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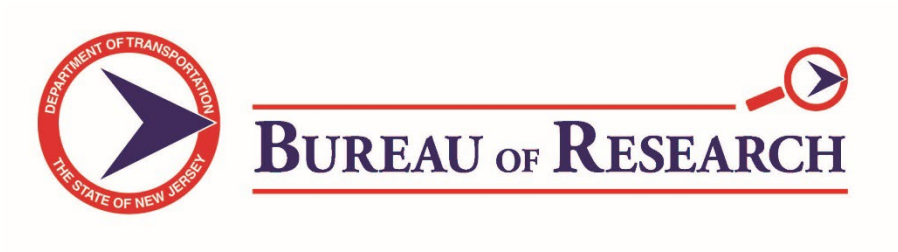

NJDOT Unmanned Aircraft Systems
FINAL REPORT

December 2023

Submitted by

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In cooperation with

New Jersey
Department of Transportation
Bureau of Research

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16. Abstract

NJDOT engaged Cambridge Systematics (CS) to review existing unmanned aircraft systems (UAS) practices within NJDOT and State DOTs to identify how UAS programs engage consultants, certify staff and consultants to conduct UAS missions, assess and manage risk associated with UAS missions, and manage and store data to comply with State and Federal regulations. This research effort included: a literature review, focused on Federal and State regulations that address UAS operations and administration, interviews with NJDOT staff and representatives from other State DOT UAS programs, and a review of NJDOT UAS program documentation and peer State DOT UAS program documentation that was either publicly available or provided to the research team during peer interviews. The research team synthesized the findings of this research effort and provided recommendations to NJDOT.

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EXECUTIVE SUMMARY

The New Jersey Department of Transportation (NJDOT) engaged Cambridge Systematics (CS) to review existing unmanned aircraft systems (UAS) practices within NJDOT and State Departments of Transportation (DOTs) to identify how UAS programs engage consultants, certify staff and consultants to conduct UAS missions, assess and manage risk associated with UAS missions, and manage and store data to comply with State and Federal regulations.

NJDOT has established a safe and well-recognized UAS program within the Bureau of Aeronautics and has been recognized as a national leader in UAS deployment. Divisions across NJDOT have acknowledged the safety benefits, cost-savings, and innovation UAS technology contributes to the agency. The benefits of the program have led NJDOT to conclude that the Department should expand the number and type of UAS-supported missions; doing so will require the use of both NJDOT staff and consultants.

An avenue for NJDOT to increase its UAS program capacity while maintaining the highest standards of safety and risk management is to implement a program to prequalify consultants, and implement standard operating procedures (SOPs) for anyone operating a UAS on behalf of NJDOT. NJDOT has developed a robust procedural framework to guide UAS training and operations by Department staff: the 2019 *Small Unmanned System (sUAS) Flight Operations Manual* (Flight Operations Manual) as well as associated guidelines and procedures. These materials can be expanded and applied to a scaled up UAS program.

The growing popularity of UAS missions – and the advancing technological capabilities of UAS fleets – has also led to increasing concerns and challenges related to UAS data collection, storage, use, and access. These processes remain vulnerable to cybersecurity threats and intersect with legislation established to protect public privacy. Federal and State legislation establishes boundaries regarding UAS data collection and use, but in the absence of comprehensive Federal guidance, NJDOT is responsible for implementing procedures to determine how UAS data shall be collected, used, and shared to maintain privacy within the State.

This research effort included: a literature review, focused on Federal and State regulations that address UAS operations and administration; interviews with the Bureau of Aeronautics; staff and Divisions that request UAS missions from the Bureau of Aeronautics; interviews with representatives from other State DOT UAS programs; and a review of NJDOT UAS program documentation and peer State DOT UAS program documentation that was either publicly available or provided to the research team during peer interviews. The research team, in consultation with the Bureau of Aeronautics , synthesized the findings of this research effort into recommendations under three areas:

- **UAS Prequalifying Criteria for Consultants and Sub-Consultants recommendations** focus on defining qualifications and certifications for consultants to maintain, as well as establishing procedures for NJDOT to manage and administer the pre-qualified pool of consultants. These recommendations are intended to apply to any NJDOT UAS consultant that is

specifically procured for UAS services and/or UAS services that fall under a more general contract for services within a Division. By equating all consultant procurement types and instituting policies specific to any consultant utilizing UAS on behalf of NJDOT, NJDOT can ensure all consultants are held to a similar, high standard.

- **UAS Standard Operating Procedures for Transportation Missions recommendations** focus on updating operating procedures for UAS missions, and are grouped into two main categories:
    - Updates and revisions to the Flight Operations Manual: Operations Manual details procedures for NJDOT UAS staff who perform routine UAS missions. Recommendations include processes for documenting, updating, and using the Flight Operations Manual; revisions and additions to risk assessment and mitigation procedures; and updates to pre-flight, in-flight, post-flight and emergency mission checklists.
    - Operating procedures for UAS special use cases: Five use cases were identified by NJDOT where operating procedures may need to include considerations beyond a typical mission. Recommendations for additional procedures and considerations for use cases were developed for:
        - High Mast Light Pole Inspections
        - Construction Project Management
        - Emergency Management
        - Operations at Public Use Airports
        - Field Observations/Demonstrations
- **UAS Data Security and Storage recommendations** focus on improving data security through a revised data management lifecycle and ensuring that the Bureau of Aeronautics and other NJDOT divisions that conduct UAS missions comply with State and Federal regulations. The recommendations touch on all steps of the data management lifecycle, including data acquisition, collection, processing, security, storage, sharing, and usage.

BACKGROUND

Unmanned aircraft systems (UAS), also known as “drones” were first developed and utilized to assist with military operations including surveillance and decoy applications via aerial imagery. Over the past five years, there has been rapid deployment of UAS technology by various Federal, State, and local agencies including State Departments of Transportation (DOTs), to enhance every-day operations.

The New Jersey Department of Transportation (NJDOT) has established a safe and well-recognized UAS program within the Bureau of Aeronautics and has been recognized as a national leader in UAS usage and deployment, conducting missions for aerial photography, high mast light pole inspections, bridge inspections, emergency management, among others. Divisions across NJDOT have acknowledged the safety benefits, cost-savings, and innovation UAS technology contributes to the agency.

With the program’s increasing popularity, it has created a high demand for UAS services. NJDOT is at an inflection point; the Department wants to scale their UAS program to the

next level, and the utilization of consultants is an effective way to bolster the program and quickly meet the demands for UAS technology across the DOT. It will be critical to do so in a way that ensures that the Department's goals are met for any mission performed by both NJDOT staff and consultants acting on behalf of the Department.

As federal regulations do not require any practical demonstration of UAS mission skills beyond possession of the Federal Aviation Administration (FAA) Remote Pilot Certification (107), the Bureau of Aeronautics is in need of a method of ensuring that UAS consultants and sub-consultants have the practical skills and experience necessary to meet the Department's critical risk management and safety objectives.

NJDOT has already developed a robust procedural framework to guide UAS operations. The primary guidance document is the Flight Operations Manual. This document details procedures for NJDOT UAS staff who are performing routine UAS missions. The *NJDOT UAS/Drone Procedures Manual and Best Practices for Use in New Jersey* report (UAS Best Practices Report) provides guidance on critical aspects of UAS operations, including risk assessment, risk management, and operational procedures.

At the same time, the growing popularity of UAS missions – and the advancing technological capabilities of UAS fleets – has led to increasing concerns and challenges related to UAS data collection, storage, use, and access. These processes remain vulnerable to cybersecurity threats and intersect with legislation established to protect public privacy. Federal and State legislation establishes boundaries regarding UAS data collection and use, but there is no single Federal agency that regulates these matters. In the absence of comprehensive Federal guidance, States are responsible for implementing procedures to determine how UAS data shall be collected, used, and shared to maintain privacy.

OBJECTIVES

Cambridge Systematics (CS) has been scoped to review and assess existing NJDOT UAS practices, conduct a best practice scan of UAS administration and operations practices at State DOTs, and provide recommendations for NJDOT to refine or update its procedures related to:

1. Prequalifying criteria and procedures for UAS consultants working with NJDOT;
2. Procedures for UAS missions and five special use cases:
    a. High mast light pole inspections
    b. Construction project management
    c. Emergency management
    d. Routine imaging of public use airports
    e. Field observation/ demonstration
3. UAS data security and storage requirements, policies, and procedures.

These recommendations are designed to enhance the Bureau of Aeronautics ability to increase its capacity to conduct UAS missions and to do so in a safe, reliable, and efficient manner.

INTRODUCTION

NJDOT engaged CS to review existing UAS practices within NJDOT and State DOTs to identify how UAS programs engage consultants, certify staff and consultants to conduct UAS missions, assess and manage risk associated with UAS missions, and manage and store data to comply with State and Federal regulations. This effort included: a literature review, focused on Federal and State regulations that address UAS operations and administration; interviews with Bureau of Aeronautics staff and Divisions that request UAS missions; interviews with other State DOT UAS program representatives; and a review of NJDOT UAS program documentation and peer State DOT UAS program documentation that was either publicly available or provided to the research team.

