Strengthening the Deployment of Uncrewed Aerial Systems (UAS) at KYTC

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in cooperation with
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Research Report
KTC-24-07

Strengthening the Deployment of Uncrewed Aerial Systems (UAS) at KYTC

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16. Abstract

The Kentucky Transportation Cabinet (KYTC) and transportation agencies around the United States increasingly depends on uncrewed aircraft systems (UAS — also commonly known as drones) to collect data and accelerate project development and delivery. Drones let transportation practitioners safely and efficiently perform many activities, including bridge and highway inspection, construction monitoring, surveying, emergency response, and measuring stockpiles. KYTC's implementation of UAS has expanded rapidly over the past 10 years, however, the agency lacks well-coordinated procedures for connecting pilots with end data users, scheduling and conducting flights, developing and documenting best practices, and processing and storing data. Based on a review of current practices and interviews, recommendations centered: (1) forming a UAS oversight committee; (2) establishing positions for UAS program leads; (3) setting up a dedicated funding stream to acquire hardware and software; (4) holding facilitated peer exchanges and building communities of practice; (5) centralizing all UAS resources and forms (e.g., flight request forms, pre-flight checklists, post-flight report templates); (6) convening an in-person each meeting that draws UAS experts from transportation agencies and industry partners from around the region to discuss lessons learned, emerging trends, and case studies; (7) introducing centralized data processing and storage solutions; and (8) adopting formalized guidance that underwrites all UAS-related activity at KYTC.

17. Key Words uncrewed aircraft systems, unmanned aircraft systems, drones, transportation, guidance, change management		**18. Distribution Statement** Unlimited with approval of the Kentucky Transportation Cabinet	
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Executive Summary

Uncrewed aircraft systems (UAS) are ubiquitous tools at state transportation agencies (STAs). They can quickly and safely perform tasks that would expose onsite personnel to hazards. Bridge and highway inspection, monitoring the construction process, coordinating emergency responses, and measuring stockpiles are all activities that have been made easier and safer through UAS deployment. Over the last 10 years staff at the Kentucky Transportation Cabinet (KYTC) have incorporated these systems into numerous workflows, most notably in Bridge Maintenance and Project Delivery and Preservation. Despite the increased use of drones at the Cabinet, the agency has not established formal, systematic guidance for their implementation at the programmatic and project levels. This report reviews practices adopted by other STAs, evaluates KYTC's current policies and practices, and draws on conversations with Cabinet UAS pilots to advance recommendations for strengthening the agency's policies, practices, and guidance.

1. Form a UAS Oversight Committee
This committee will have members from across KYTC's departments and divisions as well as industry representation. Its key responsibilities will include defining equipment and software standards, identifying new use cases, proposing pilot projects, offering guidance on purchases, overseeing UAS-related research projects, and ensuring all facets of the Cabinet's UAS program align with the agency's broader goals and objectives.

2. Establish Positions for UAS Program Leads
Job descriptions for these staff positions will explicitly describe UAS-related responsibilities. Once hired, staff will play a critical role in delivering UAS services and guidance and making sure that Cabinet staff have access to all of the resources and services they need.

3. Set Up a Dedicated Funding Stream for UAS-Related Acquisitions
KYTC has relied on FHWA funding to purchase UAS, software, and other equipment. Because FHWA grant dollars are not consistently available, the Cabinet needs to establish a funding line that pays for UAS, software, pilot projects, and potentially test or certification fees. Dedicated funding can ensure that KYTC keeps its equipment and software up to date.

4. Adopt Formalized Guidance
KYTC should adopt formal guidance that addresses essential issues related to UAS, including requirements for pilots and visual observers, pre-flight checklists, post-flight reports, equipment ownership and restrictions on its use, data storage, and data ownership. Appendix A includes a draft of proposed guidance.

5. Centralize Resources and Forms
KYTC needs a single resource where staff can learn about UAS services and the steps required to become a pilot, access forms, and view guidance and videos. This gap can be filled by developing and maintaining a website on which all UAS information and materials are centralized.

6. Introduce Unified Data Processing and Storage Solutions
UAS flights generate a lot of data that have to processed and eventually stored. Post-flight data processing can be a hurdle for KYTC staff who lack experience working with large, complex datasets. A simple way to overcome this challenge is to centralize post-flight data processing so that staff can get their hands on usable data quickly. Equally important is settling on a centralized approach to data storage that improves accessibility to all UAS data collected by the Cabinet.

7. Hold Facilitated Peer Exchanges

Establishing a user group that consists of in-house personnel and industry partners that deliver UAS services will help build a statewide network of expertise and strengthen UAS applications for transportation projects. User groups would create, publish, and share data repositories, set up an email listserv, organize webinars and trainings, and hold in-person peer exchanges. User groups will build strong, more networked communities of practice.

