A Drone's eye view

LANDAIR SURVEYS OFFERS SOME ADVISORY PRINCIPLES FOR DRONE (RPA) INSPECTIONS

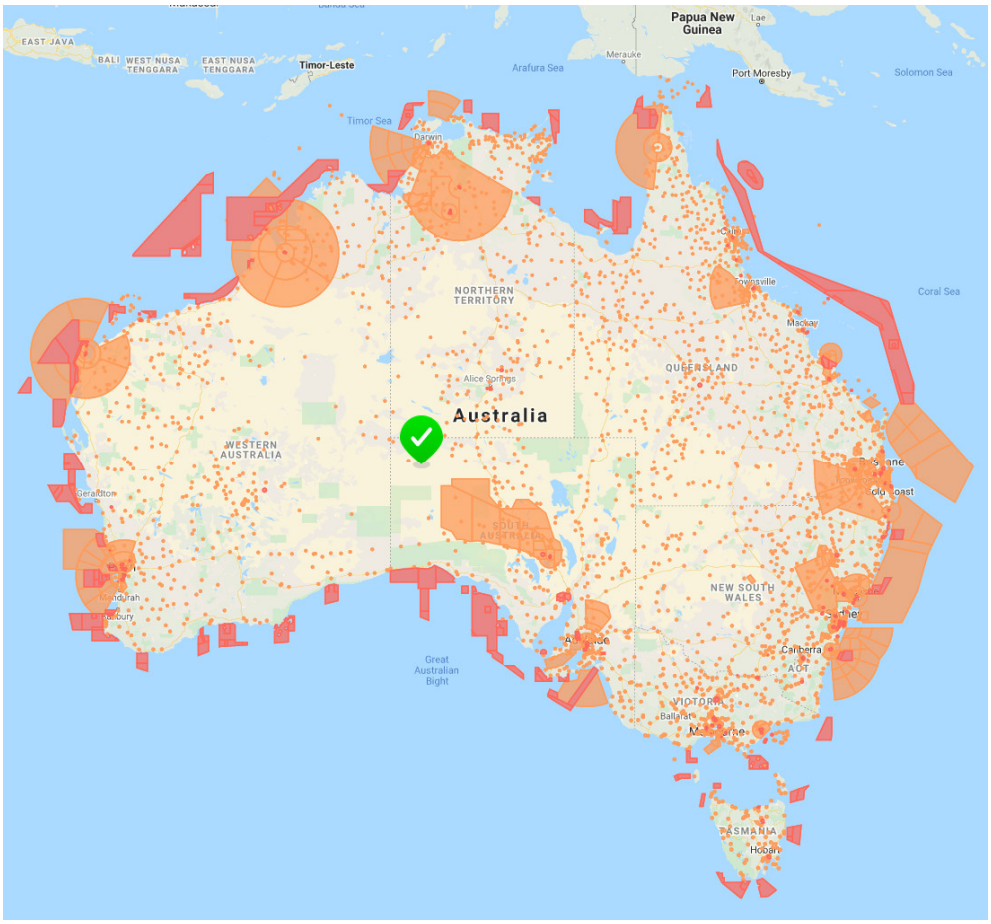
Increasingly, drone surveys are becoming a useful mechanism for remote inspections, property management and due diligence. A great number of industries have sought to utilize the benefits of drones, but as is the case with most disruptive technologies, the lag between technology uptake and best-practice guidelines can be significant. So, what makes a good drone inspection survey?

The Rules first: In the case of drones, the rules are not meant to be broken. The Civil Aviation Safety Authority (CASA) is Australia's national authority for aviation regulation. They set the framework for all piloted and remotely piloted aerial applications through the issue of licenses, approvals and ongoing enforcement of aviation laws. CASA has created drone advisory notes and regulations available on their drone webpage. Essentially, every drone survey undertaken for commercial benefit must meet the following general criteria:

- The drone pilot must hold an Aviation Reference Number (ARN) supplied by CASA regardless of commercial drone weight class or license requirement.
- Drones with a take-off weight greater than 2kg (most drones used for commercial purposes) require the drone operator to possess a Remote Pilot License (RePL) and fly under a RPA Operator's Certificate (ReOC) both granted by CASA. For sub-2kg commercial drones the license requirement is waived but CASA will need to be notified of the flight location at least five days before the mission.
- Maintain visual line of sight of the drone at all times
- Do not fly higher than 120m / 400 ft
- Do not fly within 5.5km of a controlled aerodrome
- Do not fly in the approach and departure paths of an aerodrome
- Do not fly within a prohibited area
- Do not fly autonomously without any way to take direct control of the aircraft
- Do not fly at night
- Do not fly over populous areas (any area where the general public can enter/exit at will)
- Do not fly closer than 30m from people not associated with the flight

Anything beyond these general operating conditions requires specific CASA approval.