SUMMARY OF THE LITERATURE REVIEW

An extensive literature review comprised of materials from all 50 states (including New Jersey), as well as Federal agencies and research organizations was undertaken to understand both the current state and evolution of the practice. The material incorporated in the literature review includes State DOT UAS Program Information, the Bureau of Aeronautics Documentation, additional New Jersey documentation, U.S. Code of Federal Regulations, and additional documentation from various sources. These sources utilized in this research are summarized in the following sections.

State DOT UAS Program Information

The primary source of information from other State DOTs was their UAS SOPs and related procedures related to UAS operations. State DOT SOPs range in length, format, and content, but typically contain procedures for UAS use, which may include training requirements, flight documentation, emergency procedural guidelines, maintenance forms etc. The research team reviewed a variety of State DOT UAS SOPs to compare practices across the country and enhance NJDOT's current procedural framework. Below were publicly available or peer-shared documents that were most often used to provide benchmarks, recommendations, and discussion points with NJDOT. As seen below in Figure 1, many of these States were used to lay the landscape of UAS program centralization and their estimated consultant usage, ultimately to provide NJDOT with a better understanding of the practice and DOT program development nationally.

Connecticut DOT (CTDOT) The CTDOT Unmanned Aircraft Systems (UAS) SOP (2019) is a 19-page document describing the DOT's UAS program. CTDOT provided language for insurance requirements, consultant requirements, and equipment management. CTDOT offered examples of pre-flight checklists.

Delaware DOT (DelDOT) The DelDOT Unmanned Aircraft System Operational Policy (2016) is a 4-page document describing the DOT's UAS program. DelDOT provided context for the UAS practices in relation to consultants and RPIC requirements. DelDOT offered examples of emergency procedures.

Georgia DOT (GDOT)[1] The GDOT Unmanned Aircraft Systems Policy and Forms was utilized in this research effort. This document was publicly available at the onset of the research phase, but has since been removed from GDOT's website. GDOT provided information and examples for the pre-flight checklists to the research team.

Massachusetts (MassDOT) The MassDOT Unmanned Aircraft System Operational Policy (2017) is a 4-page "interim" policy describing how to utilize UAS in respect to the DOT. MassDOT provided context for the UAS practices in relation to consultants and RPIC requirements.

Minnesota DOT (MnDOT) MnDOT did not have an official SOP, but two separate PDFs, one *UAS policy* and the other *UAS procedures* (2020). These documents were utilized in this research effort. MnDOT provided language for insurance requirements to the research team.

Nebraska DOT (NDOT)[1] The NDOT UAS SOP (2022) is a 60-page document describing the DOT's UAS program. This document was publicly available at the onset of the research phase, but has since been removed from NDOT's website. It was provided by the UAS Program Manager at NDOT subsequently. This was utilized heavily in the research effort. NDOT provided context for the UAS practices in relation to consultants and RPIC requirements. NDOT offered model language in relation to driver distraction and sterile cockpit standards to the research team.

North Carolina DOT (NCDOT) The NCDOT UAS SOP (n.d.) is a 21-page document describing the DOT's UAS program. NCDOT provided context for the UAS practices in relation to consultants, the prequalification process, and RPIC requirements. NCDOT presented the most robust examples of emergency procedures and guidelines for emergency management (which formed the basis for the Use Case addendums) and provided an example risk rating matrix.

Ohio DOT (ODOT)[1] The ODOT Flight Operations Manual (2019) is a 91-page document describing the aircrew training procedures for the DOT's UAS program. This document is not publicly available and was provided by a representative from ODOT. ODOT provided context for the UAS practices in relation to consultants and RPIC requirements.

Oregon (ODOT) The ODOT UAS Operations Manual (2023) was the most recently updated SOP reviewed. The 24-page document is considered living and consistently is updated by the UAS team at the DOT. ODOT provided context for the UAS practices in relation to consultants, RPIC requirements including example flight exercises, and discussed their flight management system. ODOT offered key research for driver distraction and helped inform the recommendations for SOP management e.g. living document standards. The SOP included a reference to the ODOT UAS Policy (ADM 2-25), identifying how UAS data can be stored and retained.

[1] This document does not have a publicly accessible online location.

Pennsylvania DOT (PennDOT) The PennDOT Unmanned Aircraft System Policy (2019) is a 19-page document describing the DOT's UAS program. PennDOT provided language for the UAS practices in relation to consultants, specifically how to define consultants and their responsibilities into the SOP documentation, RPIC requirements, and equipment and insurance standards. PennDOT offered examples of a risk assessment worksheet. The policy also provides a statement for how UAS data will be collected and shared by consultants.

Texas DOT (TxDOT) The TxDOT Unmanned Aircraft System Operational Policy (2023) is a 59-page document describing the DOT's UAS program. This document went through an update during this research effort. TxDOT provided context for the UAS practices in relation to consultants, indemnification and RPIC requirements. TxDOT offered examples of high mast light pole documentation, laid a foundation for driver distraction rules and operations near active roadways/ structures/ personnel guidelines, and provided their risk assessment process framework.

Utah DOT (UDOT) The UDOT Unmanned Aircraft System Procedures (2017) is a 4-page document describing the DOT's UAS program. UDOT provided context for the UAS practices in relation to consultants and RPIC requirements. It also defined how UAS is permitted for use in regard to data collected.

Virginia DOT (VDOT) The VDOT Unmanned Aircraft System Operations Manual (2021) is a 49-page document mirroring TxDOT's SOP and describing the DOT's UAS program. VDOT is the only State DOT that exclusively uses UAS consultants, so it provided the foundation for UAS practices in relation to consultants and with that consultant RPIC requirements, indemnification, and equipment management. VDOT was presented as an example DOT for high mast light pole inspection, laid a foundation for driver distraction rules and operations near active roadways/ structures/ personnel guidelines, and provided their risk assessment process framework. VDOT defines procedures for acceptable collected data during UAS missions.

Washington DOT (WSDOT) The WSDOT Unmanned Aircraft System Manual (2022) is a 31-page document describing the DOT's UAS program. WSDOT provided context for the UAS practices in relation to consultants and RPIC requirements. WSDOT offered examples of risk assessment documentation and preflight checklists. WSDOT identified that UAS data collected by consultants is the responsibility of WSDOT personnel.

NJDOT Bureau of Aeronautics Documentation

The Bureau of Aeronautics has a variety of documents which form the foundation of the NJDOT UAS Program. These documents grounded the research and were used to supplement gaps in information and be used as a tool for comparison. The documents most heavily used were the Flight Operations Manual and its accompanying "DA" forms, along with the UAS Best Practices Report. The research team reviewed NJDOT's current guidelines and procedures to identify opportunities and to determine if there were any current NJDOT practices left undocumented. Three groups of documents on the following pages, were the main reference points used, as a basis in creating recommendations.

NJDOT Bureau of Aeronautics Forms (DA-50, DA-51, DA-54, DA-DA-56, DA-60, DA-61, DA-62, DA-63, DA-64), Risk Assessment Worksheet The variety of detailed mission documentation was critical to understanding how UAS missions are planned, executed, and debriefed at NJDOT. Many of the research team's recommendations centered on augmenting these forms through material gathered from peer State DOTs but also expanding them to consultants so a safe and precise standard is set across all UAS DOT representatives. These "DA" forms and risk assessment sheet can be found in the Flight Operations Manual and the UAS Best Practices Report.

NJDOT Small Unmanned Aircraft System (sUAS) Flight Operations Manual (2019) The Flight Operations Manual is the backbone of the UAS program at NJDOT, containing all relevant guidelines, procedures, and protocols for UAS staff to follow. The research team reviewed and re-utilized many of the sections, diagrams, and content in the recommendations to ensure that all practices learned through research and discussion with NJDOT were documented in the Flight Operations Manual.

NJDOT UAS/Drone Procedures Manual and Best Practices for Use in New Jersey Report (UAS Best Practices Report) The research team compared this final report to the Flight Operations Manual to ensure all practices, recommendations, and procedures aligned to ultimately create a more enhanced Flight Operations Manual.

Additional New Jersey State Documentation

The following identifies additional New Jersey State resources, outside of those published by the Department of Transportation.

New Jersey Office of Information Technology (NJOIT) Statewide Information Security Manual (SISM) NJOIT'S SISM includes a set of policies and standards that support agencies in their efforts to carry out specific technology missions. These policies and standards aim to effectively manage risk and ensure the confidentiality, integrity and availability of information and information assets (e.g. data, devices, hardware, software, or other components). The following sections were used to inform this research team's recommendations: Risk Assessment, Personally Identifiable Information Processing and Transparency, Media Protection, System and Information Integrity, System and Services Acquisition, System and Communications Protection, Planning, and Physical and Environmental Security.

New Jersey Office of Information Technology (NJOIT) System Architecture Review Policy (16-05) NJOIT's System Architecture Review Policy includes a four step process to ensure alignment with the State's information technology strategy and architecture standards. The SAR process and policies were reviewed.

State of New Jersey Government Records Council - Open Public Record Act (OPRA)The project team reviewed New Jersey's Open Public Record Act, to identify legal procedures and relevance to sharing and using UAS data.

New Jersey State General Records Schedule and State of New Jersey Transportation Records Retention and Disposition Schedule These two documents outline the data retention policies for the State of New Jersey.