8. Hold an In-Person Annual Meeting

User groups and peer exchanges can play a valuable role in promoting more widespread implementation of UAS at the Cabinet. But to fully grasp the latest advances in UAS technologies and drone deployment at STAs, an in-person meeting is needed that brings together KYTC stakeholders as well as industry partners and agency officials from adjacent states. Presentations and conversations at the meeting will encourage Cabinet staff to push forward with UAS implementation in innovative and unexpected ways.

Chapter 1 Introduction

Transportation agency practitioners are rapidly incorporating uncrewed aerial systems (UAS), including drones, into routine workflows because they improve the efficiency and safety of activities like bridge and highway inspection, monitoring the process of work, documenting erosion and sedimentation, measuring stockpiles, responding to natural hazards and other infrastructure-related emergencies, and surveying (Turkan et al. 2022). UAS eliminate dangers associated with conducting field work in locations that are difficult to access or hazardous to visit in person. The growing popularity of UAS among transportation agency practitioners is also evident in the mushrooming number of publications, short courses, and events which highlight industry best practices.

Over the past 10 years, the Kentucky Transportation Cabinet (KYTC) has gradually embraced UAS for the acquisition of aerial imagery and to conduct bridge inspections. Figure 1.1 is an organizational chart that indicates Cabinet units in which UAS pilots reside at the time of this publication. The adoption of UAS has been most widespread in Bridge Maintenance — this division sports the most pilots, owns the most equipment, and has produced formal guidance that describes procedures for applying UAS in bridge inspections. Following Bridge Maintenance, the unit that has leveraged UAS the most, and which has the most active pilots, is a District 8 team with primary responsibilities in the Divisions of Incident Management, Traffic Operations, and Highway Design. In the coming years, the Cabinet's reliance on UAS will inevitably grow and reach all corners of the agency.

Ensuring that UAS are applied in a consistent and effective manner agencywide demands that KYTC establish formal guidance and recommendations for their implementation at the programmatic and project levels. Based on a review of practices and policies adopted by state transportation agencies throughout the United States, interviews with Cabinet UAS pilots, and an analysis of KYTC's UAS inventory, this report proposes best practice recommendations, formal guidance, and pre-flight and post-flight procedures that should be adopted agencywide. Chapter 2 explores how other states transportation agencies are employing UAS as well as the laws and policies that govern their use. Chapter 3 reviews KYTC's current policies and practices and advances suggestions for formalizing and strengthening the agency's efforts related to UAS.

