DroneDeploy

Skydio X10 with RTK

Platform Accuracy Testing

Author: **Ryan Hippenstiel, PLS**

Surveyor-in-Residence

DroneDeploy

Table of Contents

01
Abstract

Abstract

Over the last decade, drone photogrammetry has evolved into a core technology for survey, construction, and earthworks teams. This whitepaper presents live, real-world accuracy testing of the Skydio X10 with a VT300-L sensor package and a RTK attachment, with a focus on its performance against industry standards. The study addresses best-practice workflows, field realities, and their effect on mapping results in DroneDeploy, documenting sub-inch absolute accuracy, robust error filtering, and resilient performance at flight altitudes of 150', 250', and 350'. It demonstrates the X10's parity with high accuracy industry standards when control and correction workflows are rigorously applied.

In an effort to measure the absolute and relative accuracy of the Skydio X10, this study also aimed to document and compare workflows for PPK, RTK, and GCP data collection. Furthermore, the research sought to confirm best practices for survey control setup, ground target placement, and post-processing quality assurance.

Both absolute accuracy, which refers to map placement validated against true ground coordinates via checkpoint errors, and relative accuracy, which focuses on the consistency of measurements within the map as verified by tape-measured ground features, are critical for compliance, analytics, and reliable change tracking.

The study also provided an overview of key concepts and technologies, including the Skydio X10 with its 50MP rolling shutter sensor and RTK attachment, and another comparable platform which was used as a control with its own ≥20MP mechanical shutter. The importance of PPK & RTK corrections for enabling in-level geotagging, Ground Control Points (GCPs) for anchoring maps to global coordinates, and Checkpoints for independent accuracy validation was highlighted. Finally, the DroneDeploy Map Engine, a cloud photogrammetry software that integrates PPK, RTK, and GCP workflows, was identified as a core component of the data processing.

Best Practices

Based on this test's findings, the Skydio X10 performs well and delivers clear and accurate imagery at the sub-inch level when combined with recommended best practices for achieving accurate mapping such as:

1. Utilize clear, distributed, well-surveyed GCPs for each flight, with a preference for checkerboard markers.
2. Integrate RTK/PPK corrections with GCPs to ensure maximum reliability, particularly on large or complex sites.
3. Maintain evenly distributed checkpoints for comprehensive validation of the mapping results.
4. Conduct thorough quality assurance (QA) on all image and target tagging, filtering out ambiguous markers.

02

Introduction

Goals of This Study

This study aimed to:

- Measure the absolute (global) and relative (internal) accuracy of the Skydio X10, benchmarking it against a comparable industry standard.
- Document and compare workflows for RTK, PPK, and GCP data collection, with a focus on their impacts on construction and survey deliverables.
- Clarify best practices for survey control setup, ground target placement, and post-process quality assurance.

Absolute vs. Relative Accuracy

It is important to distinguish between absolute and relative accuracy, both of which are crucial for compliance, analytics, and reliable change tracking.

Absolute Accuracy

This refers to the map's placement validated against true ground locations, typically surveyed independently on an assigned coordinate system.

Relative Accuracy

This focuses on the consistency of measurements within the map itself, verified by comparing them against known physical distances on the ground.

Key Concepts & Tech Overview

Several key concepts and technologies were central to this study:

- **Skydio X10**
  This platform features a 50MP corrected rolling shutter, and a RTK/PPK attachment.

- **Comparable Drone Platform**
  Used as a control, this platform features a ≥20MP mechanical shutter.

- **RTK/PPK corrections**
  These corrections enable inch-level geotagging of imagery through post-processing or real-time corrections.

- **Ground Control Points (GCPs)**
  These are surveyed markers that serve to anchor the map to global coordinates.

- **Checkpoints**
  These are surveyed independently and used solely for accuracy validation of the generated map.

- **DroneDeploy Map Engine**
  These corrections enable inch-level geotagging of imagery through post-processing or real-time corrections.