New Jersey Code and Statutes The following New Jersey Codes and Statutes were

reviewed:

- ***N.J.S.A. 2C:14-19 (Invasion of Privacy)*** - Prohibits conducting UAS to observe another person engaging in sexual contact without that person's consent under circumstances in which a reasonable person would not be expected to be observed.

- ***N.J.S.A 2C: 18-3 (Trespassing)*** – Prohibits peering into a window or other opening of a dwelling or other structure adapted for overnight accommodation for the purpose of invading the privacy of another person and under circumstances in which a reasonable person in the dwelling or other structure would not expect to be observed.

- ***N.J.S.A. 2C:40-27 (Definitions relative to operation on unmanned aircraft systems***) – Defines the terms related to operation of unmanned aircraft systems and identifies that any person shall operate an unmanned aircraft in New Jersey in a manner consistent with applicable Federal law and regulations.

- ***N.J.S.A. 2C:40-28 (Violations, degree of offense, crime) -*** Defines violations, degree of offense, and crime related to UAS operations through specific use cases. Section (2) directly applies to data collection and defines that a person commits a crime of the third degree if knowingly operates an unmanned aircraft system to conduct surveillance of, or gather information about, a correctional facility without license or privilege to do so.

- ***N.J.S.A. 2c:40-29 (Provisions preempt existing laws) -*** The provisions of P.L.2017, c.315 (C.2C:40-27 et al.) shall preempt any law, ordinance, resolution, or regulation adopted by the governing body of a county or municipality concerning the private use of an unmanned aircraft system that is inconsistent with the provisions of this act.

- ***N.J.S.A 2C:40-30 (Authorized use permitted) -*** Nothing in P.L.2017, c.315 (C.2C:40-27 et al.) shall prohibit the authorized use, in compliance with applicable Federal rules and regulations, of an unmanned aircraft system by a public employee or a public entity, or by a first responder in the performance of official duties.

- ***N.J.A.C. 7:25-5.22 (Wild animals; possession; killing)*** - No person shall hunt from or shoot at any wild animal or bird from any airborne conveyance, including an unmanned aircraft or drone. Except when authorized through a permit issued pursuant to N.J.A.C. 7:25-5.32.

U.S. Code of Federal Regulations

The pertinent Codes of Federal Regulations (CFR) were reviewed to gain a greater understanding of the Federal UAS landscape.

Part 107 - Small Unmanned Aircraft Systems "Part 107" is the legal qualification and eligibility code for UAS pilots. It entails a certification to demonstrate that a pilot understands the regulations, operating requirements, and procedures for safely flying. This includes:

Part 107.145 Operations over moving vehicles. This subset of Part 107 describes the conditions needing to be met to operate UAS over an individual in a moving vehicle.

Part 135 - Operating Requirements: Commuter and On Demand Operations and Rules Governing Persons On Board Such Aircraft. "Part 135" outlines flight crew member duties necessary to prevent driver distraction from UAS operations while preserving crewmember focus.

Additional State, Federal, and Research Documentation

A number of additional documents not included in the categories above were also reviewed as part of this research. These are summarized in the following listing within this section.

AASHTO - UAS/AAM State of Play for State DOTs Brochure and Survey (2021) The AASHTO 2021 Brochure and Survey was one in a series of surveys conducted by AASHTO to learn more about issues, key activities, and State DOT operations in the UAS space.

AASHTO - UAS/Drone Survey of All 50 State DOTs (2019) The AASHTO 2019 Survey was one in a series of surveys conducted by AASHTO to learn more about the development State DOT operations in the UAS space. This was used to help establish a timeline of UAS growth and understand barriers to mass adoption of UAS at the DOT level.

AI Engineers.com - MassDOT District 6 High-Mast Light Structures UAS Inspection This media article was used as a source for the use case, High Mast Light Pole Inspection. The research team could not find any DOT documentation involving MassDOT and HMLP, but finding this article provided evidence of another State DOT conducting that use case.

Andreas Molina, Yilei Huang, and Yuhan Jiang - A Review of Unmanned Aerial Vehicle Applications in Construction Management: 2016–2021 This research report is a literature review of "UAV" research in construction management during the timeframe of 2016 to 2021. It was used as a reference to provide guidelines for the use of UAS on construction sites.

Colorado DOT - Aerial Survey Manual, Chapter 4 (2021) CDOT's Aerial Survey Manual provided fodder for the Field Observation and Demonstration use case by this research team. This included a dedicated section about UAS, describing the minimum requirements for flight crew, equipment specifications, environmental factors, and data requirements.

FAA - Office of Airports Safety and Standard Operations of UAS activities near airports The research team reviewed this FAA guidance on UAS access, communications, and operations in respect to operations and airports.

FAA Drone Zone This FAA “drone service” hub was reviewed and initially used as a tool for the research team to become familiar with the FAA’s communication about UAS, about Part 107, and recreational/commercial flying.

FHWA - Tech Brief: Use of Small Unmanned Aerial Systems for Construction Inspection (2019) This document informed guidelines for the use of UAS on construction sites. It provided sources for further research, case studies, and other considerations for UAS staff in the governmental sectors.

FHWA - Use of Unmanned Aerial Systems (UAS) by State DOTs (2018) This FHWA Peer Exchange (which NJDOT participated in) provided the research team primary sources of information for the NJDOT selected use cases and general context for promoting UAS work at the DOT level.

Florida State Senate - Use of Drones by Government Agencies (2021) Florida’s recent UAS bill outlining the responsibilities, limitations, and planning requirements law enforcement agencies, fire departments, State agencies, and political subdivisions take on when operating UAS on behalf of an agency. The new exceptions allow law enforcement agencies to use drones to gain an aerial perspective of a crowd of 50 or more persons; assist with traffic management, except that the agency may not issue a traffic infraction based on images or video captured by a drone; and facilitate evidence collection at a crime scene or traffic crash scene.

Government Fleet.com - Here's How State DOTs are Using Drones (2019) This website was used to initially understand how State DOTs were utilizing UAS technology during this research effort. It was a media publication reporting on the AASHTO 2019 survey.

Maryland Department of Transportation – Data Governance Manual (2020) Maryland’s Data Governance Manual provided the organizational data structure, used to inform the recommended New Jersey Data Management Lifecycle process.

MassDOT - The Application of Unmanned Aerial Systems In Surface Transportation - Volume II-D: Development of UAS Emergency Service Drone Network for Use in Surface Transportation (2019) This MassDOT research helped provide a case study for the Emergency Response use case.

National Academy of Sciences (NAS) Airport Cooperative Research Program (ACRP) - Report 212: Airports and Unmanned Aircraft Systems, Volume 3: Potential Use of UAS by Airport Operators (2020) The research team reviewed this National Academy of Sciences guidance on UAS access, communications, and operations in respect to operations and airports.

National Conference of State Legislatures - Current Unmanned Aircraft State Law Landscape The NCSL website provides an understanding of the national landscape, UAS related legislation, and Federal UAS regulation. This was used by this research team to contextualize the UAS program development across all 50 State DOTs.

North Carolina DOT – Rules & Regulations for Aerial Surveying in North Carolina with Unmanned Aerial Systems (UAS) (2020) NCDOT's Aerial Surveying Manual provided information for the Field Observation and Demonstration use case.

North Carolina DOT – UAS Best Practices - Incident Response Integration Exercise The NCDOT's UAS Incident Response Addendum provided a document example for the Emergency Response use case. It was one of the only addendums of its kind in the UAS space and was the basis of the NJDOT recommended addendums and most of the emergency response recommendations.

North Carolina DOT – Division of Aviation's UAS Resources Hub NCDOT Division of Aviation's goal has an online UAS resource hub to ensure that UAS flying within North Carolina are flown safely and responsibly. The purpose of this resource page is to provide State and local governments the appropriate tools to create and manage UAS programs to support their specific operational needs.

North Carolina DOT – Unmanned Aircraft System (UAS) Search And Rescue Addendum (2016) The NCDOT's Search and Rescue Addendum provided a case study example for the Emergency Response use case, discussing hurricane response. It was one of the only addendums of its kind in the UAS space.

Oregon DOT - Driving Distraction Due to Drones (2018) ODOT's research with the FHWA provided dense research involving knowledge related to the potential safety concerns of drone operations near roadway infrastructures. It was used to justify the team's recommendations.

Texas - Model Security Plan for Prohibited Technologies (2023) Texas' latest security plan for protecting the State's sensitive information and critical infrastructure from technology that poses a threat.

Texas DOT - Highway Illumination Manual (2018) TxDOT's Highway Illumination Manual provided a document example for the High Mast Light Pole inspection use case for the research team.

United States Department of Homeland Security (DHS) - Best Practices for Protecting Privacy, Civil Rights, and Civil Liberties in Unmanned Aircraft Systems Programs (2015) This report, from a DHS Working Group, is a collection of best practices to inform local, State, and Federal government partners on policies and procedures that are respectful of privacy, civil rights, and civil liberties in respect to unmanned aircraft programs.

United States Innovation and Competition Act (USICA) and U.S Department of Defense Statement on DJI Systems The USICA and the U.S Department of Defense Statement on DJI systems was used to inform and provide context related to UAS security for the research team. Although the USICA has not been adopted into Law, it declares that Federal agencies may not procure or operate any covered unmanned aircraft system that is manufactured or assembled by a covered foreign entity, which could impact UAS programs in many States. In addition, the U.S Department of Defense Statement on DJI systems aligns with the USICA, noting that DJI UAS systems could pose a threat to national security. These opinions were used by the research team to inform recommendations related to UAS security.

