Advanced Aviation Guidebook

for

North Carolina Public Airports

Prepared for North Carolina's public airports by the
N.C. Department of Transportation Division of Aviation

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DIVISION OF
AVIATION

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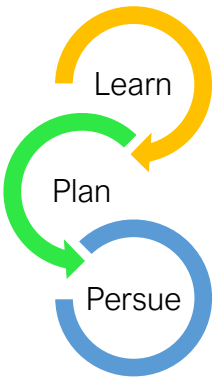
Executive Summary

The aviation industry is entering a transformative era with the rapid adoption of Uncrewed Aircraft Systems (UAS) and Advanced Air Mobility (AAM). This shift promises enhanced efficiency, sustainability and economic growth opportunities for North Carolina's public airports. The Division of Aviation at the North Carolina Department of Transportation (NCDOT), through initiatives such as Advance Mobility NC, is leading state efforts to adopt these technologies and improve transportation for residents and businesses.

To prepare for this transformation airports should begin planning the strategic integration of UAS and AAM into their existing infrastructure and operations. Key components include electric aircraft, reliable broadband networks, charging infrastructure, and in some cases, dedicated vertiports. Airports should also explore multimodal integration to enhance connectivity across transportation systems and consider dual use of existing runways and taxiways to optimize available space and resources.

Each of these components carries distinct planning and operational implications. Specialized charging stations for electric aircraft will require ground crews trained to safely manage high-voltage systems. Broadband upgrades must support real-time data exchange for autonomous and remotely piloted aircraft and enable advanced traffic management capabilities. Multimodal integration may also involve coordination with transit agencies to improve regional connectivity.

Integrating UAS into airport operations can deliver near-term benefits such as more efficient runway inspections, enhanced wildlife management, and stronger perimeter security. Realizing these advantages requires careful planning, workforce training and adherence to evolving regulatory standards. In addition, implementing technologies like Remote ID and UAS detection systems can improve situational awareness and strengthen compliance, further enhancing operational safety and security.



Funding opportunities for airport infrastructure are rapidly evolving, driven by federal initiatives and industry partnerships focused on innovation and sustainability. The FAA's Airport Improvement Program (AIP), strengthened under the 2024 FAA Reauthorization Act, now supports projects such as renewable energy generation, storage and noise compatibility. The Infrastructure Investment and Jobs Act (IIJA) also provides funding through programs like the U.S. Department of Transportation's Strengthening Mobility and Revolutionizing Transportation (SMART) grants, which allocate $100 million annually for innovative solutions that reduce congestion and improve safety. Public-private partnerships further accelerate progress, as seen in recent electrification projects at Raleigh Executive Jetport, positioning North Carolina at the forefront of sustainable aviation.

To stay ahead of evolving standards and technologies, North Carolina's airports should invest in infrastructure that is both flexible and scalable. This guide highlights opportunities enabled by emerging aviation technologies, offering a roadmap for airports to effectively plan, pursue and implement these innovations. The insights provided will help airports prepare for the future of transportation and foster sustainable economic growth in their communities. For additional information and support, contact the Division of Aviation, North Carolina Department of Transportation at 1050 Meridian Drive, Morrisville, NC 27560, Phone: (919) 814-0550, or visit ncdot.gov/aviation.

Welcome to the Future of Aviation

The aviation industry is undergoing a transformative shift with the emergence of Uncrewed Aircraft Systems (UAS) and Advanced Air Mobility (AAM), technologies that promise to revolutionize air travel by enhancing efficiency, sustainability and accessibility. By embracing the potential of this next generation of aircraft, both large and small, North Carolina's airports can unlock new business opportunities, create additional revenue streams, and improve operational efficiencies. This guide introduces these technologies to North Carolina's public airport community, offering practical guidance to help airports identify, evaluate and integrate them into their operations in ways that benefit both the airport and the surrounding community.