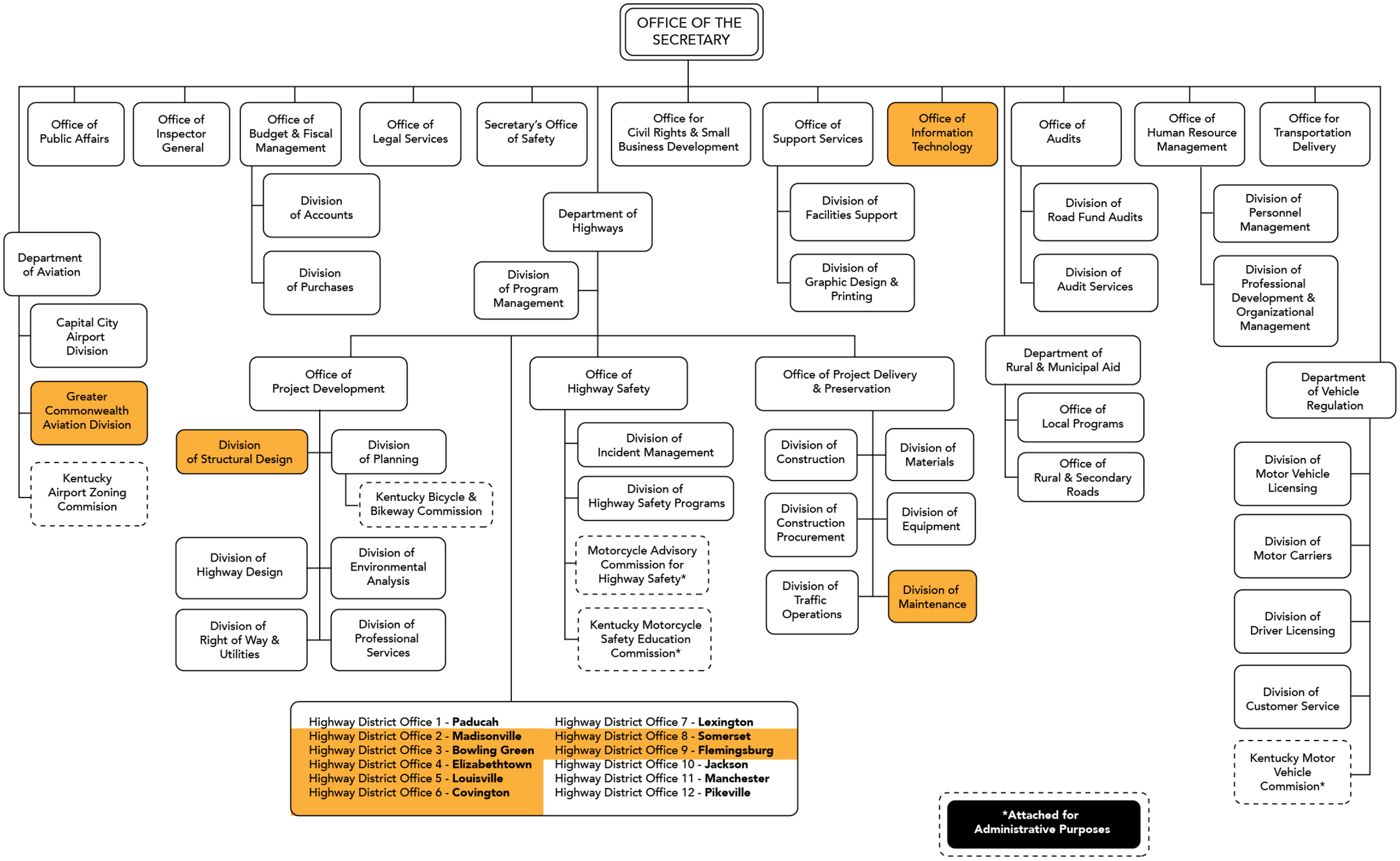

Figure 1.1 Locations of UAS Pilots Within KYTC

Chapter 2 State Laws, Policies, Applications for Unmanned Aerial Systems

This chapter discusses UAS-related laws, policies, and applications adopted by state departments of transportation (DOTs). States have taken different, sometimes divergent steps to integrate UAS into operations over the last decade. Some states narrowly regard UAS as tools to help employees with specific activities, while others take a more programmatic approach that involves partnerships with the federal government and other stakeholders. Three states reviewed here (Tennessee, Virginia, North Carolina) participated in the 2017 UAS Integrated Pilot Program and BEYOND, which was the 2020 continuation of this program. These federally funded programs brought federal and state DOT and Federal Aviation Administration (FAA) partners together with private sector partners to test and evaluate UAS operations. As Kentucky refines its policies and procedures for UAS adoption and implementation, officials can draw from the examples below for information on and insights into program implementation.

Tennessee

The Tennessee DOT (TDOT) is responsible for the state's UAS policies. Tennessee follows all FAA requirements and advocates that commercial and recreational flyers adhere to the following practices:

- Always fly below 400 feet above ground level
- Always keep the aircraft in visual line of sight, unless a waiver has been obtained
- Always yield the right of way to manned aircraft
- Understand the airspace in which a UAS is operating and applicable FAA restrictions
- Do not fly in controlled airspace without FAA ATC approval
- Do not fly over people or large crowds of people without a waiver
- Do not fly at night without a waiver
- Never fly a UAS while impaired

Tennessee's legislature has passed several laws related to UAS. These stipulate:

- No UAS within 250 feet of critical infrastructure facilities
- No flying over firework displays or open-air events without the owner's prior consent
- No video surveillance of private citizens lawfully engaged in hunting and fishing activities without consent
- No unlawful surveillance of persons or property
- No drone interference with the lawful exercise of hunting or fishing
- Law enforcement agencies are authorized to use UAS with an official search warrant

In 2017, the FAA selected the Memphis County Airport Authority (MSCAA) for the UAS Integration Pilot Program (UAS-IPP). After the program ended in 2020, MSCAA signed a new agreement with the FAA to continue working on UAS integration challenges. Central to this program have been collaborations with private sector partners (e.g., FedEx, Asylon, DJI). The program tests and evaluates the integration of UAS operations into national airspace and assists the USDOT and the FAA in designing new rules to support complex low-altitude UAS operations. Priority topics include aircraft inspections and security and perimeter surveillance.

Before TDOT employees operate UAS in an official capacity, they must sign a TDOT UAS Operator Acknowledgement Statement verifying they will comply with the TDOT UAS Standard Operating Guidelines. Prior to UAS operations,

these statements are filed with the Aeronautics Division UAS Office. The agency's UAS Standard Operating Guidelines are available online.[1]

Missouri

UAS operations are governed solely by FAA rules and regulations. Despite the absence of state laws, several local governments have enacted ordinances related to UAS operations. A 2018 research study funded by the Missouri DOT (MoDOT) recommended that agency employees develop policies to support safe and legal UAS operations within the organization. The study also advised MoDOT to partner with universities and their extension offices to develop UAS flight training activities. It suggested that the agency gauge the level of interest among other state and local governments in developing a cost-sharing program for training and forming a UAS stakeholder partnership with agencies and organizations interested in or employing UAS technologies.

