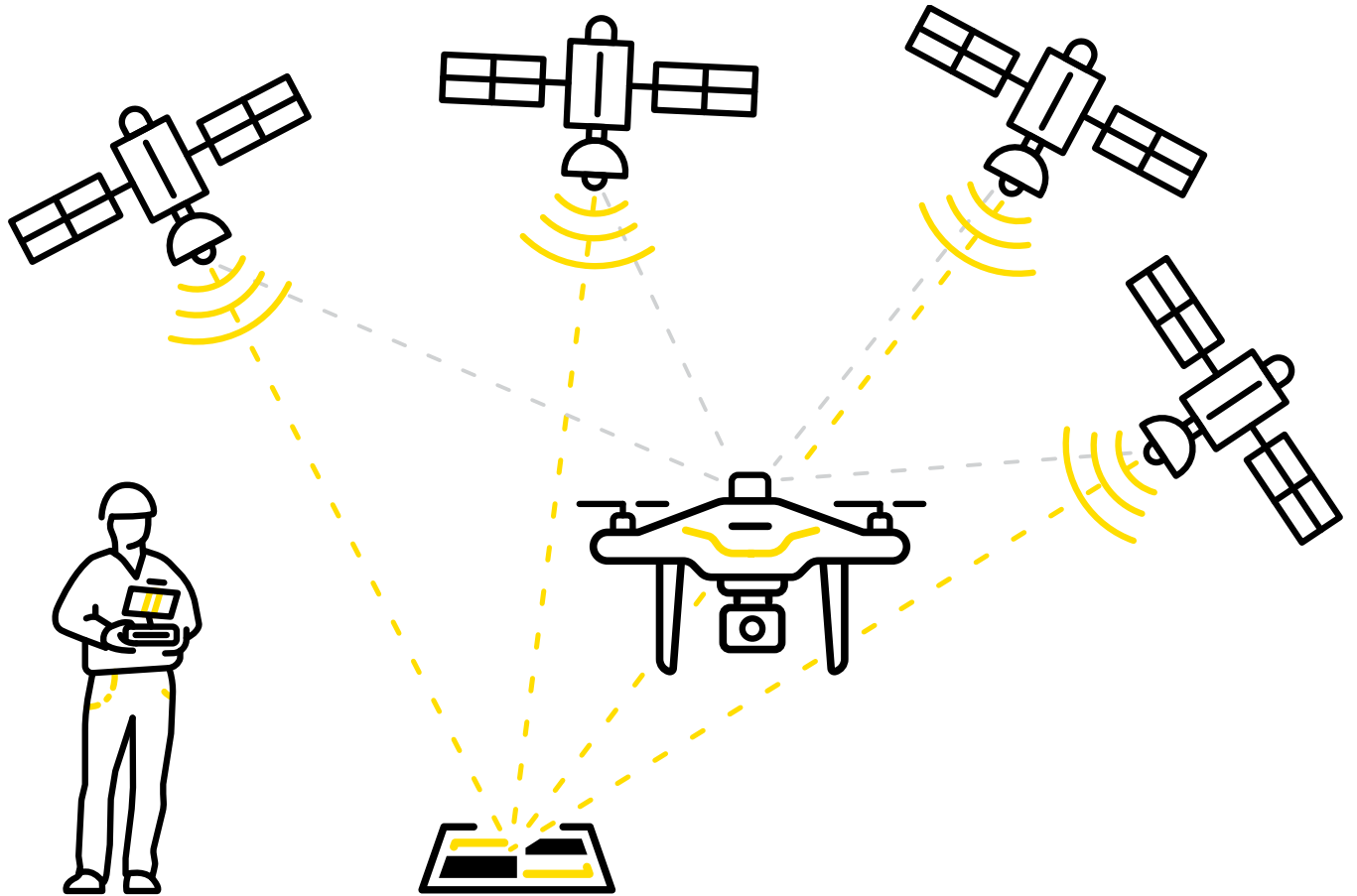
CAMERAS

A good camera for surveying purposes should have a 20MP (or better) sensor. Avoid cameras with interchangeable lenses unless you are certain you'll need that feature (often used for inspections). They overcomplicate the surveying process and often worsen the quality of data with images that can be out of focus.