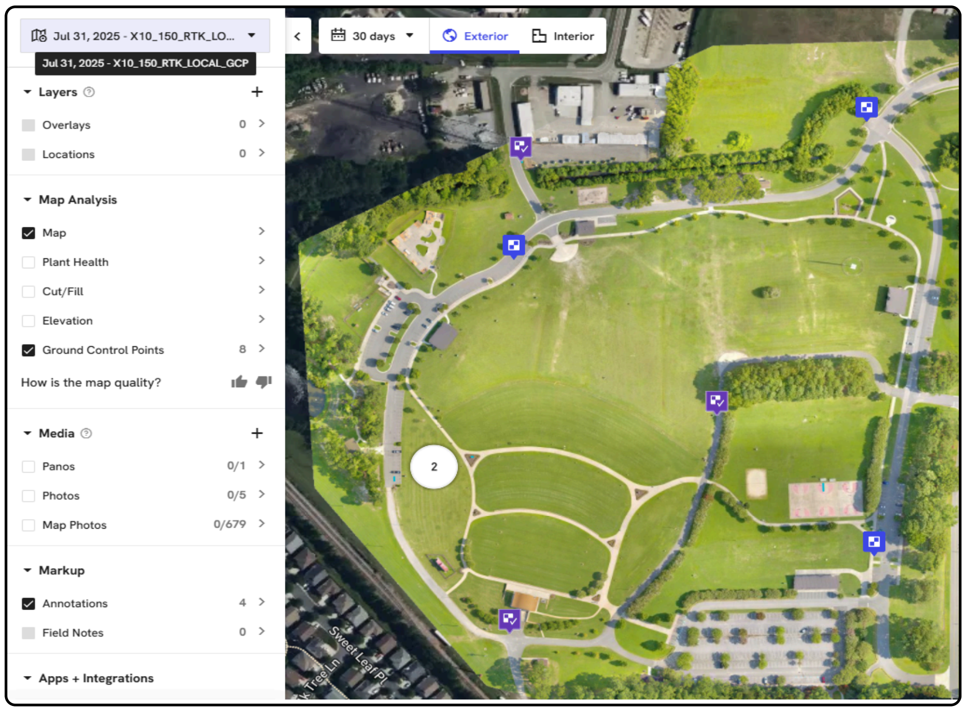
Platform	Key Specs	Correction Capabilities
Skydio X10 with a VT300-L sensor package and a RTK attachment	50MP, Rolling Shutter	RTK, PPK
Market Leader	≥20MP, Mech. Shutter	RTK, PPK

03

Methodology

Site Description & Field Conditions

The study was conducted on an active site characterized by frequent public movement, moderate obstructions, and mixed surfaces including concrete, grass, and small elevation changes. Weather conditions during the study were challenging, with hot temperatures (90+ °F), sunny skies, and high humidity. The field conditions, including high pedestrian activity, variable sunlight, and active conditions, mimicked common issues with drone mapping where sites are busy and in use during flight.



Survey Control Establishment

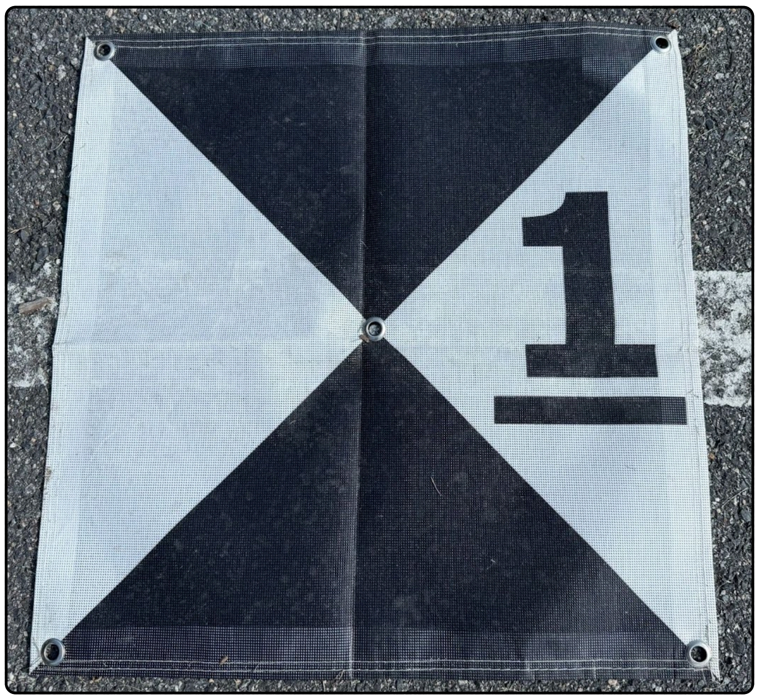
Control points were established using a variety of methods:

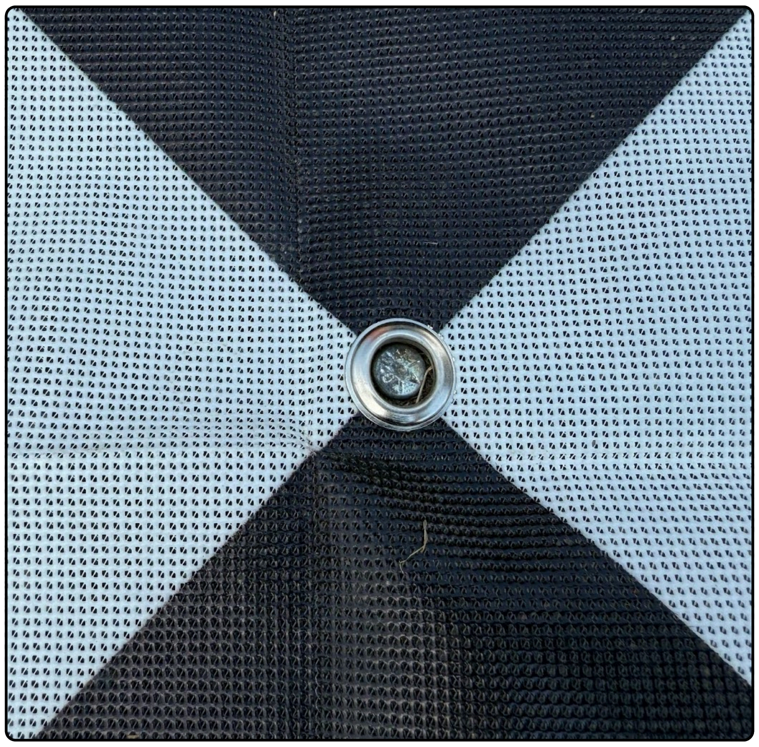
- Mag nails were embedded in hard surfaces to provide durable reference points.
- Supplemental photo-ID points, such as sidewalk seams and utility markers, were also identified.
- All marks were measured via GNSS receivers corrected with an NTRIP; a subset was resurveyed with base/rover GNSS for the highest accuracy, checking within an inch or less in the field and during post-processing.
- On flight days, canvas targets and makeshift painted bucket lids were placed over selected marks and surveyed as primary GCPs and checkpoints.
- Points were documented and flagged by type with accompanying field notes.

Control Point Type	Survey Method (GNSS)	Targeting Approach	Intended Use
Mag Nail (hard surface) w/target	NTRIP-corrected rover	Canvas checkerboard/ad hoc	GCP/Checkpoint
Photo-ID Feature w/ bucket lids	NTRIP-corrected rover	Makeshift marker	Checkpoint / Analysis

Targets Used & Tagging Workflow

Manufactured GCPs, specifically canvas checkerboard targets (≥2'x2'), were used for their high contrast and durable placement. Checkpoints, adhering to the same standards as GCPs, were reserved solely for map validation. Makeshift targets, such as plastic bucket lids and sidewalk seams (referred to as photo-ID features in the 'Survey Control Establishment' table), were also included to replicate common user shortcuts for controlled testing. These photo-ID features were analyzed to assess photo quality and their visibility from various flight altitudes. For instance, the smaller of two bucket lids with a painted target was not clear from 350' and was thus excluded from analysis at that altitude, though it was recognizable at 150' and 250'. The larger bucket lid, however, was visible from all three altitudes. In general, these types of makeshift targets are not advisable, but their inclusion provided realism, reflecting how some field teams occasionally resort to non-standard targets.





Due to their inherent unreliability as control points for mapping, most were subsequently removed from the statistical analysis of accuracy outcomes. During tagging in DroneDeploy, a minimum of eight distinct angular views per target was sought, but not always achieved based on flight altitude and its effect on numbers of images. Poor or ambiguous points, such as those that were blurry at high altitude or showed vertical inconsistency, were filtered out.