North Carolina is at the forefront of aviation transformation, thanks to strong support from the N.C. General Assembly and initiatives by the North Carolina Department of Transportation, such as Advance Mobility NC. This program aims to develop a multimodal transportation system that improves the movement of people and freight across the state. Through Advance Mobility NC, NCDOT invests in emerging technologies and leads efforts to create sustainable multimodal services, including connected and automated vehicles, advanced air mobility, connected streets, freight transfer hubs and electrification. These efforts have positioned North Carolina as a leader in integrating innovative transportation solutions. Results to date include:

- Securing $2 million to create a University Transportation Center of Excellence for AAM and UAS to conduct research to redefine how we transport people and goods through innovative aviation technologies. N.C. Agricultural and Technical State University, N.C. State University, and Elizabeth City State University were selected to establish the center.
- Facilitating the installation of the state's first multimodal electric charging station at Raleigh Executive Jetport in Sanford, which also hosted the state's first electric aircraft landing.
- Awarded a competitive $500,000 planning grant to identify targeted technology and infrastructure upgrades at rural Appalachian airports, laying the groundwork for future implementation funding, supporting local economies and creating a model for statewide innovation in aviation
- Being awarded a $1.1 million Strengthening Mobility and Revolutionizing Transportation (SMART) grant to develop a drone-in-a-box (DIAB) program in Lumberton, N.C, designed to collect data during and after natural disasters.

As UAS and AAM technologies continue to evolve, airports will play a crucial role in integrating them into routine operations. The first three sections of this guide – ***Learn, Plan, and Pursue*** – are designed to outline pathways airports can explore as they navigate aviation's new frontier. The fourth section, ***Implementation Guide***, provides step-by-step guidance for integrating UAS and AAM technologies in ways that support airport operations, enhance the customer experience and contribute to community benefits. The final section, ***Glossary***, defines many of the terms that may be encountered and should be understood when engaging with stakeholders in the UAS and AAM industries. To reflect evolving language standards, this guide uses "uncrewed" instead of "unmanned," though both terms remain interchangeable in federal regulations and existing sources.

NCDOT's Division of Aviation is committed to helping North Carolina's public airports approach the future of air transportation strategically. Airports are encouraged to collaborate with AAM experts at the Division to explore emerging aviation technologies that meet the mobility needs of North Carolina residents, businesses and communities.

Learn

UAS and AAM at Airports

Uncrewed Aircraft Systems (UAS) refer to the complete set of components required for uncrewed flights, including the aircraft itself, the control station, communication links and other supporting technologies. Most civil UAS relevant to airport environments fall under the category of small UAS (sUAS), which weigh less than 55 pounds, operate at lower altitudes (typically under 400 feet above ground level [AGL]), and are regulated under 14 CFR Part 107. These regulations govern commercial and other non-recreational operations, requiring visual line of sight (VLOS) unless a waiver for beyond visual line of sight (BVLOS) is granted

UAS can also include much larger systems, with some platforms exceeding 30,000 pounds, particularly in military or specialized commercial applications. While remotely piloted operations are increasingly common, fully autonomous flights remain limited due to regulatory, technological and safety considerations

UAS can support airport operations by enhancing infrastructure inspections, cargo delivery and emergency response. Airports may use UAS for tasks such as runway inspections and wildlife hazard mitigation and should also proactively manage nearby UAS activity to prevent unintended or unauthorized operations.

Advanced air mobility (AAM) refers to transportation systems that move people and cargo by air using advanced technologies. It includes electric and alternative-fuel aircraft, as well as vertical and short takeoff and landing (VTOL/STOL) vehicles. These aircraft are typically designed to carry passengers or larger payloads over short to medium distances and may be human-piloted or incorporate increasing levels of automation. While some systems are capable of autonomous functions, fully autonomous operations remain limited due to regulatory, technological and safety considerations.

UAS and AAM Defined

Uncrewed aircraft systems (UAS) are the aircraft and supporting technologies needed for uncrewed flight operations. UAS are operated either through remote piloting or autonomous systems.