Keep in mind the camera specifications that affect ground sample distance (GSD) and resolution. The GSD is the real-world size of a pixel in your images. This generally sets a physical limit on the accuracy of your aerial survey. For example, if your GSD is 5cm, the survey produced will only be accurate to 5cm.

GSD is measured in cm/pixel, usually ranging from less than 1cm to 5cm for aerial surveys. Note that the altitude of your flight also affects this number. If you want to fiddle with possible GSDs, this handy calculator can compute them for you.

In general, make sure you have a high-resolution camera, with a larger sensor and a 35mm-equivalent focal length. This lets you get more detail about any point and increases your image contrast in order to help generate better 3D renderings and point clouds.

If you want to go deeper on this topic, check out our article on what makes a good camera for drone surveys and inspections.

PICK THE RIGHT SOFTWARE FOR YOUR NEEDS

As we've seen, there are various options on the hardware side of things, but you can usually rig together some combination to acquire the data you need.

Software, however, is a different matter. Construction jobs are complex, involving many levels of oversight, design, and management. You need to pick the software that's right for your workflows.

There are a couple of software pieces that go into successful drone surveying. Let's start with actually flying your drone.

FLIGHT PLANNING APPS

We can't overstate the importance of steady, consistent flight. The best way to achieve that is with flights controlled automatically by a flight planning app on a mobile device.

There are tons of apps on the market. We recommend DJI's Ground Station Pro. We field-tested it on real missions like 3D aerial surveys, precision mapping, and drone inspection flights. Below are our key takeaways.

Like most apps, it will estimate the flight time and GSD from your survey boundary, front- and side-lap percentage, and flight altitude.

It has additional features that allow you to optimize the image capture configuration for common missions:

- Saving and reusing missions is easy. For fixed sites that need regular monitoring, this takes all the guesswork out of flying after the first successful survey.

- Images can be taken at equal distance or time intervals—a very useful feature for inspections.

- The camera angle can be set in a 0–90 degree range (facing straight down to forward). If you need consistent obliques of terrain, this is very useful.

This app is accessible and features an intuitive user interface, which makes drone mission planning pretty easy, even for beginners.

We found the in-flight performance is great. The drone follows its path precisely, though we think it could be faster.

The recommended options are mostly acceptable if the user is trying to achieve quality maps through a service like Propeller. We recommend adjusting front and side overlap to 75%. Higher overlaps (80–85%) can help in areas where the ground looks more uniform. Also, be sure your aspect ratio is set to the highest resolution available and that it's not cropping out parts of the image.

There are other options you might use already, like Map Pilot from Drones Made Easy, Litchi, DroneDeploy, and Pix4D's planner. All of these do a great job capturing the survey photos you need as well.

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DATA PROCESSING SOLUTIONS

IN-HOUSE PHOTOGRAMMETRY

Now that you've captured the raw data, you need to process it. This means stitching the images together and pinning the images to the ground control positions; then getting powerful machines and data experts to digest all the raw photos, find overlaps and common points in images, and make a 3D reconstruction of the terrain.

We know, that seems intimidating, right? (Luckily, there's an alternative that we cover a few paragraphs down).

Photogrammetry is a resource-intensive process which requires lots of technical knowledge to perform—powerful machines and skilled personnel are necessary. Both of these are expensive and difficult to scale alongside your business.

How much of you and your team's time will be required to process your current and future workload every day? Would that time be better spent doing other work?

Desktop software has been the norm, but that's optimized for processing data from a single site or a single drone. If you're dealing with multiple surveys simultaneously, or multiple sites, it's best to use cloud computing.