Attribute	Best Practice	Poor Practice
Target Type	Checkerboard, durable	Small bucket lid, painted X
Placement	Flat, buffered surface	Slope, obstructed/edge
Tagging	8+ angles, clear center	Blurry, ambiguous references

Flight Plans & Parameters

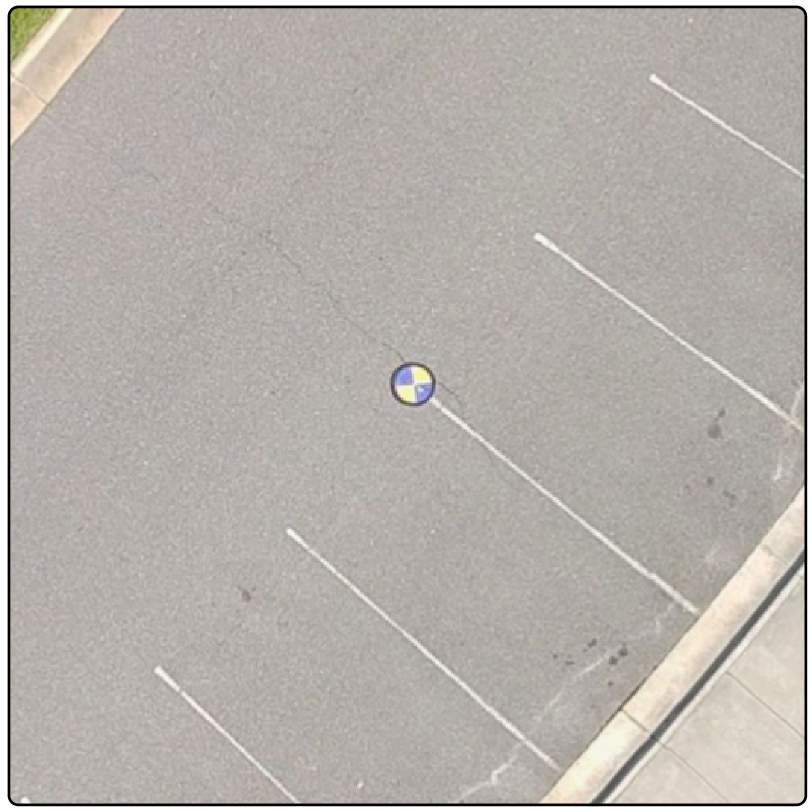
Flights were conducted at altitudes of 150', 250', and 350' to allow for X10-specific benchmarking. An overlap of 75% frontlap and 65% sidelap was maintained using a lawnmower nadir pattern. The primary platforms were the Skydio X10 and a comparable drone platform. The RTK/PPK workflow was meticulously tracked for each flight, with corrections being turned on and off for the various flights. In addition, a consistent flight speed of 20mph was used for each flight. For the Skydio X10 flights, the Skydio controller and onboard software was used for flight planning, settings, and monitoring.

Data Collection & Processing

Images were processed using the DroneDeploy Map Engine. During tagging, initial targets were reviewed for clarity and elevation consistency; ambiguous bucket lids and pedestal marks were excluded. Each flight was finalized with 4-6 well-surveyed GCPs and 2-3 evenly distributed checkpoints.

Workflow Efficiency

The Skydio X10 was able to complete moderate-sized missions on a single battery charge across all tested altitudes. The onboard planning software delivered image and flight length estimates that were accurate and reliable, and a real-time view of flight progress.



04

Key Findings

Key Findings - Absolute & Relative Accuracy

Both Skydio X10 flights and those conducted with a comparable market leader consistently checked against GCP's with sub-inch accuracy when utilizing GCP plus correction workflows. While PPK/RTK-only workflows were reliable for most use cases, they demonstrated greater susceptibility to vertical (Z-axis) error. The inclusion of GCPs in PPK or RTK flights resulted in an error reduction of up to an order of magnitude because it minimizes the errors that can be found in short PPK flights and RTK corrections from distant or intermittent base stations.