Ohio

The Ohio DOT (ODOT) established the Ohio Unmanned Aircraft Systems Center (OUASC) in 2013 to conduct all UAS operations for the agency and to serve as a shared resource for local and state agencies on matters related to flight operations and UAS program development. The Center also manages access to ODOT's right of way and authorizes contractors, subcontractors, suppliers and consultants to employ UAS in these areas. OUASC conducted 2,009 flights for ODOT and other state agencies in 2020. ODOT's Local Technical Assistance Program has also offered two free eLearning courses on UAS.

Ohio has found multiple applications for UAS. SkyVision, a ground-based detection and avoidance radar system is located at the Springfield-Beckley Municipal Airport in Springfield. OUASC, the Air Force Research Laboratory in Dayton, and other partners use FAA active radar systems to track UAS, which enables aircraft operations beyond line of sight. UAS facilitate the following operations statewide:

- Bridge inspections
- Aerial photography / GIS
- Exterior / interior inspections
- Construction monitoring
- Traffic monitoring
- Quick clear operations
- Emergency management
- Communications / promotional videos
- Structures / facilities inspections

Additionally, HB 166 (signed into law in 2019) appropriates $125,000 per year to support expansion of the UAS STEM program for high school students.

Indiana

Unlike other agencies, the Indiana DOT (IDOT) hired a consultant — Woolpert — to develop UAS policies, procedures, and standards that could be managed, shared, and coordinated with agencies throughout the state. A research

[1] https://www.tn.gov/tdot/aeronautics/unmanned-aircraft-systems--uas--drones/tdot-sog-and-flight-log.html

project funded by the agency, *Investigation of Strategic Deployment Opportunities for Unmanned Aerial Systems (UAS)*, suggests that IDOT prioritize UAS in: (1) bridge inspection, (2) construction, and (3) emergency management.

Virginia

Although the Virginia DOT (VDOT) is responsible for managing and enforcing UAS policies in Virginia, the state has enacted a number of laws since 2013 related to UAS. These laws have authorized a range of activities, including the use of UAS by law enforcement for accident reconstruction; establishment of a UAS commission; funding UAS research and development at Virginia Tech University; financing UAS companies; the development of UAS industries; and establishment of the UAS Commercial Center of Excellence and Business Accelerator. The state's legislature in 2020 passed three bills focused on UAS. The first empowers localities to regulate UAS takeoffs and landings on properties owned by those localities. A second law mandates the annual evaluation and measurement of current and future initiatives related to technology-driven industries such as UAS. The third appropriates $2 million over two years for the Virginia Center for Unmanned Systems, directing the Center to facilitate collaborations between business, investors, universities, entrepreneurs, and government organizations.

In January 2021, VDOT published its *UAS Operations Manual*, which covers agency policies, applications, and official forms. Use cases identified by the manual include incident and traffic management, infrastructure inspections and condition assessments, project development and delivery, and communication and public outreach.[2] Currently, a project funded by the Virginia Transportation Research Council is developing a plan to help VDOT broaden UAS applications throughout its operations.

Iowa

The Office of Aviation in the Iowa DOT (IDOT) administers UAS laws and regulations. IDOT use cases include accident reconstruction, assessing flood events, and search and rescue scenarios. Other entities that employ UAS include the Iowa Departments of Emergency Management and Homeland Security as well as the Highway Patrol.

Kansas

The Kansas DOT (KDOT) administers the state's UAS policy through its Division of Aviation. UAS technologies have been advanced through KDOT's partnerships with K-State Polytechnia, Westar Energy, and Irish Automation. In 2019, Kansas was approved for the first beyond-visual-line-of-sight UAS operation in the nation. KDOT holds the distinction of deploying the first unmanned traffic management system in the US and plans to deploy UAS to support beyond-visual-line-of-sight operations in rural areas. Operations will use technologies such as detection and avoidance, Automatic Dependent Surveillance-Broadcast, satellite communications, and geo-fencing.

SB 249 (enacted in 2016) appropriated funds for UAS research and development at state educational institutions and requires that the UAS Director make recommendations that balance privacy concerns against the need for economic development. KDOT's UAS Joint Task Force consists of a seasoned team of aviation, unmanned, and industry experts pursuing the goal of leading the nation in safe and practical UAS integration. KDOT also leads one of the 10 regional UAS Integration Pilot Programs (IPP). The regional program focuses on applying UAS in long-line linear infrastructure inspections and for precision agriculture. Beyond KDOT, K-State Polytechnic offers UAS training for law enforcement activities, with a focus on safety.