Advanced air mobility (AAM) refers to transportation systems that move people and cargo by air using advanced technologies, including electric or alternative-fuel aircraft, as well as vertical and short takeoff and landing (VTOL/STOL) vehicles

AAM systems rely on both physical and digital infrastructure to operate effectively and typically fly at higher altitudes than small UAS. They can expand access to destinations not easily reached by surface transportation and improve connectivity in areas underserved by traditional aviation. AAM operations hold the promise of faster, cleaner and more efficient solutions that overcome transportation challenges and increase resiliency.

While UAS operations generally have minimal impact on airport operations, AAM may require dedicated takeoff and landing infrastructure, energy sources and airspace integration, which will significantly affect airport facilities and planning. As these technologies evolve, thoughtful integration and coordination will be essential to ensure safe, efficient and resilient airport environments.

Your Airport's Transportation Future

As the aviation industry evolves, airports can expect a future that is increasingly electric, connected and multimodal. Technologies like UAS and AAM will play a key role in this transformation. Airports will be central to integrating these innovations, which will require collaboration with new partners and stakeholders. By embracing these emerging technologies, N.C. airports can lead the way in shaping the future of air transportation and supporting economic growth throughout the state.

Electric. Future advanced aircraft technologies leverage electric or hybrid sources of power, marking a significant shift in the aviation landscape. As these technologies evolve, it is crucial for airport owners and operators to consider these factors when planning for futureproofing facilities. Electric aircraft require dedicated charging infrastructure to ensure efficient and sustainable operations. Smart grid technologies should be considered to manage energy distribution efficiently, ensuring optimal performance and cost-effectiveness of charging infrastructure. This includes advanced metering infrastructure, demand response systems and energy storage solutions that help balance the load and provide backup power during peak demand times.

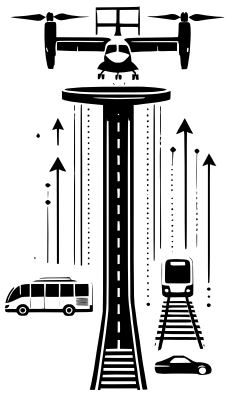
The shift to electric aircraft will require new skills for ground support crews to safely handle high-voltage systems, ensuring a smooth transition to more reliable and efficient electric aviation. It will also require developing a new revenue model to accommodate both traditional aircraft fuels and electrification.

By diversifying their revenue models, airports may maximize the financial potential of electric aircraft charging infrastructure, ensuring long-term sustainability and profitability.

Connected. UAS and AAM aircraft require robust broadband services to support real-time data exchange, autonomous navigation and enhanced safety measures. Investing in these infrastructures now can facilitate the seamless integration of UAS and AAM technologies in the future, positioning airports to lead in the next generation of aviation advancements.

This may include upgrading broadband networks to support high-speed data transfer required for autonomous and remotely piloted aircraft, UAS traffic management services (UTM) and micro-weather reporting systems required for uncrewed aviation.

Ensuring airports have the necessary broadband infrastructure and bandwidth will enable the advanced operational requirements of UAS and AAM technologies.



Multimodal/Intermodal. Multimodal transportation, in cargo operations, refers to the use of multiple modes of transportation (such as air, road, rail and sea) under a single contract, with one carrier responsible for the entire journey, providing a single point of contact for the shipper. Intermodal transportation involves the use of multiple modes as well, but each mode operates under separate contracts with different carriers responsible for their segment of the journey.

Integrating airports and AAM into the broader transportation network is essential for maximizing its benefits. Airports should consider how to facilitate seamless connections between air mobility and other modes of transportation, such as ground transit systems, rail networks and ride-sharing services to move both people and goods to and from community and regional destinations.