The Site: You have a location in mind and are weighing up whether the drone inspection option is the better one. The very first step is to ascertain whether a drone can be legally flown at the location to the satisfaction of the CASA general operating procedures. A useful tool for initial reconnaissance is the OpenSky website. Type in the site address and it will show any relevant restriction and danger zones. Select the icon and it will list the specific restrictions and dangers.



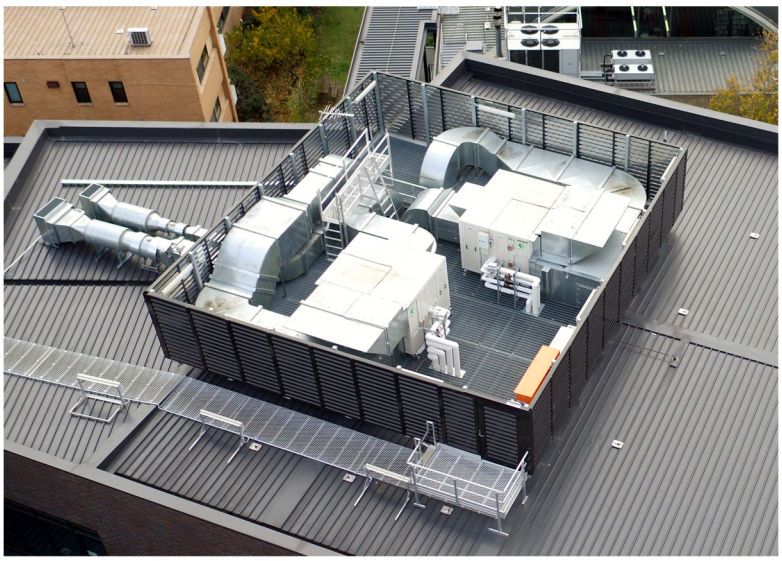
OpenSky web portal image

Once the site restrictions/dangers are known the decision can be made whether to utilize drone technology. It is useful to know that restricted doesn't necessarily mean totally restricted. The Chief Pilot listed in a RPA Operator's Certificate can apply to CASA for an exemption to the restriction. However, CASA require a non-refundable administration fee to process the application and if the response is negative, the significant application amount is lost for no commercial benefit. Restrictions within airport approach and departure paths will almost always return a negative response.

The Stakeholders: So, the drone option is the best one moving forward. It's now important to identify those with an interest in the operation. Apart from the client, the usual stakeholders consist of the following:

- CASA – governs the use of commercial drone operations through granting licenses and approvals. For sub-2kg unlicensed drone operations they require pre-notification.
- Public – the general public need to be restricted from access to the survey location (including take off and landing points) during the survey.
- Surrounding Property Owners – If the drone survey involves flying over surrounding private/commercial property not related to the specific site, permissions will need to be sought from the relevant owners to fly over their property if posing a risk to personal safety or property damage.
- Local Government Authorities – Most capital city CBD councils will require additional application for permits to fly drones over public spaces. Often part of the application process is to ensure public-access open spaces, footpaths, and roads are cordoned off during the survey at the approved times. The costs associated with this are bourne by the client.
- Service Authorities – For example, state government roads departments or electricity service providers will require specific approvals to undertake drone surveys where the risk of significant personal or property damage exists.
- The Contractor undertaking the survey – Do they have a license and operate under a company Operator's Certificate? Do they have in place relevant drone-specific OH&S procedures? Do they have the required liability and indemnity insurances in place?

A professional drone operator will be able to advise on what additional requirements exist for a particular site and also advise on stakeholder engagement.



The Deliverables: Before any drone survey is undertaken it's important to decide what the final data set will look like. Different data deliverables require different survey procedures and it's often difficult to meet specific requirements after the fact. For example, if drone video was the initial deliverable, but post-survey it was decided high resolution images were better suited, the choice would be to export frames from the video with a loss of resolution or fly again. Different deliverables also require different processing times which will affect job pricing.