Cloud-based applications (a.k.a. software that doesn't just live in your computer) are the most cost-effective way to leverage powerful computing that scales well with your business and requires no installation or maintenance on your end. Having your data device-independent also means easier collaboration and sharing.
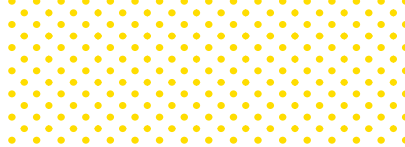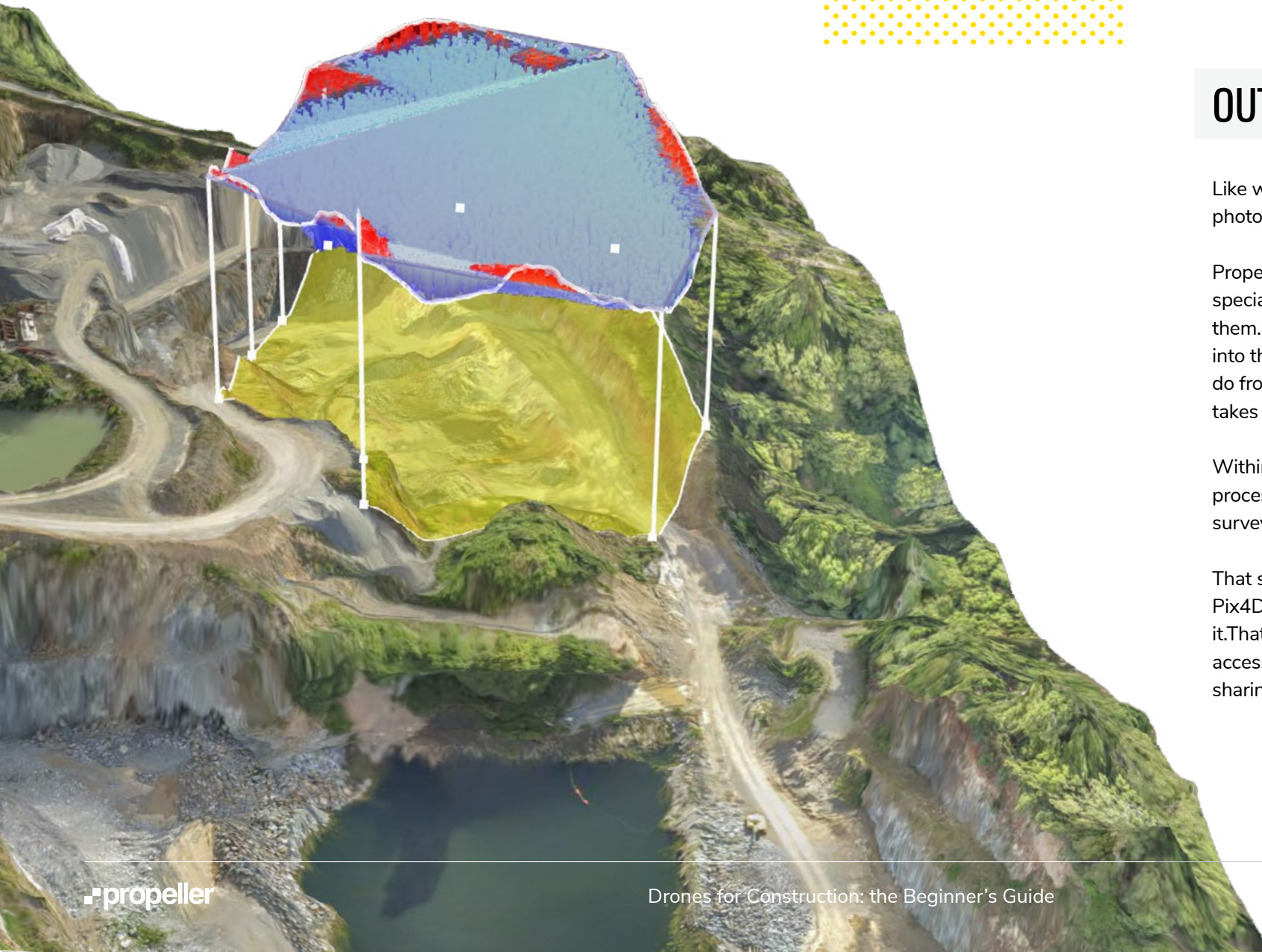
OUTSOURCED DATA PROCESSING

Like we mentioned earlier, having in-house photogrammetrists is not the only option.

Propeller customers skip the expensive computers and specialized resources by letting us process their data for them. It's as easy as dragging and dropping the flight files into the uploader—something anyone on your team can do from anywhere with an internet connection. Our team takes care of it from there.

Within 24 hours, we'll have your data back to you, processed into an interactive 3D model of your latest survey.

That said, if you're already using desktop software, like Pix4D, Propeller can accept the files you generate in it.That way, you can still reap the benefits of convenient access, collaboration, advanced measurements, and sharing.