SUMMARY OF WORK PERFORMED

The literature review, conducted interviews with NJDOT and other State staff, and discussions with the Bureau of Aeronautics were used in tandem to develop a set of findings and recommendations across the following research categories:

- **UAS Policies and Procedures of Peer State Agencies** – overview of the national landscape of UAS operations at State DOT's, including assessing safety programs, providing a timeline of UAS program development, and identifying challenges to State UAS programs.
- **UAS Prequalifying Criteria for Consultants and Sub-Consultants** – research findings and recommendations regarding qualification and certification of consultants for the purposes of conducting UAs missions on behalf of the DOT.
- **UAS Standard Operating Procedures for Transportation Missions** – review of existing procedures and recommendations for updates to operating procedures for general and specific use case missions (e.g., High Mast Light Pole Inspections, Construction Project Management, Operations at Public Use Airports, and Field Observations/Demonstrations).
- **UAS Data Security and Storage** –research findings and recommendations regarding UAS data security and storage.

Assessment of the Current State of the Practice

State DOT UAS programs are an emerging area of research and practice. To determine how well New Jersey's UAS program compared to other State programs, Federal guidance, and general best practices, the research conducted a broad scan of State DOT, Federal, and other resources, which are described in the Summary of the Literature Review.

UAS Program practices across State DOTs varied widely. In terms of use of consultants, there were wide differences in both how often consultants were used and how they were managed, with NJDOT scoring high for both usage of consultants and

department management of consultant UAS operations (Figure 1). The research team discussed the desired use of consultants and reviewed the findings from the research scan with the Bureau of Aeronautics staff and applied this guidance to filter the spectrum of information on UAS program consultant usage practices to craft recommendations most suitable to NJDOT.

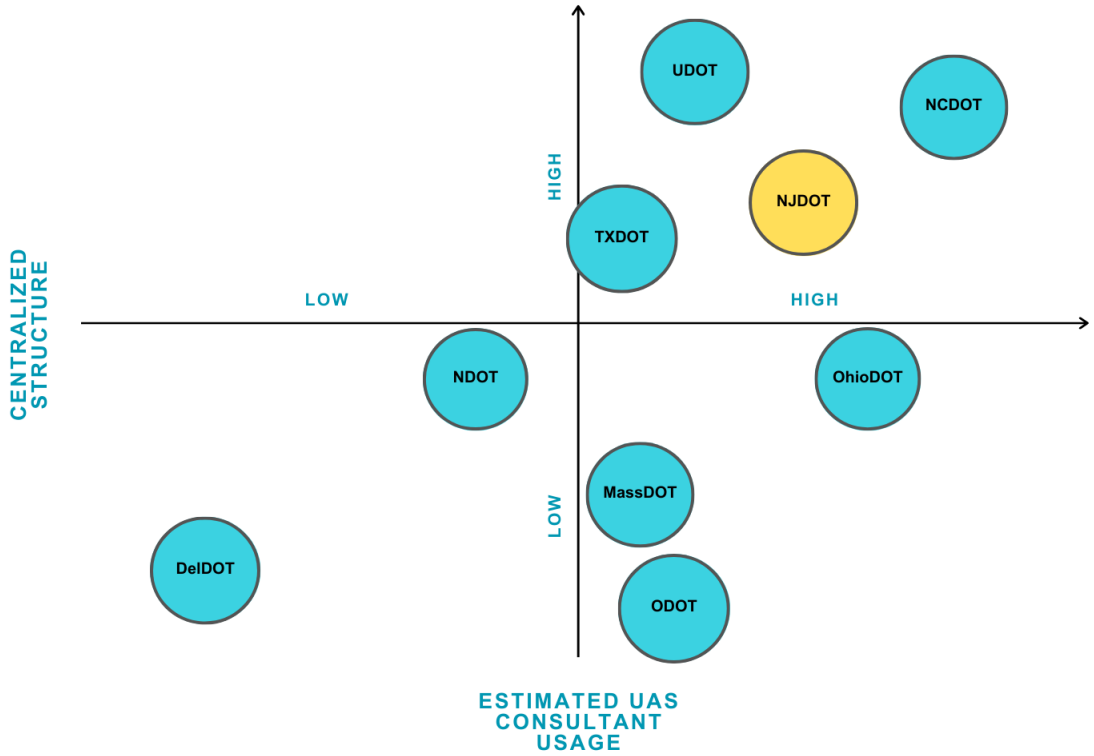

Figure 1: Spectrum of Usage of UAS Consultants

The research team also found wide differences in terms of the existence of, content of, and use of standard operating procedures, guidance, or mission standards within State DOTs. The research team conducted a review of UAS procedures from 14 publicly available standard operating procedures from peer State DOTs. This included documentation such as flight operations manuals, risk assessment and mitigation approaches, checklists, and supplementary materials. The research team reviewed NJDOT's current procedures for UAS operations and received information from the Bureau of Aeronautics staff. Based on these sources, the research team identified opportunities and gaps within these existing NJDOT UAS guidance and procedures. Similarly, the research team reviewed the findings with the Bureau of Aeronautics staff, who provided guidance which was incorporated into the development of recommendations.

In regard to UAS Data Management Procedures, while all State DOTs acknowledge the importance of being sensitive to individual's privacy when conducting UAS missions,

State DOT's have various structures and processes for collecting, storing, sharing, and using UAS data. A common theme across all DOT's included the importance of establishing data security, storage, sharing, and accessing procedures as they expand UAS in their State, and overall lack of provided guidance related to UAS data sharing procedures from Federal agencies. information received from interviews within NJDOT as well as review of NJDOT legal and privacy policies, Information Technology procedures, and similar documentation was reviewed. An analysis was conducted to identify gaps or opportunities for improvements to NJDOT policy and the research team developed recommendations to address these.

Interviews of Other State DOTs and Key Stakeholders

State DOT Interviewees

To gain a deeper understanding of the practices and experiences of other States, the research team identified and conducted interviews with UAS program managers, coordinators, or other relevant staff at nine State DOTs. Interviewees are listed in Table 1. These State programs were identified based on recommendations from the Bureau of Aeronautics staff, an initial scan of State programs, or participation in peer research sharing through AASHTO or similar organizations.

Peer Agency	Interviewees
Delaware DOT (DelDOT)	• Dwayne Day, Homeland Security Planner
Massachusetts DOT (MassDOT)	• Scott Uebelhart, Chief Scientist, Drone Program, Aeronautics Division • Robin Grace, Chief, UAS Operations • Paige Scott Reed, Chief Legal Counsel
Nebraska DOT (NDOT)	• Jon Starr, Engineering Technology and UAS Program Leader
North Carolina DOT (NCDOT)	• Thomas Wall, UAS Operations Manager • Riley Beaman, UAS Program Manager
Ohio DOT (Ohio DOT)	• Fred Judson, UAS Program Director
Oregon DOT (ODOT)	• Christopher Garris, Construction Automation Engineer
Pennsylvania DOT (PennDOT)	• John Melville, Aviation Safety Supervisor • Anthony McCloskey, Director, Bureau of Aviation Director
Texas DOT (TxDOT)	• Sergio Roman, II, UAS Program Manager
Utah DOT (UDOT)	• Paul Damron, Manager, Advanced Air Mobility • Jared Esselman, Director, Aeronautics • Riley Lindsay, Manager, UAS Operations

Table 1: List of Peer State DOT Interviewees

State DOT Interview Guide

The peer State agency interview guide included seven (7) core questions, with options to explore the responses in more detail at the interviewer's discretion. The core questions were:

1. What types of UAS missions do you perform and how do you coordinate with other divisions/business units within your agency?

2. How are potential risks of UAS missions identified and evaluated to ensure mission safety?

3. What procedures does your agency use to mitigate risk and ensure safety during UAS missions?

4. Does your agency have standard operating procedures, mission checklists, or other documentation that supports your UAS program?

5. Do you utilize consultants for UAS missions? If so, how do you ensure they are qualified to perform the contracted missions?

6. What types of data are gathered during UAS missions and how are they processed, stored, and disposed of?

7. Are there any State laws applicable to UAS data retention and usage or public privacy which create barriers to conducting UAS missions?

State DOT Interview Findings

The interviewees described many details about the history and structure of the UAS program in the State, the types of use cases for which they are utilizing UAS, context related to working with consultants, and information about their standard operating procedures including their standards for data management. Many States mentioned that an issue they are often tackling is how dispersed the UAS program may be across the State, resulting in difficulties ensuring that all operators are complying with their standardized procedures. Some States explained that they do not use consultants for UAS missions, while others explained how they ensure that the consultants they hire meet the standard of their in-house UAS operators. All interviewees described their methods for ensuring safety during their mission and mentioned at least some details about their data collection and management principles. They also provided some context about the development their standard operating procedures, flight operations manual, or other related UAS materials.

Interviews with Key Stakeholders at NJDOT

NJDOT Interviewees

The research team also conducted interviews with several representatives from different NJDOT Divisions, Offices, and roles to better understand how the agency is currently utilizing UAS. Several interviewees preferred to provide the research team written

responses. Interviewees are listed in Table 2. These individuals were identified based on recommendations from the Bureau of Aeronautics staff.