[2] https://www.virginiadot.org/business/resources/LocDes/Unmanned_Aerial_Systems_Manual.pdf

Kansas has regulations for government operators (i.e., public agencies and government entities, including schools and universities). Government operators:

- Must be at least 16 years old
- Must take and pass the Unmanned Aircraft System Operators Knowledge Test and apply for a state permit
- Agree to list of additional terms and conditions[3]

West Virginia

The West Virginia DOT (WVDOT) established a UAS program in 2017 by crafting standard operating procedures with the assistance of the West Virginia Department of Environmental Protection. By 2018, WVDOT had developed a UAS policy and began flying test missions. UAS have proven especially useful for stockpile surveys. For example, in one month the agency estimates that it saved $340,000 using UAS rather than conventional methods. Other areas in which WVDOT anticipates adopting UAS include:

- Construction
- Preliminary surveying
- Topographical mapping
- Road safety assessments
- Lidar surveys

During interviews, WVDOT leadership offered three key lessons for states establishing a UAS program:[4]

- Start small when building a UAS program
- Scale up and rely on a comprehensive UAS management platform
- Identify use cases

Adoption of Skyward's Drone Management Platform has proven integral to the agency's UAS strategy.[5] The platform manages all flights, pilots, and equipment, and offers a single, digital platform to coordinate complex missions and obtain airspace permissions.

Beyond FAA regulations, West Virginia has enacted several UAS-related laws. These laws:

- Prohibit hunting with UAS
- Prohibit operating a UAS with lethal weaponry and/or interrupting the flight of a manned aircraft
- Allow UAS for recreational purposes in state parks and forests

[3] https://www.ncdot.gov/divisions/aviation/uas/Pages/terms-conditions.aspx
[4] https://www.constructionbusinessowner.com/technology/3-lessons-west-virginia-dot-developing-drone-program
[5] Verizon, however, shuttered Skyward in June 2022 (https://www.therobotreport.com/verizon-shutting-down-skyward-drone-management-company/)

North Carolina

The North Carolina DOT (NCDOT) Division of Aviation implements and manages the state's UAS regulations. NCDOT requires that UAS operators pass an Operator's Knowledge Test before they request a UAS permit from the Division of Aviation. Several laws have been enacted related to UAS. These laws hold that:

- No images of a person or their home can be obtained with a UAS
- No weapons may be attached to a UAS
- Operators may not use a UAS to hunt or fish or to take wildlife resources
- UAS cannot interfere with manned flights
- Operators may not recover a UAS from private or state property without the property owner's consent
- UAS cannot fly over any prisons

In 2018, NCDOT participated in the UAS-IPP program, partnering with UPS, Matternet, and WakMed. The program leveraged UAS to deliver medical supplies, food supplies, and conduct bridge and infrastructure inspections. In 2019, the state and its private partners launched the first commercial UAS delivery of medical services. In 2019, the North Carolina legislature also appropriated $4 million for NCDOT to purchase UAS equipment, mobile command systems, and other technology.

State Summary/Highlights

States that have funded research and development of UAS applications and pursued UAS-focused partnerships with the private sector and/or the federal government tend to be further along in implementing UAS programs than states which have not. These states include Virginia, Ohio, North Carolina, Kansas, and Tennessee.

The National Conference of State Legislatures publishes the Current Unmanned [*sic*] Aircraft State Law Landscape, which summarizes state-level legislation on UAS. It was last updated in March 2023

Chapter 3 Strengthening KYTC's UAS Program

3.1 Assessment of KYTC's UAS Program

To understand the current state of KYTC's UAS program, we interviewed several UAS pilots, documented existing workflows, and reconciled inventory and pilot lists to consolidate data and locate opportunities for improvement.

We identified five UAS workflows commonly used at KYTC. These are for (1) construction project inspection, (2) geotechnical site tracking, (3) emergency response, (4) missions assigned to pilots without local access to equipment, and (5) consultant- and contractor-led projects. The construction project inspection workflow is the most complete. It outlines the steps pilots take to complete a project, beginning with the request, moving through flight scheduling and data retrieval, and ending with data processing, software use, data processing, and storage and sharing. Moving forward, the Cabinet should develop flowcharts and explicit instructions for different workflows as this will demystify the process and encourage more productive and efficient collaborations between pilots and the staff who request their services.

Our interviews with Cabinet UAS pilots revealed several other challenges and barriers to implementation that need to be addressed:

- Not all people listed on the current pilot's list have equipment. Some inconsistencies in pilot lists and equipment inventories were also observed, with mismatches between the physical locations of UAS and where pilots are located. KYTC turnover arguably contributes to issues with inventory lists and pilot lists, but greater consistency is achievable through proactive data management.

- Some KYTC staff have not obtained licenses or lack consistent access to the equipment required for drone missions. Although equipment can be purchased with relative ease, all Cabinet UAS pilots must hold a Remote Pilot Certificate from the FAA if they are piloting vehicles in accordance with the FAA's Small UAS Rule (Part 107).