MANAGE YOUR WORKSITE USING DRONE DATA

Drones cut down surveying times to hours instead of days or months, and they're cheaper than traditional survey equipment. Let's look at some common surveying workflows to see how you can use your drone data to best effect.
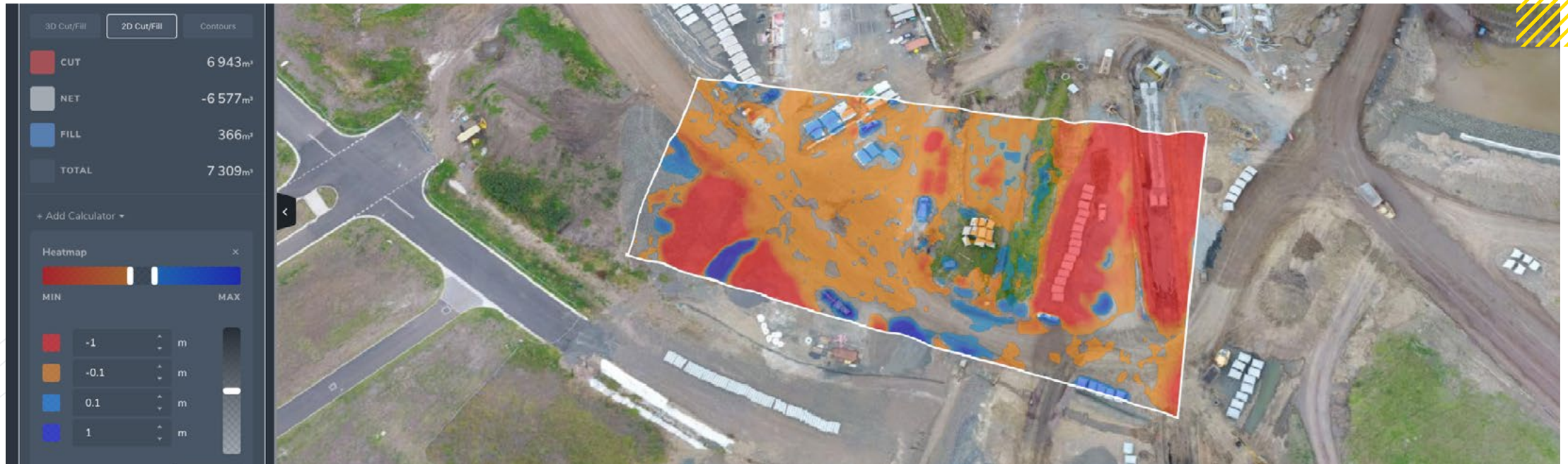
CALCULATE VOLUMES ACCURATELY AND QUICKLY

Volumetrics is the most popular use case for drones on any worksite. For many construction companies that operate their own quarries, drone-captured data is the affordable source of timely and accurate information on volumes.

Instead of relying on outsourced survey teams or walking around each site with a GPS rover, you can now fly a drone and capture an entire site, usually in a couple hours or less. Once the data has been uploaded and processed, you can get accurate cut/fill volumes and other survey analytics necessary for planning and tracking job progress.

COMPARE YOUR SITE AGAINST THE DESIGN

If you're actively moving earth, regular drone surveys allow you to compare current ground levels against the plan and identify anything off-track.