Office or Division	Interviewees
Office of Enterprise Management (EMO)	• Komila Pandit, Manager 1, Information Processing
Bureau of IT and Security Services	• Steven Prichard, Manager of IT HelpDesk and Chief Information Security Officer • Gary Zayas, Director, Division of Information Technology
Structural Evaluation and Bridge Management	• Utsab Pokharel, Senior Engineer, Structural Evaluation
Bureau of Aeronautics	• David Nevil, Program Specialist 1 • Shadman Mohammed, Principal Engineer, Transportation
Structural Design & Geotechnical Engineering	• Christina Comuso, Geologist 1
Central Operations, Office of Emergency Management	• James Nunn, Area Supervisor Highway Operations • Nicholas Canulli, Area Supervisor Highway Operations

Table 2: List of NJDOT Interviewees

NJDOT Interview Guidance

Interview questions were provided to interviewees ahead of time, and were tailored specifically to the role of the Office or Division that was interviewed. For example, the discussion with the Bureau of IT and Security Services focused on data management and security procedures for NJDOT, while the interview with Structural Evaluation and Bridge Management illuminated details about considerations such as the GPS challenges for using UAS for under-deck bridge inspections and also details about utilizing the different forms required by NJDOT (e.g. DA-50) to complete a UAS mission.

NJDOT Interview Findings

Notable highlights from the NJDOT interviews include:

- The interview with the Bridge Engineering and Infrastructure Management Division revealed many details about how UAS are being used to conduct bridge and high mast light pole inspections, including that NJDOT is participating in AASHTO-led research on the topic.
- The interview with the Bureau of IT and Security Services provided specific details and documents that were integral to providing recommended improvements to NJDOT's data security and management principles for UAS.
- The interview with two RPICs from the Bureau of Aeronautics illuminated many

specificities about working with and utilizing consultants for UAS missions, the process of preparing, completing, and debriefing after a mission, and the different kinds of use cases of UAS in the DOT.
- Other interviews provided helpful details about how UAS are or are desired to be used for other mission types such as emergency response missions.

CONCLUSIONS AND RECOMMENDATIONS

The research team developed a comprehensive set of deliverables which incorporated findings from the literature review, State DOT interviews, NJDOT interviews, and discussions with the Bureau of Aeronautics staff to produce a set of over **51 recommendations and considerations** across the three key research areas: UAS Prequalifying Criteria for Consultants and Sub-Consultants, UAS Standard Operating Procedures for Transportation Missions, and UAS Data Security and Storage. These are summarized below.

UAS Prequalifying Criteria for Consultants and Sub-Consultants

The Bureau of Aeronautics has articulated a goal to establish and maintain a pre-qualified UAS consultant list. The recommendations in this research area focus on defining qualifications and certifications for consultants to maintain, as well as establishing procedures for NJDOT to manage and administer a pre-qualified pool of consultants. These recommendations are intended to apply to any NJDOT UAS consultant that is specifically procured for UAS services and/or UAS services that fall under a general contract for services within a Division.

As many documents, guidelines, and procedures that currently exist for NJDOT UAS missions are aimed at NJDOT staff, there are numerous times within the UAS Mission Lifecycle where changes or updates will need to be made to achieve NJDOT's goal of establishing, maintaining, and utilizing a pre-qualified UAS consultant list. Figure 2 shows how the recommendations fall within the existing structure of the UAS Mission Lifecycle, as defined in the Flight Operations Manual. In this figure, the yellow boxes outline where this research team developed recommendations.

The research team identified 16 recommendations under two categories and one consideration under this research task area. These recommendations, labeled as **Consult** and numbered, are presented on the following pages.

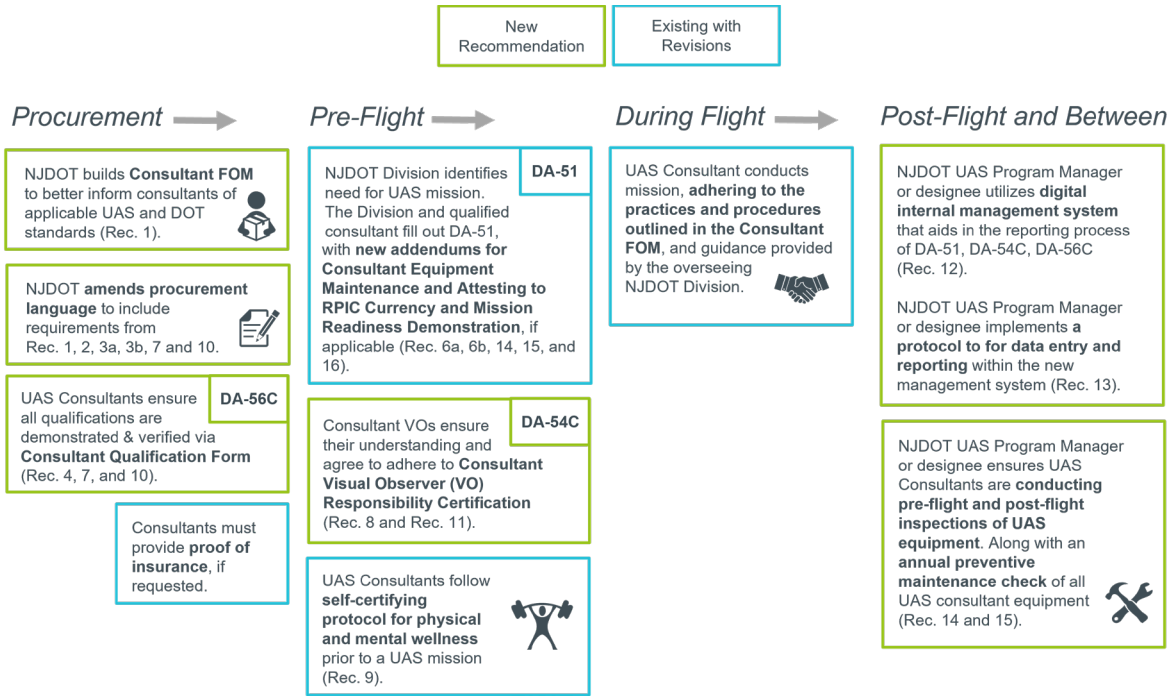

Figure 2: Pre-Qualification of consultants, recommendations organized within the structure of the NJDOT UAS Mission Lifecycle

RPIC and VO Qualifications

There are two primary roles defined for UAS operators by NJDOT: Remote Pilot in Command (RPIC) and Visual Observer (VO). RPICs are the leading entity during any UAS mission, responsible for making all final decisions regarding the safety of flight operations. For NJDOT Missions, RPICs are accompanied by a Visual Observer (VO) who are responsible for observing the UAS mission and providing situational awareness to the RPIC during flight. When developing a qualified UAS consultants list, NJDOT should require consultants to submit information on both RPICs and VOs, and require RPICs and VOs to certify that they meet the minimum standards required for UAS operations for NJDOT.

Recommendation (Consult.1): The Bureau of Aeronautics should update the Flight Operations Manual published in 2019 and make certain portions available to consultants to review in a “Consultant Flight Operations Manual”.

Recommendation (Consult.2): The Bureau of Aeronautics should require a qualified UAS consultant to possess, maintain, and present their Part 107 certification if requested.

Recommendation (Consult.3a): To become a qualified UAS consultant, NJDOT should require consultant RPICs to demonstrate five qualifying hours of recorded flight time and certify their experience in the skills required for operating UAS missions on behalf of NJDOT.

Recommendation (Consult.3b): NJDOT should require qualified UAS consultant RPICs who will be conducting missions in any controlled airspace (Class B, C, D, or E where air traffic control authorization is required), to submit documentation of five qualifying hours of recorded flight time in controlled airspace.

Recommendation (Consult.4): The Bureau of Aeronautics should implement a process for proficiency checks of qualified UAS consultant RPICs.

Recommendation (Consult.5): If a State of Emergency[2] is declared for any portion of New Jersey by the Governor before, during, or after a disaster or in an emergency situation defined by NJDOT , the UAS Program Manager may choose to waive any of these requirements and allow consultants to operate within the State of New Jersey.

Recommendation (Consult.6a): NJDOT should require qualified UAS consultant RPICs to maintain 90 day currency with the Department.

Recommendation (Consult.6b): NJDOT should implement a practice that requires qualified UAS consultants to be responsible for mission readiness of themselves, their team, and their equipment.

Recommendation (Consult.7): NJDOT should require qualified UAS consultants to submit qualifications for VOs, similar to RPICs, including demonstrated practical experience for VOs.

Recommendation (Consult.8): Prior to each mission, NJDOT should require qualified UAS consultant RPICs to affirm that they have briefed VOs as per the process outlined in the current DA-54 and require qualified UAS consultant VOs to have read and reviewed the information outlined in DA-54.

Recommendation (Consult.9): NJDOT should work with the NJDOT civil rights office (or other appropriate office or division) to define a self-certifying mission readiness checklist for RPICs and VOs that includes attesting to adequate physical and mental state for a UAS mission.