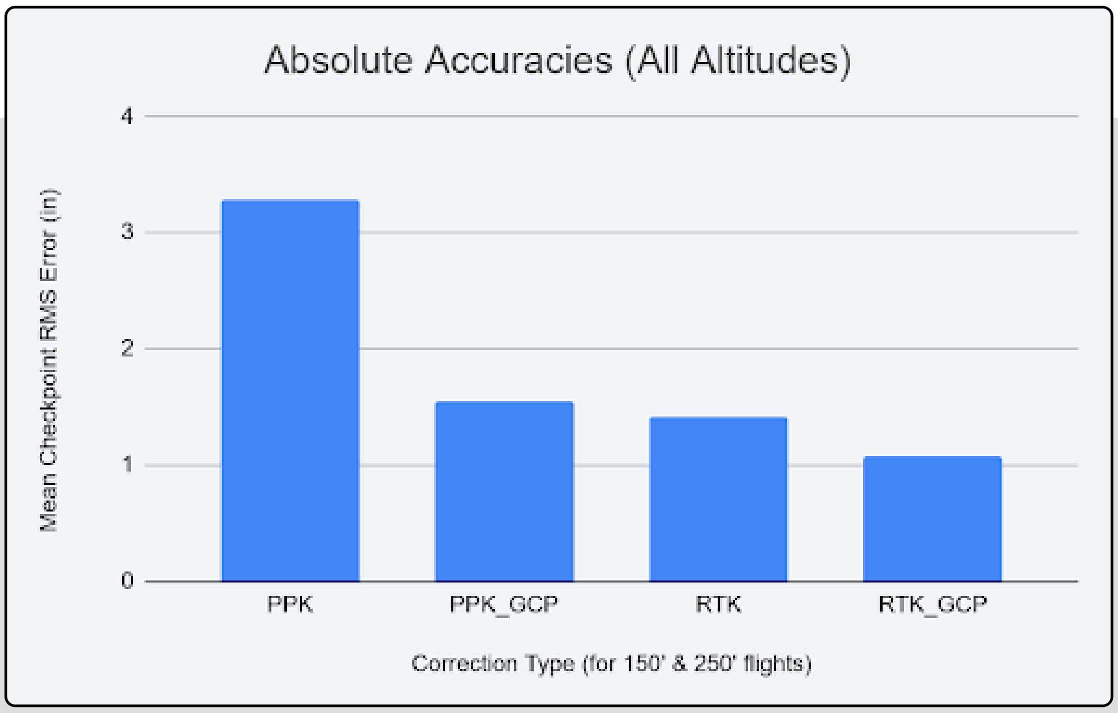
4.1. Average Absolute Accuracy: Sub-inch when using control and RTK.

Targeted checkpoints that were independent of the GCPs were analyzed as part of the DroneDeploy map processing and reporting to determine the absolute accuracy. GCP workflows delivered the lowest checkpoint RMS errors, consistently achieving total mean checkpoint RMS errors under 1.5″, and often below 1″. The vertical (Z) error consistently proved to be the most variable and presented the biggest challenge for non-GCP workflows. RTK-only flights generally achieved substantially better accuracy than PPK-only workflows though this can differ based on the availability of and distance to the nearest base. For a site this size (60 acres), shorter flights likely led to a diminished PPK solution.

Here's a breakdown of the average Mean Checkpoint RMS Error for each correction type across all altitudes:

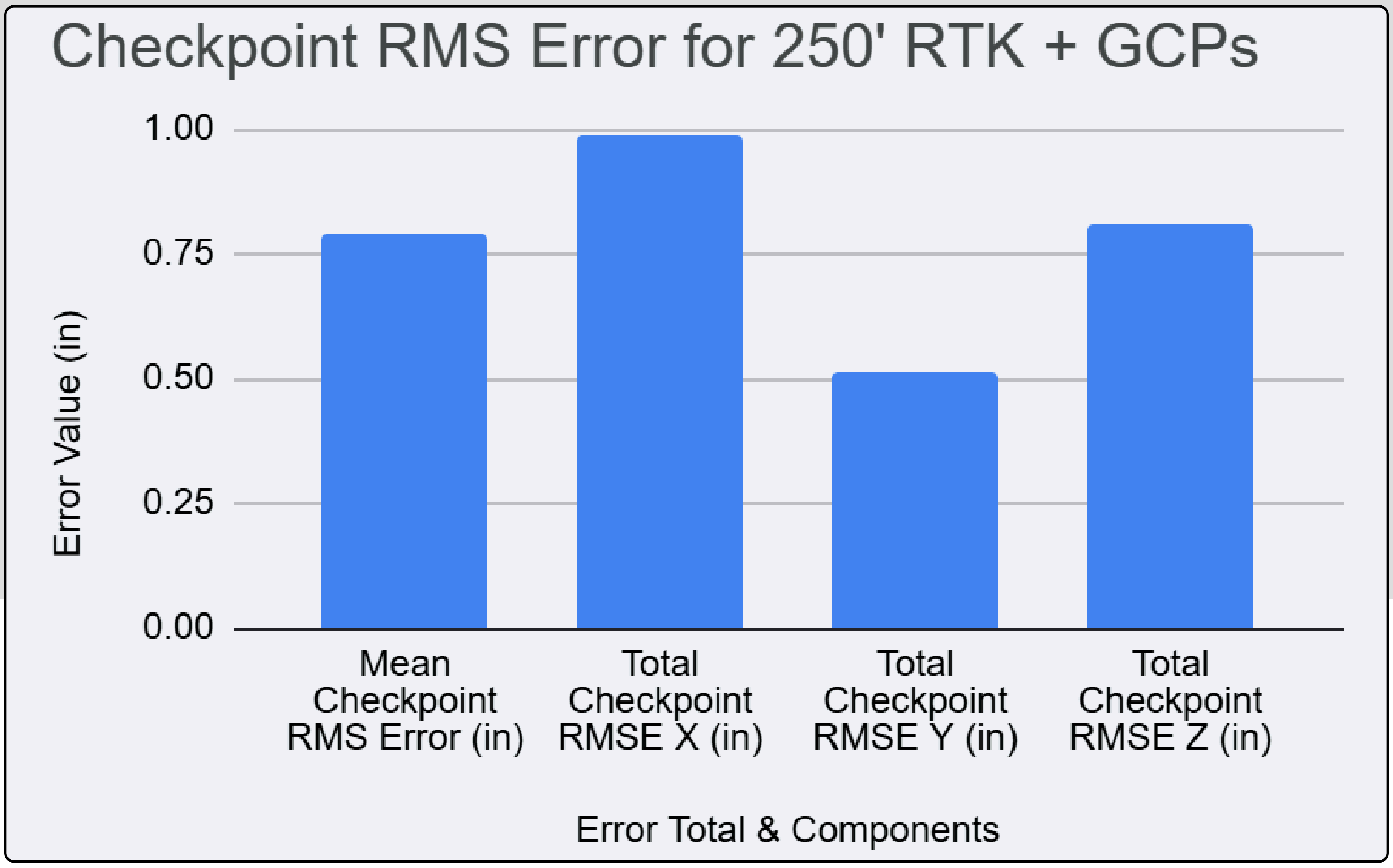
- PPK: 3.28 inches.
- PPK GCP: 1.54 inches.
- RTK: 1.41 inches.
- RTK GCP: 0.98 inches.

Overall, even with challenging conditions, the X10 delivered sub-inch absolute accuracies for multiple maps and averaged less than 1.3″ for flights controlled with GCPs. This benchmarked well for this project area with the market leader averaging at 1″ across controlled maps.



4.2. Optimal Absolute Accuracy: 0.8 inch absolute accuracy when using control, RTK, and flying at 250 ft.

For this test and field conditions, the best results in absolute accuracy was the combination of RTK with surveyed GCPs, flown at 250′. The X10 delivered image quality that was ample for tagging of all control points while flying at a higher altitude, lowering the amount of images and flight time for collection.