You can do this by overlaying design surfaces or linework on your 3D visualization. With all the information on one screen, it's simple to understand if volumes and elevations are matching design or not. And, since it's a simple visual of the physical space, you can easily communicate your findings to others.
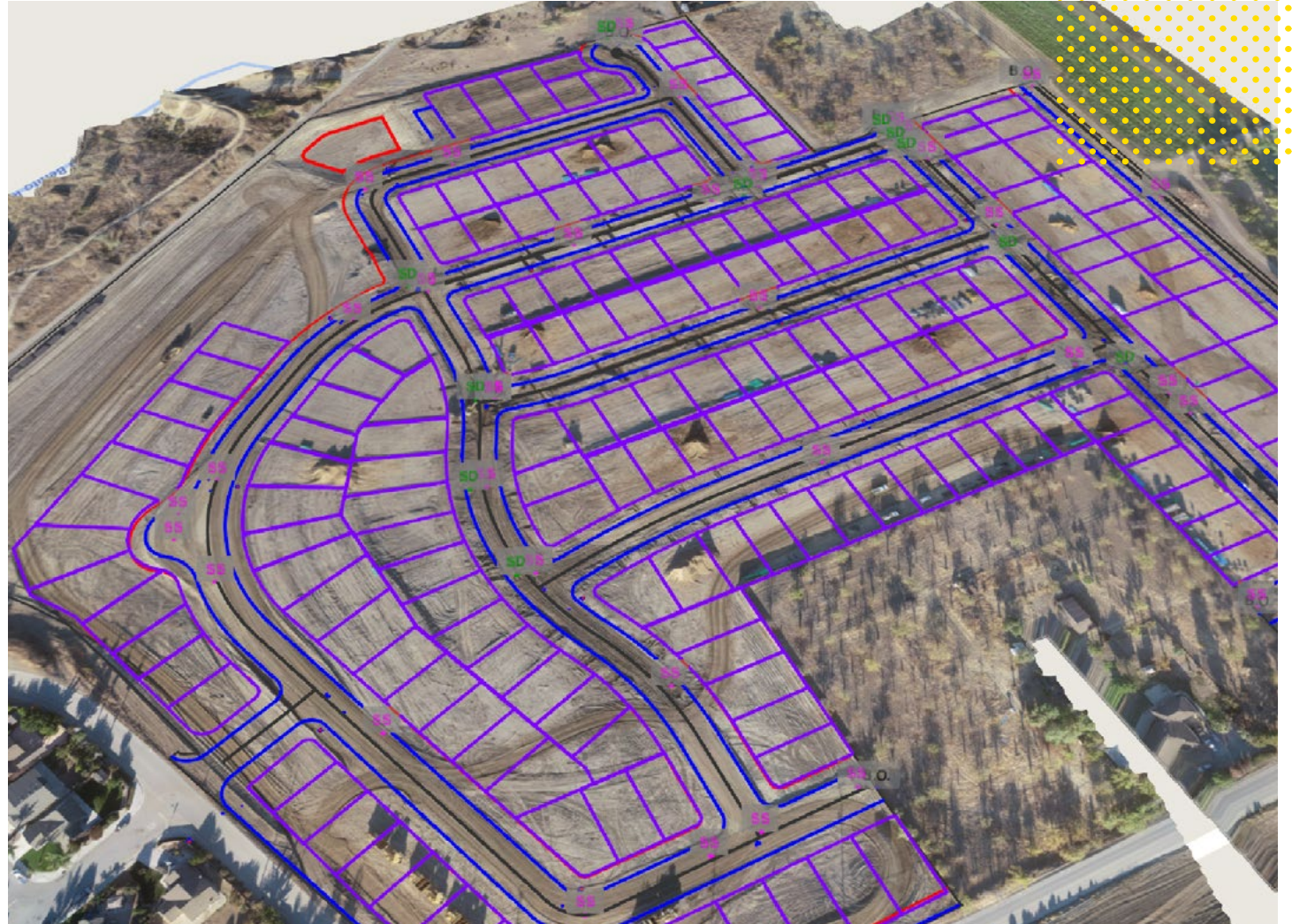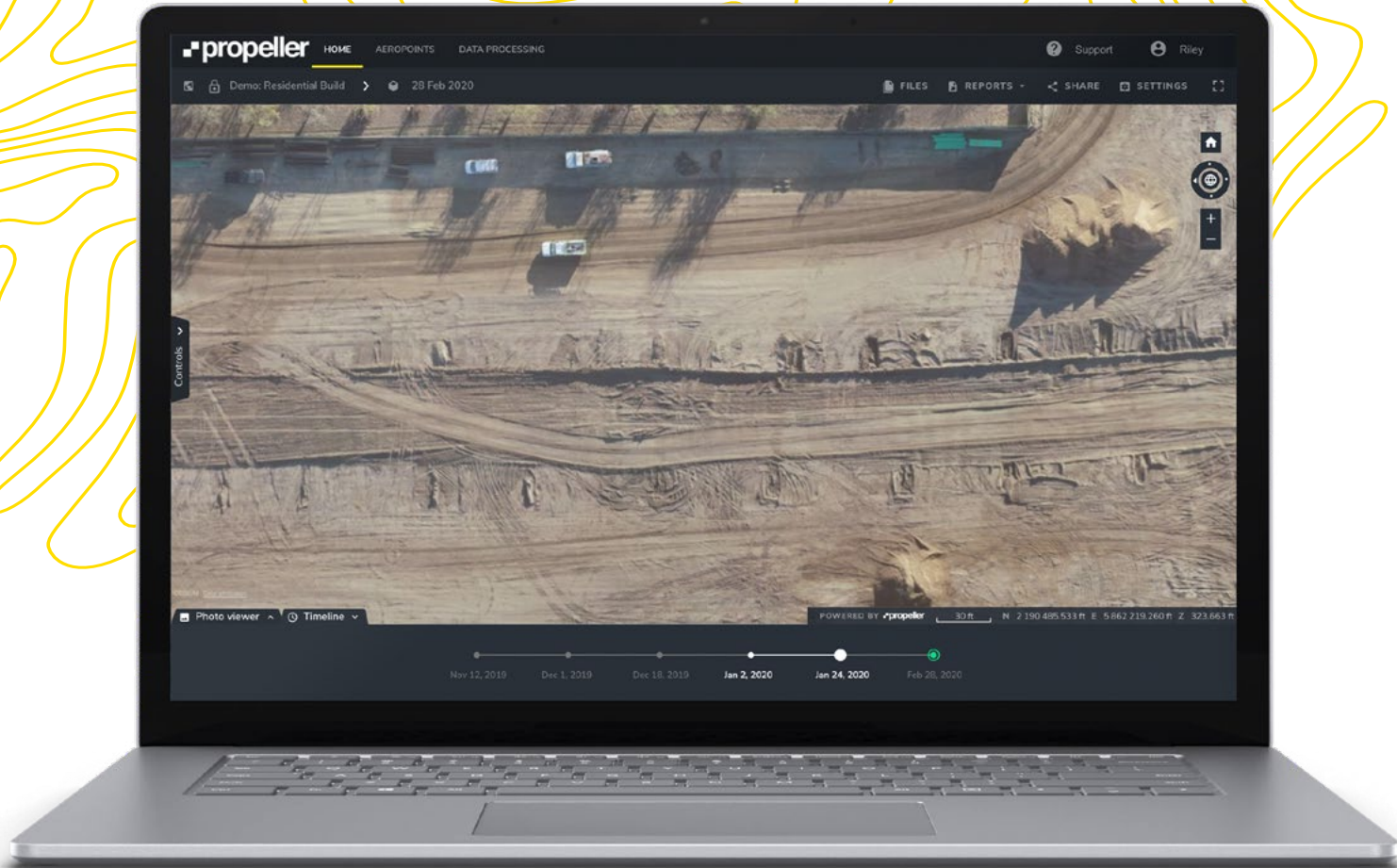
TRACK YOUR PROGRESS AND PRODUCTIVITY