Consultant and Equipment Management

The manner in which DOTs manage their UAS programs impacts their management of consultants. The NJDOT UAS program team seeks a more unified structure when managing UAS consultants to ensure the DOT's standards are upheld across all Divisions, all consultants and Divisions utilize the processes the Bureau of Aeronautics has in place, and consultants' qualifications and competencies are verified. Creating a centralized process where all consultant and equipment documentation is kept, verified, and used for reporting, will streamline processes, create higher standards of

2 A State of Emergency as defined by the Office of Emergency Management of the State of New Jersey: https://nj.gov/njoem/about-us/state-of-emergency.shtml

compliance, and ease administrative communication within NJDOT. These recommendations also discuss standards pertaining to equipment, including hardware, maintenance, roles and responsibilities, and registration. This is particularly relevant considering the need to maintain, handle, and prepare equipment properly often helps mitigate the risk of injury or damage.

Recommendation (Consult.10): NJDOT should develop form DA-56C Internal Form to Track and Record UAS Consultant Qualifications for use in creating and ensuring currency of a pre-qualified pool of UAS consultants.

Recommendation (Consult.11): NJDOT should repurpose DA-54 (Visual Observer (VO) Responsibility Certification) as DA-54C Consultant Visual Observer (VO) Responsibility Certification, extending it for qualified consultant VO use.

Recommendation (Consult.12): NJDOT should amend the existing SimpliGov digital internal management system that aids in the reporting process of DA-51, DA-54C, DA-56C, and tracks UAS consultant qualifications, mission eligibility, proficiency in operations, and/or currency.

Recommendation (Consult.13): NJDOT should implement a protocol to clearly define who is responsible for data entry and reporting within the new management system.

Recommendation (Consult.14): NJDOT should codify in the Consultant Flight Operations Manual that qualified UAS consultants are responsible to ensure equipment is airworthy, including pre-flight and post-flight inspections of UAS equipment.

Recommendation (Consult.15): NJDOT should implement a procedure within the Consultant Flight Operations Manual for consultants to annually conduct preventive maintenance of all UAS equipment.

Recommendation (Consult.16): NJDOT should amend DA-51 to include the objectives from DA-60, creating DA-51 Consultant Maintenance Requirements.

Insurance Considerations

According to the FAA, Federal laws do not require UAS insurance. However, many States do require or advise that consultant UAS operators have insurance, including liability coverage and indemnification, in the event of an accident. Determinations around insurance requirements within NJDOT are subject to additional review that is outside the purview of the research team. Therefore no recommendations regarding insurance are provided. Instead, NJDOT should review these considerations when determining their insurance and liability requirements for consultants.

Consideration (Consult): There are several insurance requirements related to UAS operations by consultants common in other States that, to the knowledge of the research team, are not currently underway in New Jersey. These include:

- Requirement of insurance for consultants undertaking UAS operations. The most common minimum limit of coverage in other States reviewed is $1,000,000 per occurrence.
- Certain States also require liability coverage and mandate the DOT to be listed as an additional insured on the coverage.
- Indemnification was underscored within a few DOTs, which shields the DOT from taking on more risk than necessary and legally prohibits compensating for harm or loss if an accident occurs.

UAS Standard Operating Procedures for Transportation Missions

The Bureau of Aeronautics has articulated a goal to establish operating procedures for special use case UAS missions. While undertaking this task, the research team found that there are also opportunities to address gaps in current UAS procedures as well as align both general and special use case UAS procedures with best practices. The research team proposed to the Bureau of Aeronautics and was approved to expand the scope of this task to include both general and special use case procedures. This change is desirable because is critical to have one set of guiding procedures for UAS operations to ensure safety and consistency in all mission types; as well identifying specific considerations and requirements for special use cases.

Recommendations in this research area are grouped into two main categories: updates and revisions to the current Flight Operations Manual for all UAS missions; and revisions and new procedures for the five special mission types. The Flight Operations Manual details procedures for NJDOT UAS staff who perform routine UAS missions. As such, the research team has developed a set of recommendations to update or enhance the information in the Flight Operations Manual, as well as supporting procedures, that apply to all UAS missions undertaken by NJDOT staff or consultants.

With the update to SOPs for existing UAS missions, the research team was also tasked with providing recommendations to NJDOT regarding five special mission types, or “use cases”: high mast light pole inspections; construction project management; emergency management; operations at public use airports; and field observation/demonstration. The approach of the research team has been to develop a set of recommendations for each use case, including mission-specific information to be incorporated into the Flight Operations Manuals as addendums. Figure 3 shows how the recommendations fall within the existing structure of the UAS Mission Lifecycle, as defined in the Flight Operations Manual. In this figure, the yellow boxes outline where this research team developed recommendations.

The research team identified 20 recommendations under these two categories. These recommendations, labeled as **SOP** and numbered, are presented on the following pages.

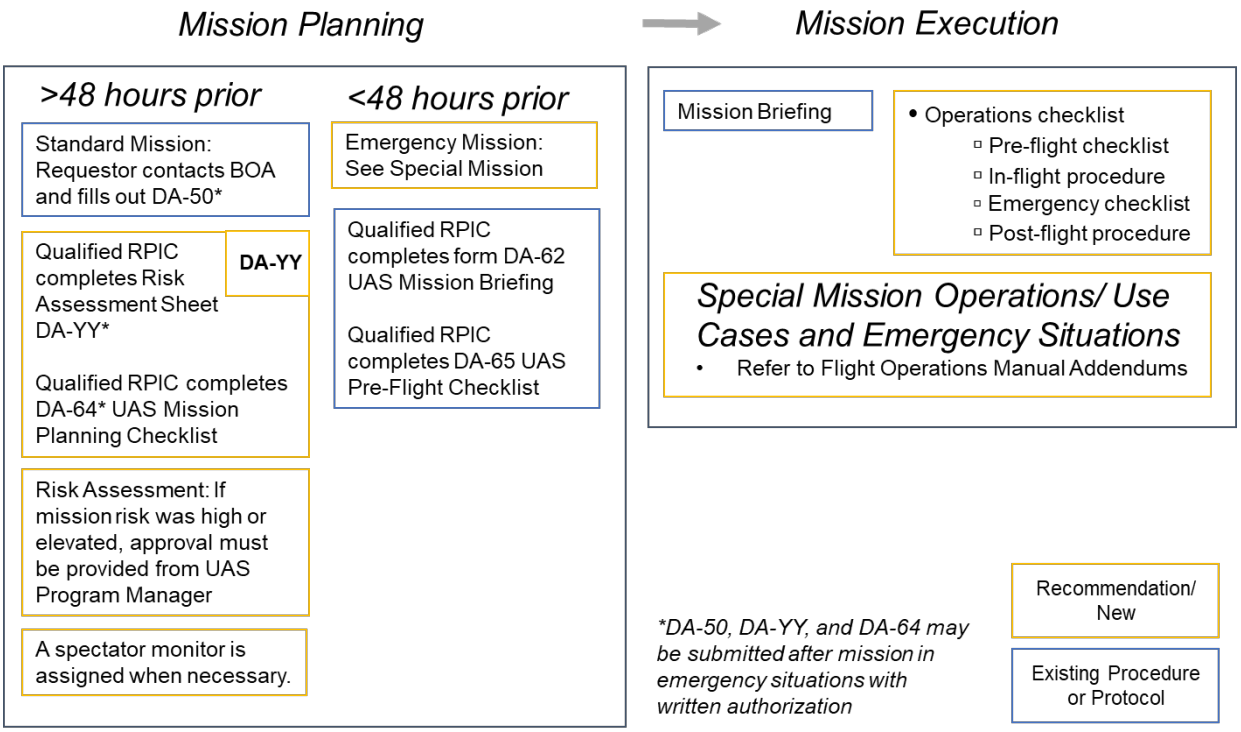

Figure 3. Flight operations recommendations organized within the structure of the NJDOT UAS Mission Lifecycle

Current Flight Operations Manual: Documentation, Updates, and Use of the Flight Operations Manual

While the Flight Operations Manual represents a solid foundation for UAS operations and administration, the research team identified some areas for improvement in how the Flight Operations Manual itself is administered. These areas of improvement include its distribution to consultants and other NJDOT divisions, the process for updating the Flight Operations Manual to reflect Federal and State policy updates as well as best practices, and its level of detail for specific use cases.

Recommendation (SOP.1a): NJDOT should leverage the existing Flight Operations Manual to contain all relevant and important practices and procedures for UAS operations.

Recommendation (SOP.1b): NJDOT should make relevant portions of the Flight Operations Manual available to consultants as well as staff.

Recommendation (SOP.1c): NJDOT should establish a goal of updating the Flight Operations Manual and other mission forms on a two year review cycle to incorporate best practices.

Recommendation (SOP.1d): NJDOT should add “Use Case” or “Special Mission” addendums of the procedures and other considerations that should be made for certain kinds of use cases.

Current Flight Operations Manual: Risk Management

It is critical for all NJDOT staff and consultant UAS operators to be aware of and follow safety procedures and policies. To this end, safety and risk related policies and procedures, including updates proposed in this research, should be documented in the Flight Operations Manual, and made available to all NJDOT staff and consultant UAS operators.

Recommendation (SOP.2): NJDOT should revise the current Risk Assessment Worksheet to include additional hazards or risk types.