4.3. Flight Altitude: 250 ft yielded measurements all within 1″ of absolute accuracy

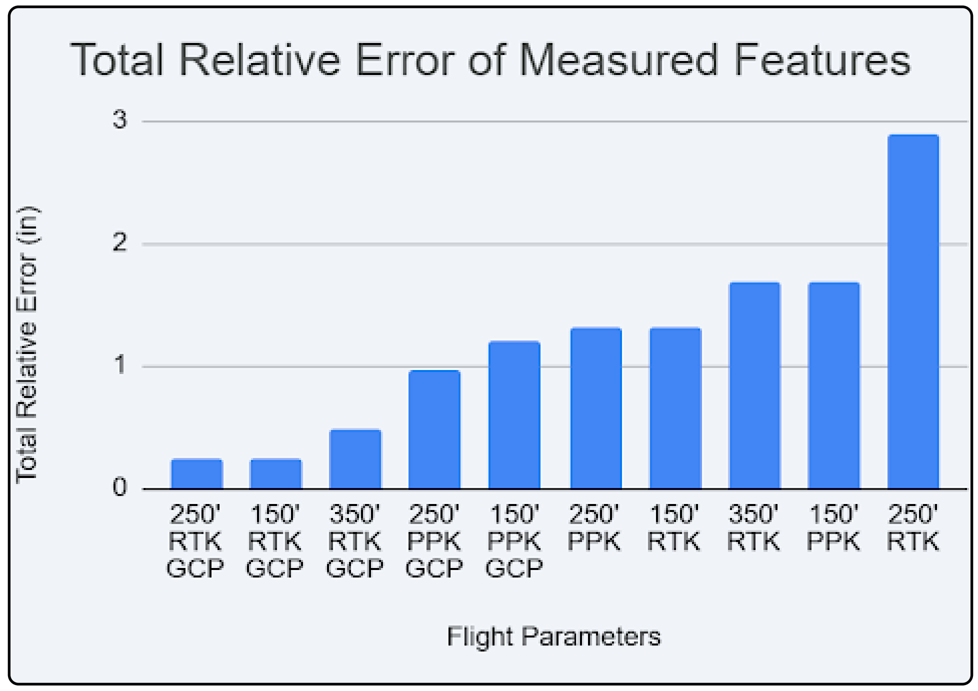
Across the tested altitudes of 150', 250', and 350', the PPK-only flights were the least accurate with the vertical errors being the worst. Four of the top five most accurate flights during this test did occur at the 250′ altitude all within 1″ of absolute accuracy. In addition, eight of the top ten flights were controlled with GCPs.

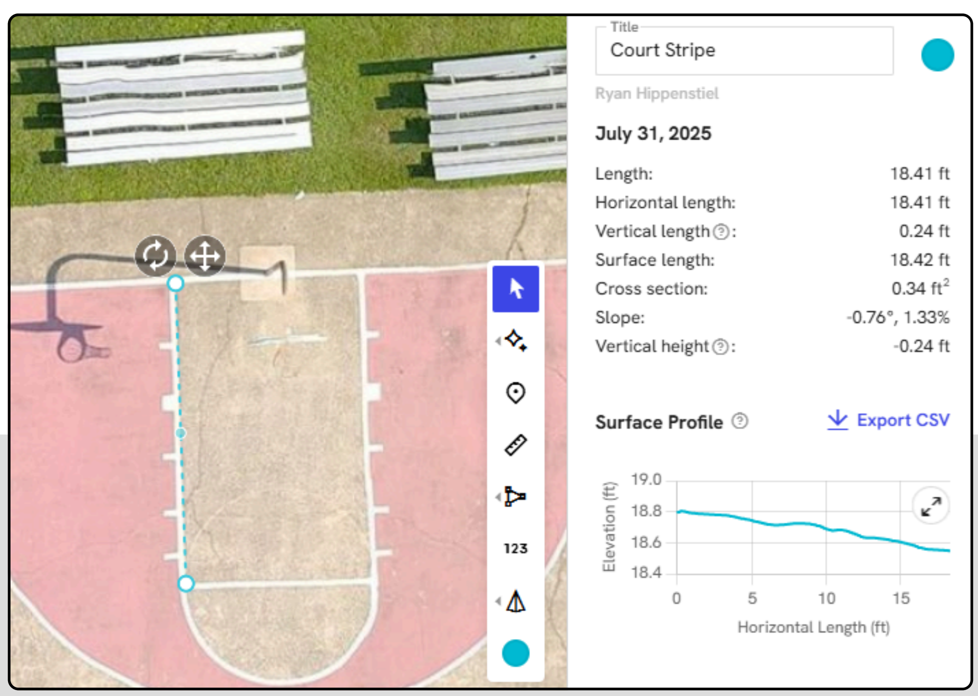
The clarity of features on the ground is of course improved at lower altitudes, but it does lead to more images and thus more photogrammetric processing. Image Resolution, size, overlap, ground control quality, and GNSS availability all exert influence on your result. Ultimately, the chosen flight altitude for any project should be determined based on scope of work, clarity needed, and available time and resources onsite.