- KYTC lacks UAS user communities — which are critical for sharing knowledge on best practices, technology changes, and use cases. Individual drone pilots have mostly relied on their own initiative and resources to integrate UAS into Cabinet workflows. Support from management has been uneven, and the agency lacks a reimbursement mechanism for incidental expenses (e.g., software purchases, fees).

- KYTC has not systematically analyzed questions of personal liability that could arise if a pilot who has UAS equipment at their home encounters a problem. The Cabinet has not established formal policies related to equipment storage. Nor has space been set aside for storage. Both of these issues need to be resolved so that UAS remain secure when not being used, and so pilots do not have to store equipment at non-KYTC properties.

- Cabinet staff who need imagery and data collected with UAS often have to leverage personal relationships and informal methods to get drone missions flown on their behalf. As KYTC ramps up implementation of drones, the agency must ensure all staff have equitable access to UAS through formal channels. Failure to provide universal access to UAS-derived information will impede project delivery.

3.2 Recommendations to Strengthen KYTC's UAS Program

Below we present eight recommendations that can strengthen the integration UAS-derived products into agency operations. Accompanying each recommendation is a brief narrative that justifies its inclusion and documents the benefits KYTC can expect to see once the practice or policy is adopted.

Form a UAS Oversight Committee

The committee should draw members from across KYTC's departments and divisions (e.g., Department of Aviation, Division of Construction, Division of Bridge Maintenance) as well as industry partners. Committee members would set standards for equipment and software acquisition, identify new use cases and pilot projects, offer guidance on purchases, oversee UAS-related research projects and case-studies, and ensure all facets of the Cabinet's UAS program align with the agency's broader goals and objectives. Given that the UAS industry is dynamic, committee members must have the bandwidth and agility to keep tabs on emerging trends. Other issues the committee would address include comparing the use cases and effectiveness of Lidar- and photogrammetry-equipped drones as well as developing agencywide guidance and issuing guidance updates. For example, drones equipped with mechanical global shutters deliver more accurate data capture than those with a rolling-type shutter. Ideally, the committee would help prepare unit-specific guidance since individual departments and divisions have unique implementation needs.

Establish Positions for UAS Program Leads

Two positions should be created for program leads. A UAS Program with dual Program Lead positions would offer a straightforward means to possess and maintain necessary expertise in UAS leadership, replicating the two-person minimum required for flights. Unlike in-house members of the UAS Oversight Committee, staff who occupy these roles will have position descriptions that explicitly outline responsibilities related to UAS. Due to increased demand for UAS services and guidance, having two leads is critical for ensuring all Cabinet staff can access the services they need.

Set Up a Dedicated Funding Stream for UAS-Related Acquisitions

To date, KYTC has mostly relied on grant dollars from FHWA to purchase drones and software. This funding has not been consistently available, however. To ensure that the Cabinet can acquire up-to-date equipment and meet the growing demand for UAS services, the agency will benefit from establishing funding lines used exclusively to finance the UAS program. These funds can pay for drones, software, pilot projects, and potentially test or certification fees. A related issue KYTC should explore is whether UAS leasing opportunities are available. UAS hardware improves rapidly, and the Cabinet does not want to be saddled with outdated equipment, the effectiveness of which wanes over time and which will eventually be unable to collect high-quality data. Affordable leasing options will keep the latest equipment in the hands of UAS pilots and forestall interruptions in data collection and project delivery.

Adopt Formalized Guidance

KYTC should adopt formalized guidance for UAS. We have drafted guidance (Appendix A) that address several topics, including requirements for pilots and visual observers, a pre-flight checklist, a post-flight report template, equipment ownership and restrictions on use, ownership and storage of data gathered during UAS missions, and a provision that states the Cabinet will revisit its policies and practices routinely and make updates as needed. Appendix B contains a draft pre-flight checklist, while Appendix C has a draft post-flight report template. Both documents should be completed when KYTC personnel pilot a UAS mission.

Centralize Resources and Forms

KYTC lacks a comprehensive one-stop resource that staff can turn to when they need UAS services, are interested in becoming involved in a pilot, want to participate in the UAS user groups, or require access to forms, such as the mission/flight request form (Appendix D) and pre-flight and post-flight checklists (Appendices B and C). To remedy this situation, the Cabinet should develop a website where all UAS materials and forms are centralized. Locating all information and resources on one site will improve efficiencies and eliminate confusion about where materials can be accessed. To give KYTC employees an idea of how their projects can benefit from UAS, the site could also host videos that highlight use cases and examples of drones being used to strengthen project delivery.