Recommendation (SOP.3): NJDOT should make the Risk Assessment Worksheet a DA-form (“DA-YY”) and require its use for missions undertaken by both NJDOT staff and consultants.

Recommendation (SOP.4): NJDOT should revise Table 2.2 in the Flight Operations Manual (the Risk Mitigation Table) to include all risks of the recommended updated Risk Assessment Sheet plus the emergencies in the Aligned List of Emergencies.

Recommendation (SOP.5): NJDOT should amend DA-64, the Mission Planning Checklist, with the following three changes:

- Complete form DA-YY: Risk Assessment Worksheet.
- Include “Reviewing the Risk Mitigation Table” within the Pre-mission section.
- Include “Reviewing recommended addendum ‘Mitigating Potential Distractions’ to Operations section in Flight Operations Manual” within the Pre-mission section.

Recommendation (SOP.6): NJDOT should add a section to the Flight Operations Manual to define the process, timeframe, and criteria more clearly for high-risk mission approval.

Recommendation (SOP.7): NJDOT should include a sample diagram of existing distraction mitigation practices (e.g. concealment practice, in Chapter 2 of the Flight Operations Manual.

Recommendation (SOP. 8a): NJDOT should create a new section in Chapter 2 of the Flight Operations Manual specifically detailing practices and strategies for *Mitigating Potential Distractions to UAS Operations*.

Recommendation (SOP. 8b): NJDOT should formalize currently used distraction mitigation practices (e.g., concealing takeoff and landing areas and utilizing a spectator vehicle), by explicitly including them within the new Flight Operations Manual section, *Mitigating Potential Distractions to UAS Operations.*

Recommendation (SOP. 8c): NJDOT should amend the sterile cockpit procedures in the Flight Operations Manual (Section 4.8 *Crew Related Operational Issues)* to be included in the new section in Chapter 2, *Mitigating Potential Distractions to UAS Operations*.

Recommendation (SOP.9): NJDOT should amend the text in Row 14 of Table 2.2. Hazards and associated risks before mitigation (in Chapter 2 of Flight Operations Manual) to read "*operation near active roadways*" instead of "operation near traffic".

Current Flight Operations Manual: Flight Checklists

Like most agencies, NJDOT uses checklists to ensure compliance and minimize risk in UAS operations. From the research activities, the project team identified a series of revisions and updates that are designed to improve the utility of the checklists and to align them with best practices.

Recommendation (SOP.10): NJDOT add the following items to the DA-65 form:

- In the "Equipment inspection/assembly" section, add: Ensure memory card is installed properly with sufficient memory and storage available for the flight.
- In the "Equipment inspection/assembly" section, add: Confirm adequate charge of batteries for both UAS and remote control and any other devices that require batteries (if charge level cannot be determined, extra batteries should be available).
- In the "Environmental" section, add: Ensure areas is clear of non-participating spectators and all possible hazards.

Recommendation (SOP.11): NJDOT should develop a short (1 page) in-flight and post-flight checklist that can be used by UAS flight crews during flights.

Recommendation (SOP.12): NJDOT should align the list of emergencies and associated mitigation procedures across all forms: DA-62, DA-66, and the Risk Mitigation Table.

Recommendation (SOP.13): NJDOT should update DA-66 emergency checklist procedures to include the following categories: fixed object strike, interference with flight crew, and nearby emergency.

Recommendation (SOP.14): NJDOT should amend the Flight Operations Manual Chapter 4 to include five use case addendums.

Use Cases: High Mast Light Pole Inspections

High Mast Light Pole (HMLP) Inspections are missions to visually inspect structures that can be 55 feet high or more.

Recommendation (SOP. 15): NJDOT should incorporate procedures related to HMLP inspections into the Flight Operations Manual and establish procedures unique to this use case, including the requirement for the RPIC or assisting Subject Matter Expert to

complete a UAS-tailored HMLP inspection report that specifies the use of a UAS in the conduct of the inspection**.**

Use Cases: Construction Management

UAS-assisted Construction Project Management includes missions to inspect, survey, and perform other tasks applicable to the management of construction activities.

Recommendation (SOP.16): NJDOT should incorporate unique practices, procedures, and other considerations related to Construction Project Management as an addendum to the Flight Operations Manual. This includes the requirement for the assisting SME to be part of the flight crew, and to coordinate with a Construction Site Manager (or designee) who alerts all personnel on the construction site of the anticipated mission.

Use Cases: Emergency Management

Emergency management operations include activities such as post-disaster recovery, search and rescue, critical infrastructure restoration, incident management, and others. UAS provide advantages in emergency situations, including increasing visibility and ability to reach impacted locations, and reducing risk to operators and personnel. NJDOT uses a combination of approaches, including UAS, to respond to emergencies. Because emergency management operations differ significantly from other UAS-assisted missions both in terms of complexity and urgency development of procedures to conduct emergency management missions requires both specialization and built-in flexibility.

Recommendation (SOP.17): NJDOT should incorporate unique practices, procedures, and other considerations for emergency management as an addendum to the Flight Operations Manual.

Recommendation (SOP.18): NJDOT should consider the implementation of the additional activities that that can better prepare UAS flight crews, and the public, for emergency situations. These activities include:

- Establish a pool of qualified flight crews (DOT staff and/or consultants) that are knowledgeable about both standard and special emergency management procedures and can be called upon during a time-sensitive or emergency mission.
- Coordinate training opportunities between the Bureau of Aeronautics and OEM to identify any Emergency Management special training or information for UAS flight crews. These may include E0986 National Incident Management System (NIMS) and Incident Command System (ICS) Air Support Group Supervisor trainings.
- Develop a coordinated incident command structure and system with OEM (and other affiliated parties) incorporating the role of UAS flight crews. Establish clear expectations for chain of command, communication protocols, and other roles/responsibilities.
- Undertake a campaign to educate the public and local officials about use of UAS during emergency events. This may include aircraft capabilities, sensors, and the

types of activities the UAS will perform; expected outputs or outcomes from UAS deployments in emergency events; and the risk mitigations implemented to ensure public safety and the consequences of unauthorized interference with UAS during emergency events.
- Collaborate with local emergency response and law enforcement agencies to review and, if necessary, update, data management procedures and standards (e.g., data acquisition, collection, processing, security, storing, sharing, usage, archiving, and disposal) for use in emergency situations.

Use Cases: UAS Operations at Public Use Airports

Operations at public use airports, such as routing imaging or inspections is a core function of the Bureau of Aeronautics . Missions at airports require significant pre-planning coordination with the FAA (including the Flight Standards District Office (FSDO) and/or Regional or District Offices), air traffic control (including the tower at a towered airport), and stakeholders including operations personnel, emergency personnel, air traffic personnel, military, or airlines, if applicable.

Recommendation (SOP.19): NJDOT should incorporate unique practices, procedures, and other considerations related to UAS operations at public use airports as an amendment to the Flight Operations Manual, including procedures to maintain coordination between airport personnel, Air Traffic Control (ATC), and the UAS flight crews.

Use Cases: Field Observation/Demonstration

Field observations and demonstration missions cover a wide range of activities including aerial photography, traffic incident management, environmental monitoring, and more.

Recommendation (SOP.20): NJDOT should incorporate procedures for UAS-assisted field observation and demonstration into the Flight Operations Manual, including use case-specific tasks to ensure that mission data is maintained, stored, and used in accordance with surveying standards, such as the American Society of Photogrammetry and Remote Sensing.

UAS Data Security and Storage

Technology and the regulations governing the use of technology change rapidly, and so data and security standards require review and updates on a periodic basis to ensure the highest standards are being implemented. One approach to organizing information around data security and storage is to use the *data management lifecycle.* The research team, in consultation with the Bureau of Aeronautics , developed a graphical data management lifecycle, shown in Figure 4. The key steps of the data management lifecycle include:

- **Data Acquisition**: The acquisition of new or replacement data and information systems.
- **Data Collection**: The process of gathering data.

- **Data Processing**: The process of handling data to ensure quality, validity and integrity are maintained and adjustments to data collection in response to failed validation.
- **Data Security**: Controls and policies to prevent unauthorized access to data or data corruption.
- **Data Storing, Sharing and Usage**: Focused on long-term data storage, data access, and acceptable use.
- **Data Archiving and Disposal**: Protocols for data retention, archiving, and disposal.