It's an unfortunate fact that most construction projects run over time and over budget. You want an easy way to visualize your site transformation as the project progresses. While it's particularly important to make sure you're on schedule and not running up costs, it's also necessary to inform remote stakeholders on progress and to monitor contractor work.

When you combine frequent, regular drone surveys with something like the Propeller Platform's timeline tool, you can compare between multiple datasets and visually track changes in a way that makes sense for everyone.

INSPECT YOUR ASSETS REMOTELY, FASTER

Depending on your company and the job itself, you might have assets to inspect on your site. Drones can quickly capture high-res photos that can be viewed in platforms like Propeller. There, they can be annotated, downloaded as a report, and shared with contractors or project stakeholders.

Using drones for remote asset inspections not only saves money, but also reduces safety risks for employees and contractors by keeping them away from hard-to-reach or dangerous locations.

RESOLVE DISPUTES MORE EASILY

No one wants to move dirt they don't have to. Drone technology allows you to have more control over a project and define how much you should pay your contractors based on the actual amount of work done.

Drone survey data, timeline features, and reports can all be used as tools to resolve disputes with contractors. Because they provide a paper trail of the physical state of the site at every survey, you can easily show where material moved and when.
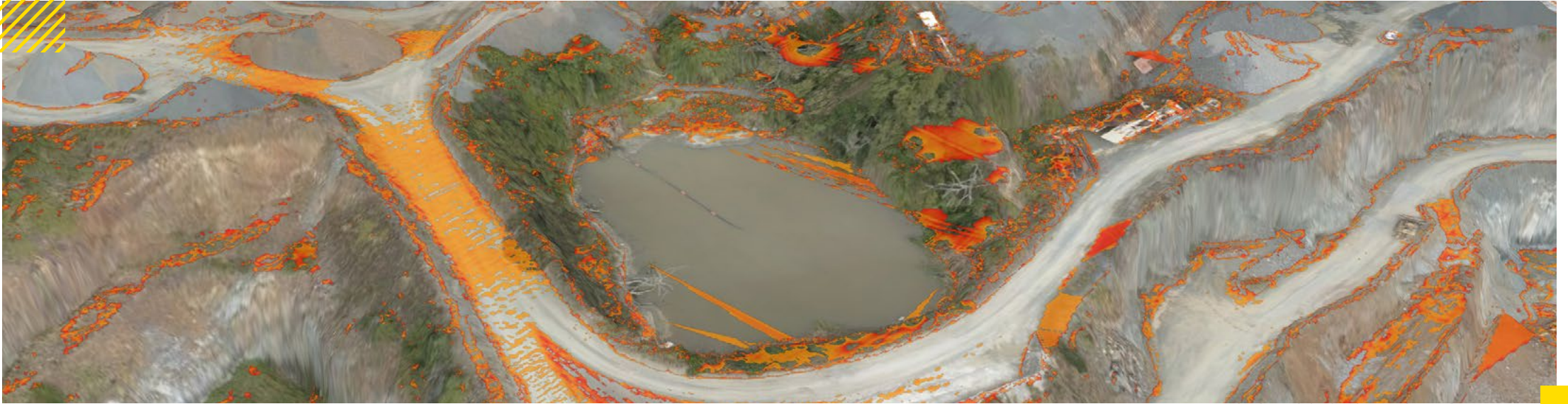
SIMPLIFY REPORTING

Regular drone surveys help deliver up-to-date information to project stakeholders and contractors by providing visual data that they wouldn't have seen from the ground. And processing your data with an online platform reduces the time and expenses associated with on-site visits.

For example, Propeller has PDF and CSV reports that are easy-to-create and share with your team or your boss.

EXPORT DRONE DATA INTO THIRD-PARTY SOFTWARE

Some construction companies often require drone data to be exported into CAD or BIM software for further work.

Processing engines like the Propeller Platform allow the export of high-resolution point clouds, geoTIFFs, and DXF files, which can be used in a wide range of software applications.

DRONES ARE REVOLUTIONIZING THE INDUSTRY

Construction is a multifaceted industry. With so many moving parts, accountability, progress tracking, and accurate data are the keys to success.

But as we've seen here, it's too often that you don't have the tools you need to accomplish your job on time and on budget, not to mention make day-to-day management easier. Drones can drastically improve these issues by solving problems more quickly, with less trouble, and through less costly means.

Using a drone on your site does not require someone with extensive special training. Often, you can learn how to fly it yourself and obtain the required certification, depending on where you are located.

A drone surveying platform like Propeller is cloud- and browser-based, which means you can access it from your device wherever you are.

This also means that your team has the same access, making collaboration easier than ever. And, because drone surveying is quicker than traditional methods, you can have more up-to-date data than ever before, which enables everyone to make better, data-driven decisions confidently.

Now, all of this is great to think about theoretically, but, when it comes down to it, what are companies actually seeing when they start using drones and processing software?

HERE ARE A FEW EXAMPLES OF REAL PEOPLE SOLVING REAL PROBLEMS ON THEIR SITES:

"

I can go out and fly a site in two to three hours and then just upload everything to Propeller and come in the next day, and it's done. If I have a question or something, I can just email someone and usually within a few hours—or within 24 hours—I have a solution back. It simplified everything that we do. Before, we weren't doing a lot of monitoring on every site, so now we try to fly every site at least once a month.

Jim Croan | JRC Construction

"

Being able to produce and share centimeter-accurate mapping that's rivaling GPS topo survey is pretty unique and awesome. Propeller's software facilitates more fluid communication as now we're all working on the same page with the same reference information.

Ray Penner | Scheffer Andrew Ltd

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Drones for Construction:
the Beginner's Guide

WANT TO LEARN MORE ABOUT DRONE DATA PROCESSING AND ANALYTICS?

Contact us today

INTERESTED IN BECOMING A CERTIFIED DRONE PILOT?

Download our Part 107 Study Guide