Introduce Unified Data Processing and Storage Solutions

UAS flights generate enormous amounts of data. Using these data requires post-flight processing, which can be an obstacle for KYTC staff who are not well-versed in the platforms and methods used to translate geospatial data into usable information. A simple way to overcome this issue is to centralize all post-flight data processing in-house so that staff can get their hands on processed data as soon as possible. Assigning dedicated internal staff to process data will result in a net efficiency gain, although it may require some up-front investment to hire experts. As part of the effort to streamline data processing, the Cabinet should investigate storage solutions that consolidate all UAS data in a single environment. Ideally, the agency will leverage existing frameworks and platforms so that all geospatial data are housed in a single location and users can retrieve data through location-based searches. Getting this type of solution into place will demand collaborations between user divisions/departments and the Office of Information Technology (OIT) to ensure data processing, sharing, storage, retrieval, and management adhere to agencywide requirements.

Hold Facilitated Peer Exchanges

Communities of practice keep their members in the loop about new developments and best practices. Establishing a user group that consists of in-house personnel and industry partners which deliver UAS services will help build a statewide network of expertise and strengthen UAS applications on transportation projects. The user groups should (1) set up, share, and tap into data repositories; (2) establish and maintain an email listserv; (3) organize webinars and training presentations regularly; and (4) hold one- or two-day peer exchanges where members of the user group can meet in person to discuss success stories, lessons learned, and emerging trends. The University of Kentucky's Unmanned Systems Research Consortium is another valuable resource, with researchers potentially being able to coordinate field visits and share ideas about workflows.

Hold an In-Person Annual Meeting

Although user groups and peer exchanges would be valuable for stimulating conversations in and around KYTC about UAS, they may not capture advances occurring at state DOTs throughout the region. Holding an in-person meeting each year that invites KYTC users, industry partners, and stakeholders from nearby states such as Ohio, Tennessee, Indiana, and Illinois to share experiences and project success sources will be valuable for deepening communities of practice statewide and regionwide. It will also help the Cabinet's user base develop new ideas for employing UAS in innovative and unexpected ways. Although the time and expense required to convene a multi-state conference is considerable, the long-term return on investment will be significant.

3.3 Status of Recommendations (March 2024)

KYTC has started to implement recommendations presented in Section 3.3. Updates on the latest developments are presented below.

- The Department of Highways designated two positions as Drone Program Leads, both of which are filled. Leads have developed a two-day training program that is delivered through the University of Kentucky's Technology Transfer Program. KYTC staff who successfully complete this course are eligible to have their certification fee reimbursed. They also receive access to a Microsoft Teams group exclusively for pilots that supports discussion among pilots and facilitates peer exchange.

- The Cabinet has introduced a system of drone flight forms, which are available in KYTC's Microsoft SharePoint database. The agency is also developing a public-facing webpage on UAS activities.

- Vendor-supported data processing and cloud data storage solutions are now used to build and manage photo and terrain data. This is done under the direction of the Drone Program Leads.

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Appendix A KYTC UAS Draft Guidance

Introduction

Uncrewed aircraft systems (UAS), or drones, are used throughout the Kentucky Transportation Cabinet (KYTC) to acquire data on project sites, including photographs, videos, classified point clouds, and digital elevation models (DEMs). This guidance serves as KYTC's official policy for the operation of UAS, the collection and retention of data procured via UAS, and the storage and proper implementation of UAS.

Pilot in Command and Visual Observer

UAS are regulated as aircraft by the Federal Aviation Administration (FAA). To operate UAS an employee must hold a Remote Pilot Certificate, which can be earned by passing a written test at a FAA testing center. Commercial and government aircraft may operate under 14 CFR Part 107 rules. The Pilot in Command (PIC) must demonstrate their proficiency with each UAS model and system they are using. The PIC must also acquire at least 4 hours of flight time before operating in a non-sterile environment.

FAA regulations require a Visual Observer (VO) to be present during all non-sterile flights. The VO helps the PIC by scanning for aircraft, determining UAS telemetry, and controlling the flight area, along with any task that would be beneficial to the flight.

On some projects KYTC retains a consultant PIC and/or VO to fly UAS missions on the agency's behalf. Consultant PICs and VOs may not conduct official state business until:

- Both the PIC and VO submit verification that demonstrates they have completed all necessary training and have the requisite competence to conduct a UAS flight, and
- The PIC submits a copy of their Remote Pilot Certificate.

Preflight Checklist

Prior to beginning a flight, the PIC must complete a pre-flight checklist that includes but is not limited to the following items:

- PIC
- VO(s)
- Date
- Time
- Location
- UAS type and model being used
- Flight purpose
- Visual inspection of the aircraft
- Verification that wind and weather conditions provide a proper UAS operational environment
- Team member's roles and responsibilities
- Establishment of an emergency landing plan with the flight team
- Check communications link
- Verification that the surrounding area and airspace are clear for launch

Once completed, the pre-flight checklist is stored in accordance with KYTC data storage policies for future use.