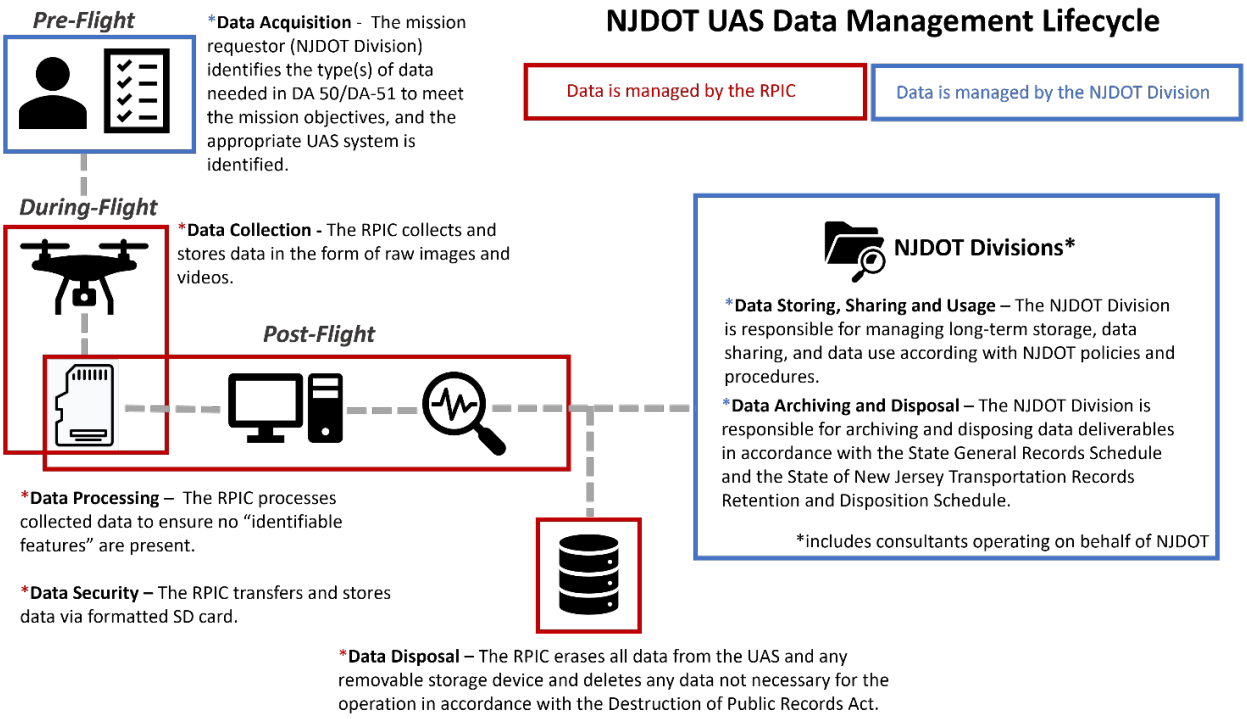

Figure 4: NJDOT UAS Data Management Lifecycle

The recommendations in this research area focus on improving UAS mission data management and ensuring that the NJDOT UAS mission procedures are in compliance with State and Federal regulations. The research team identified 15 recommendations within the data management lifecycle. These recommendations, labeled as **Data** and numbered, are presented below.

UAS Data Management Lifecycle

Recommendation (Data.1): NJDOT should consider integrating the NJDOT UAS Data Management Lifecycle graphic (shown in Figure 4) and supporting narrative into the NJDOT Small Unmanned System (sUAS) Flight Operations Manual to clearly define the

required procedures and individuals roles and responsibilities when conducting UAS missions, and provide a comprehensive framework and tool to guide NJDOT Divisions and its consultants through the UAS data management lifecycle.

Recommendation (Data.2): NJDOT should consider defining or providing a description of the types of data management skills needed to become a UAS RPIC in Section 3.2 of the NJDOT Small Unmanned System (sUAS) Flight Operations Manual.

Recommendation (Data.3): In response to the United States Innovation and Competition Act (USICA), NJDOT should conduct a safety assessment to consider how their existing fleet of DJI drones, manufactured by a foreign entity, may pose a security risk to New Jersey and take mitigation steps to minimize any identified risks.

Data Collection and Processing

Recommendation (Data.4): NJDOT should consider amending the UAS consent best practice principle provided in Section 1.12 of the NJDOT Small Unmanned System (sUAS) Flight Operations Manual to be reflective of the specific UAS environment in New Jersey.

Recommendation (Data.5): NJDOT should consider amending the data collection best practice principle in Section 1.12 of the NJDOT Small Unmanned System (sUAS) Flight Operations Manual to clearly document NJDOT's commitment to protecting privacy as referenced in the NJDOT Procedures Manual, and ensure all RPICs across both NJDOT Divisions and consultants are sensitive to people's privacy concerns when collecting UAS data.

Recommendation (Data.6): NJDOT should consider amending the clause "The data collected during the mission shall be submitted to the Bureau of Aeronautics and will be processed in the following manner" provided in section 4.6 of the NJDOT Small Unmanned System (sUAS) Flight Operations Manual to the following suggested language "*It is the responsibility of the NJDOT Division and its consultants to process UAS data in accordance with NJDOT policies and submit UAS data to the Bureau of Aeronautics in the following manner*".

Data Security: Data Classification

Recommendation (Data.7): NJDOT should consider requiring NJDOT Divisions to identify the appropriate UAS data security classification in alignment with the New Jersey SISM, and provide supporting rationale behind the classification, as part of the DA-50/DA-51 UAS/Drone support request forms.

Data Security: Data Transfer and Physical Security

Recommendation (Data.8): NJDOT should consider implementing a procedure in Section 4.3 of the NJDOT sUAS Flight Operations Manual to clearly document and specify that all UAS missions conducted by NJDOT Divisions and consultants are

required to collect, store, and transfer UAS data via a formatted SD card and avoid drone systems that require cloud-based or wireless data transfer connections.

Recommendation (Data.9): NJDOT should consider integrating the procedures provided in the SISM Securing Portable Information Assets Standard (PE-20) into section 4.3 of the NJDOT sUAS Flight Operations Manual to ensure NJDOT Divisions and its consultants understand their responsibility to protect the physical security of UAS assets and ensure that UAS assets, which may contain sensitive information, are encrypted in accordance with the New Jersey SISM policies and standards.

Data Storing, Sharing, and Usage: Long-Term Data Storage

Recommendation (Data.10): NJDOT should consider defining that it is the responsibility of the NJDOT Division or its consultant to manage the UAS data in regards to long-term storage in compliance with NJDOT policies in Section 1.12 of the NJDOT UAS Flight Manual.

Data Storing, Sharing, and Usage: Open Public Records Act

Recommendation (Data.11): NJDOT should consider integrating the recommendation provided in the NJDOT Procedures Manual into the best practice principle related to data management in Section 1.12 of the NJDOT Small Unmanned System (sUAS) Flight Operations Manual to ensure consistency across both guiding documents and clearly define that all collected UAS data shall be compliant with the Open Public Records Act (OPRA).

Recommendation (Data.12): NJDOT should consider updating the critical infrastructure best practice principle in Section 1.12 of the NJDOT Small Unmanned System (sUAS) Flight Operations Manual to reflect the most current FAA rules and regulations, and replace the broad definition of critical infrastructures provided in the context of foreign terrorism.

Data Storing, Sharing, and Usage: Legal Proceedings and Other Governmental Use

Recommendation (Data.13): NJDOT should consider publishing a publicly available statement to clearly address respect for privacy, civil rights, and civil liberties regarding UAS operations, while also making it clear that some information may not be able to be made publicly available based upon legal, investigative or operational security reasons.

Data Retention and Disposal

Recommendation (Data.14): NJDOT should consider implementing a procedure within section 4.6 of the NJDOT Small Unmanned System (sUAS) Flight Operations Manual to clearly define that UAS collected data shall be deleted in accordance with the Destruction of Public Records Act, N.J.S.A. 47:3-15 et seq. and ensure NJDOT Divisions refer to the State of New Jersey Transportation Records Retention and Disposition Schedule and the State General Records Schedule as the guiding framework for retention periods.

Recommendation (Data.15): NJDOT should consider implementing a procedure within section 4.6 of the NJDOT Small Unmanned System (sUAS) Flight Operations Manual to clearly document that all UAS data shall be erased from the NJDOT Division or consultants UAS system and removable storage device.

Recommended Next Steps

The research team recommends the following next steps:

- Coordinate on the development of an updated set of standards, , and procedures for UAS consultant procurements with relevant NJDOT Divisions and Offices. Prepare and facilitate training sessions on the updated UAS consultant procurement procedures and standards for relevant NJDOT staff.
- Reach out to consultant organizations such as regional chapters of the Association for Uncrewed Vehicle Systems International to inform them of the updated UAS consultant procurement procedures and standards. Facilitate training sessions on the procurement procedures with these associations as necessary.
- Incorporate revisions and additions to policies and procedures into an updated Flight Operations Manual. Update supplemental documentation such as checklists and forms. Update appropriate information in SimpliGov.
- Develop procedures for sharing the updated Flight Operations Manual and related documentation with all NJDOT staff and consultants who conduct UAS missions. Prepare and facilitate training sessions on updated material and processes.
- Coordinate with NJDOT staff in other Divisions to conduct pilot tests for the five use case missions under the revised policies and procedures. Conduct post-test mission reviews to ensure missions meet goals and objectives for use cases.
- Incorporate the Data Management Lifecycle framework and associated policies and procedures into the Flight Operations Manual. Prepare and facilitate training sessions on data acquisition; collection and processing; security; storing, sharing and usage; and data retention and disposal for relevant NJDOT staff and consultants.
- Develop procedures to review and update UAS materials on a regular basis that draw on multiple inputs, including:
    - Feedback from UAS staff, consultants, and NJDOT Divisions conducting UAS missions.
    - Findings from performance evaluations of UAS missions.
    - Best practices and continual learning on UAS operations and administration, including presentations at AASHTO and other trade associations within and outside of the transportation sector.

- Facilitate UAS peer workshops with representatives from State and Federal agencies, including (but not limited to) State DOTs, the FAA, the NJ State Police, and the NJ Forest Fire Service to share updates on policies and procedures and to identify opportunities for interagency learning and coordination.