The most common deliverables supplied from drone surveys are the following:

- Individual high-res imagery of pre-determined locations
- Whole site ortho-mosaics (multiple individual images 'stitched together' and rectified into a larger single image to represent real-world distances and orientation)
- Video footage
- Point clouds generated from multiple overlapping calibrated images using photogrammetry or on-board lidar instruments.
- 3D Models (i.e. Revit, 3D AutoCAD, etc)

The Accuracies: The final data deliverable has been communicated, so what level of accuracy is achievable? Generally, for single images or a video, accuracy is not important because resolution is the determining factor. However, for occasions that require a good spatial link between the end product and the real-world location, it's important to know how well the data relates to a given co-ordinate system.

A normal, commercial-grade drone will be positioned using its inbuilt GPS navigation with an accuracy of up to +/-5m horizontally and +/-10m vertically. This may be accurate enough for single imagery, but to generate whole-site ortho-mosaics, point clouds or 3D models aligned to the real-world, accuracies need to be improved. Some commercial drones have built in systems that can increase accuracy by linking to a nearby ground base station with known, accurate coordinates. This can increase image geo-location accuracy to within the 3-10cm range depending on site specifics. Such technology, though, is best suited to broad-acre mapping instead of built-up urban environments with tall buildings and electromagnetic interference.

The best method to increase global accuracy is to utilize multiple Ground Control Points (GCPs) scattered evenly throughout the survey zone. These ground-surveyed control marks are then used to align the images accurately to one another and calibrate the finished product to the reference co-ordinate system.

It's also important to note that camera quality and image stability play a crucial role in data quality. For example, a low-end drone with a GoPro will generally yield lower quality results compared to more expensive drones with quality cameras attached to stabilizing gimbals.

If the final deliverable is a 3D point cloud or model, the overlapping images are used to determine a best-estimate of the pixel's position horizontally and vertically. Higher levels of image overlap and quality and a sufficient amount of GCPs increase the probability that the generated pixel co-ordinate matches its real-world position. However, in the process of creating 3D positions from 2D images, additional error sources are often introduced into the data set.

It is also important not to confuse image Ground Sampling Distance (GSD) with drone data accuracy. GSD is simply the distance between two consecutive pixel centres measured on the ground. A 2cm GSD doesn't mean accuracy to 2cm. It only means the pixel size is 2cm. The only way to confirm drone data accuracy is to check against independently surveyed points.

Generally, the highest expected real-world accuracies for drone data deliverables using GCPs are as follows:

- Ortho-mosaics – approximately +/- 5cm (depending on flying height and image quality)
- Point clouds – approximately +/- 7cm for horizontal positioning and +/- 15cm for vertical positioning (depending on image quality and object colour/shadow. Large dark objects can result in +/-50cm)
- 3D models – similar accuracies to point clouds with added error sources concerning modelling level of detail (i.e. best fit of point cloud for an entire wall as opposed to segments of a wall)

The Quality Product: So, what makes a good quality drone survey? What are the critical success factors? It can be summed up in three words—Personnel, Procedures and Precision.

Personnel:

- Is the drone operator experienced with the type of work requested?
- Is the drone operator licensed?
- Has the drone operator completed the necessary pre-flight safety and regulatory requirements?

Procedures:

- Have the desired final deliverables been clearly communicated?
- Have the relevant stakeholders been accounted for?
- Have the fieldwork OH&S requirements been identified?

Precision:

- Is the requested level of detail achievable?
- Is the required level of accuracy realistic and agreed between client and contractor?
- Can the real-world position of the final product be verified?

An answer in the affirmative to all of the above questions will give the greatest chance for mission success. There is more to a successful drone inspection survey than just flying a drone. Anyone can learn how to fly a drone, but it's the professional drone operator that can navigate the regulatory framework, advise clients on achievable outcomes, maintain OH&S as well as public safety standards, and deliver a quality end product.

Further Information

CASA drone-specific website: https://www.casa.gov.au/drones
OpenSky website: https://opensky.wing.com

About Landair

Landair Surveys is an aerial, land and engineering surveying company servicing corporate and government clients in the infrastructure, environment, property and resources industries Australia-wide. With over thirty years of aerial survey experience they utilize both piloted and drone aerial surveying technologies and are CASA-certified.

The information given in this paper is advisory only. The relevant legislative framework and guidelines should be consulted in addition to the general principles found in this paper.

Landair surveys

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