For example:

- Developing multimodal hubs that incorporate AAM, traditional aviation and surface transportation to enhance overall mobility, reduce travel times and improve accessibility for both rural and urban communities.
- Facilitating middle-mile logistics and last-mile delivery (micro-freight) using UAS and AAM capabilities to position airports as potential hubs for cargo operations, providing efficient and timely delivery of goods.
- Coordinating with local transit authorities, rail networks and ride-sharing services to increase accessibility for all users.
- Collaborating with metropolitan planning organizations (MPOs), rural planning organizations (RPOs), and other planning, economic development and transportation officials to align airport development with regional transportation and economic plans. This helps secure funding for infrastructure projects and ensures cohesive integration across transportation modes.

This multimodal approach can ensure that airports serve as comprehensive transportation centers, meeting diverse travel needs and supporting sustainable urban and regional development.

Collaborative. Collaboration with stakeholders at every level will be essential for positioning airports at the center of advanced, integrated mobility networks. Airport operators can continue working closely with Airport Project Managers (APM) at NCDOT Division of Aviation to leverage and align state-level initiatives with local needs and opportunities. Staying informed about Federal Aviation Administration (FAA) initiatives to advance AAM will ensure compliance with evolving regulations and leverage the latest guidance and support. Additionally, engaging with MPOs, RPOs, and local government agencies is critical for coordinated economic development. These partnerships help to identify and address community needs, optimize infrastructure investments and promote sustainable growth. State APM contact information is provided in the appendix.

By prioritizing electric and connected infrastructure and collaborating with stakeholders, airport operators can equip their facilities to meet the demands of future air transportation, enhancing operational efficiency and sustainability. By fostering strong collaborative relationships, airports can drive innovation, enhance regional connectivity and support the broader economic development goals of their communities.

Pathways to Integration

While UAS and AAM technologies offer the potential to revolutionize air travel and airport operations, the pace of innovation and the steps airports should take to best integrate them will vary based on market and regulatory factors and community needs.

The landscape of UAS and AAM technologies is rapidly evolving, with standards, regulations and market demands continuously shifting. This dynamic environment presents opportunities and challenges for airports.

- Near-term opportunities involve actions that can be taken now, leveraging current technologies with established standards.
    - For example, using small UAS for airport inspections or upgrading broadband capabilities.
- Mid-term opportunities require monitoring and inclusion in future planning for the airport, as they depend on regulatory developments and broader market adoption.

    - For example, using UAS for wildlife management and the construction of vertiports.
- **Long-term** opportunities are more speculative and involve emerging technologies that may require significant changes in infrastructure and policy.
    - For example, using autonomous aircraft as transportation for passengers in urban areas.

This section outlines near- and mid-term integration opportunities that airport leaders can explore to prepare for emerging UAS and AAM technologies. Some pathways may be ready for immediate action, while others warrant monitoring and future planning. The table below summarizes these opportunities along with some associated challenges. Additional implementation guidance is provided in the *Pursue* chapter of this guide.

Integration Pathway	OPPORTUNITY/CHALLENGE	Term	Page
Airport Business Development			
Airport Business Development for AAM Services	**Opportunity:** Airports can establish themselves as key hubs for AAM, benefiting from early investments as the market expands, driving economic growth and connectivity. **Challenge:** Attracting industry partnerships requires clear use cases, competitive incentives and infrastructure readiness, with the added risks associated with early AAM ventures.	Near	15-16
Using UAS to Improve Airport Operational Efficiency			
UAS for Airport Infrastructure Inspections	**Opportunity:** Improve efficiency and reduce disruptions **Challenge:** Navigating regulatory and operational requirements, ensuring proper training	Near	17-18
UAS for Wildlife Management	**Opportunity:** Enhance wildlife management, reducing risk of wildlife strikes **Challenge:** Coordination to avoid interference with operations, ensuring FAA compliance	Mid	18
UAS for Perimeter Security	**Opportunity:** Solution for enhancing airport perimeter security providing time efficiencies **Challenge:** Integration with existing systems, addressing privacy and regulatory concerns, need to assess airport security requirements	Mid	19
Detecting and Identifying UAS			
Remote Identification Technologies	**Opportunity:** Enhance safety and compliance with affordable technology **Challenge:** Evolving regulations may require updates to infrastructure	Near	20-21