4.4 Average Relative Accuracy:

Within 1% of real world measurements

In addition to checkpoint RMSE values, features in the field, such as painted stripes and electrical boxes, were measured for comparison with post-processed imagery. There were 4 distances measured with a steel tape, ranging from a small inlet cover of 2.5′ to a basketball court line at 18.5′. In all cases and all altitudes, the on-screen measurements were highly accurate with short or shadowed features that were harder to determine being within 3-4%, and the longer, clearer distances determined under 1%. The X10 easily delivered image quality and locations for sub-inch relative accuracy on these features across all flight altitudes and correction types.





05

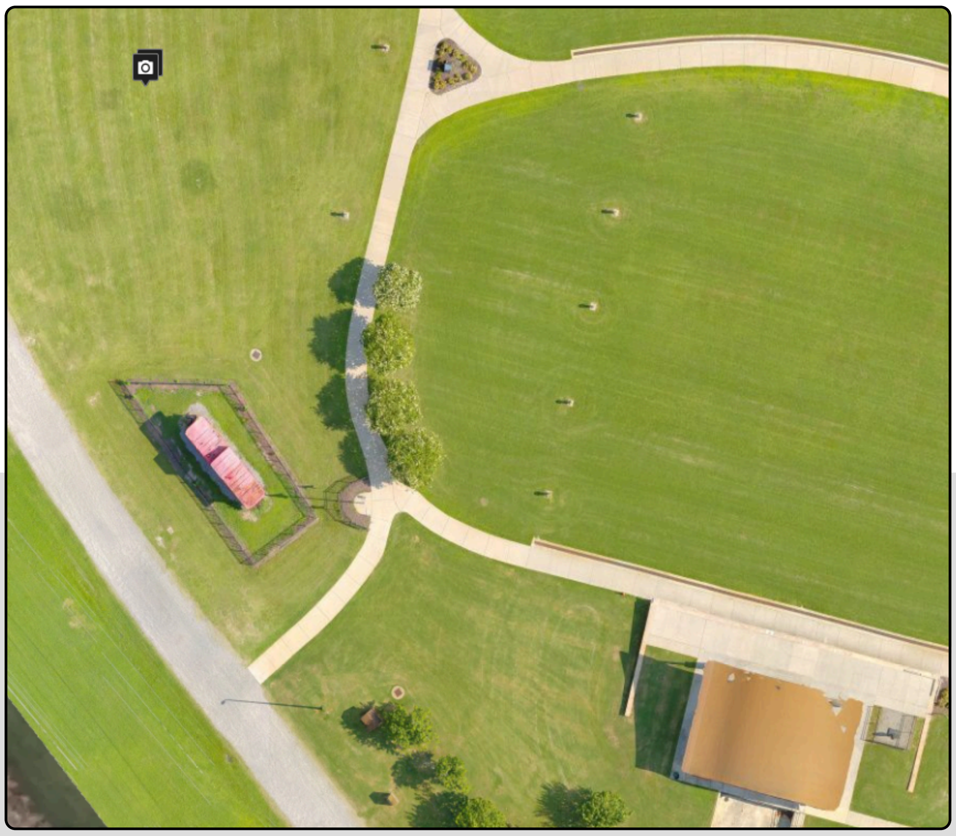
Recommendations

Recommendations

The results of this test show that the Skydio X10 is capable of operating at a number of altitudes and utilizing multiple correction types. As expected based on previous tests and studies, the combination of RTK and GCPs (ideally 1 GCPs per 200 images) is the best practice for accurate mapping and survey-grade deliverables.

If GCP's cannot be used, RTK-only corrections can deliver reliable results with x and y errors around 1″ being possible in good conditions, with vertical accuracy approximately double that. PPK-only solutions are more susceptible to errors, especially in the vertical component, and require that the flight time (or waiting) are sufficient for convergence.

Following these recommendations will deliver imagery with high accuracy and quality.



06

Conclusion

Conclusion

The Skydio X10, when paired with robust GCP and correction workflows, consistently achieved survey-grade mapping accuracy, demonstrating its capability to meet high industry standards under parallel test conditions. Live field trials in a challenging, active environment confirmed the platform's resilience and performance. The use of manufactured targets consistently appeared clear in images and delivered the highest accuracies. Strict ground control, GNSS protocols, and rigorous data QA are essential for reliable photogrammetry, and using GCP-supported corrections (PPK & RTK), the Skydio X10 delivered impressive results.