Post-Flight Report

Immediately following a flight, the PIC must complete a post-flight report. Items addressed in the post-flight report include but are not limited to:

- PIC
- VO(s)
- Date
- Flight starting and ending times
- UAS type and model used
- Interferences (organized by type)
- If an emergency landing was necessary, answers to the following questions:
    - How was it completed?
    - What conditions necessitated the emergency landing?
    - Did the emergency landing result in any damage to the UAS?

Once completed, the post-flight report is stored in accordance with KYTC data storage policies for future use.

Equipment

State-owned UAS equipment is subject to the Division of Equipment's inventory requirements for UAS equipment. UAS equipment must also be registered in accordance with FAA regulations.

State-owned UAS equipment may only be used for official state business. Under no circumstances can state-owned equipment be used on personal projects. Personal UAS equipment cannot be used for official state business.

UAS equipment owned and operated by a consultant that will be used for official state business must be registered in accordance with FAA regulations. Verification of registration must be provided to KYTC prior to performing official state business.

UAS Data and Storage

- All data gathered from UAS flights on official state business are the property of KYTC.
- All data gathered from UAS flights on official state business are stored in accordance with KYTC data retention policies.

UAS Updates

KYTC will conduct an annual review of its standing UAS policies, procedures, and guidance. Updates will be made whenever appropriate based on committee experience, FAA regulations, emergence of new national best practices, or other factors.

Appendix B Draft KYTC UAS Pre-Flight Checklist

Uncrewed Aircraft Systems (UAS) Preflight Checklist

Pilot in Command (PIC) _____ **Date** _____
Visual Observer(s) (VOs) _____ **Time** _____
Location _____
UAS Type and Model _____

Purpose of Flight

Checklist

☐ Ensure proper paperwork is completed for the flight.
☐ Check that batteries (and backup batteries) are fully charged.
☐ Visually inspect the aircraft for any defects.
☐ Complete aircraft assembly per the manufacturer's guide.
☐ Review team member's roles and responsibilities.
☐ Review purpose of flight with team members.
☐ Determine an emergency landing plan with flight team.
☐ Verify that wind and weather conditions provide a proper UAS operational environment.
☐ Check communications link.
☐ Verify surrounding area and airspace are clear for launch.
☐ Initiate the launch per the manufacturer's guide.
☐ Complete basic maneuvers to ensure proper functionality.
☐ Line up UAS for landing.
☐ Complete recovery sequence.
☐ Power down and remove batteries.
☐ Disassemble UAS per manufacturer's guide.
☐ Properly store UAS for transport.
☐ Complete post-flight documentation.

PIC Signature _____ **Date** _____

Appendix C Draft KYTC UAS Post-Flight Report

Uncrewed Aircraft Systems (UAS) Post-Flight Report

Pilot in Command (PIC) _____ **Date** _____
Visual Observer(s) (VOs) _____ **Begin Time** _____
Location _____ **End Time** _____
UAS Type and Model _____

Purpose of the Flight

Abnormal or Adverse Events

Please indicate if any of the following occurred.

Equipment Malfunction		Lost Link Events		Other Mishaps	
	Onboard flight controls		Lost link of operation control		Bird attack or interference
	Navigation systems		Lost link of ground telemetry		Damage to property other than UAS
	Powerplant failure in flight		Lost link of payload telemetry		Substantial damage to UAS
	Fuel system failure		Fly-away resulting in flight termination		Total loss of UAS
	Electrical system failure		Execution of preplanned lost link procedure		Serious Injury
	Control station failure		Execution of unplanned lost link procedure		Fatal Injury
	In-flight fire		Other:		Other:
	UAS collision involving another aircraft		None		None
	Deviation from COA				
	Other:				
	None				

Please provide additional comments for any occurrences.

Was an emergency landing necessary? If so, please provide details below.

PIC Signature _____ **Date** _____

Appendix D Mission Request Form

KYTC Department of Highways Uncrewed Aircraft Systems (UAS) Mission Request

Requestor _____ **Emergency Request? (circle) Y or N**
Requestor Agency (if not KYTC DOH) _____
Requestor Phone _____
Requestor Email _____

Purpose of the Flight

Mission Category
Please indicate which of the following apply.

☐ Project Management
☐ Public Outreach/Public Information
☐ Emergency Response
☐ Bridge Inspection
☐ Asset Inspection
☐ Geotechnical Investigation
☐ Damage Assessment (non-emergency)
☐ Property Inspection
☐ Environmental Study
☐ Training
☐ Other (please explain) _____

Attach map of location, if available. Otherwise, provide Lat/Lon: _____
Project-related identifying information (e.g., Contract ID, Item Number): _____
Does this request apply to a periodic or reoccurring request for repeated flights? If yes, please explain:
_____
_____

Requestor Signature _____ **Date** _____