UAS Detection Technologies	**Opportunity:** Comprehensive monitoring with fewer infrastructure needs **Challenge:** High cost and evolving regulations	Mid	21-22
Infrastructure Enhancements			
Upgrading Broadband Networks at Airports	**Opportunity:** Supports growing demands for AAM, UAS, as well as current demands **Challenge:** Investment, integration with existing systems, addressing cybersecurity concerns	Near	23-24
Electric Grid Assessment	**Opportunity:** Prepares airport for future electrification, aligns with funding opportunities **Challenge:** High costs, regulatory uncertainty, competing priorities within the community	Near	24-25
Aircraft Charging Infrastructure	**Opportunity:** Optimizes operations and supports electric aircraft **Challenge:** High cost, evolving regulations, ROI concerns, ensuring FAA compliance	Near	25-26
Dedicated Vertiport Infrastructure	**Opportunity:** Enhances vertical take-off and landing (VTOL) AAM operations and supports economic growth. Airports may also explore repurposing existing infrastructure — such as helipads, rooftops, or underutilized lots — as more flexible, lower-cost options for early-stage operations **Challenge:** Evolving standards and aircraft technology may complicate long-term planning and investment decisions	Mid	26-28

Plan

Effective planning is essential for integrating UAS and AAM into airport operations. However, the evolving regulatory landscape and rapid pace of technological change can make this process complex. For example, the FAA Reauthorization Act of 2024 mandates updated vertiport design standards by December 31, 2024, with a new performance-based advisory circular due by the end of 2025. Airports must therefore ensure their infrastructure plans remain flexible to accommodate future guidance and consider funding needs early in the planning process to align with available resources.

Planning for the integration of UAS and AAM operations requires airports to design flexible infrastructure, ensuring compliance and readiness for new aircraft technologies, while fostering innovation and maintaining operational efficiency.

Airport planning for all North Carolina General Aviation airports starts with NCDOT Division of Aviation and coordination with regional APMs and environmental and planning managers.

Planning for UAS and AAM operations requires airports to design flexible infrastructure, ensuring compliance and readiness for new aircraft technologies, while fostering innovation and maintaining operational efficiency.

Integrating AAM into Airport Master/Layout Plans

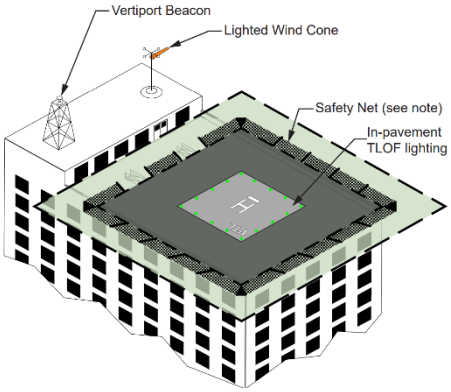
Strategic planning for AAM follows a familiar process: assess current conditions, explore opportunities and challenges, engage stakeholders and develop a plan aligned with community needs and budget. Stakeholders can contribute valuable insights, help shape a shared vision and support implementation. Integrating AAM into an airport's master plan and airport layout plan (ALP) can ensure airports remain at the forefront of innovation.

The essential steps for integration of AAM into airport master and layout plans include:

- **Assess current infrastructure and capabilities.** Evaluate existing infrastructure to determine its capacity to support AAM operations. Identify areas that require upgrades or modifications, such as runways, taxiways, aprons and terminal facilities. Consider the specific needs of AAM vehicles, such as electric and vertical take-off-and-landing (VTOL) aircraft, which may require vertiports and dedicated charging stations.
    - **Consider potential AAM use cases** that could benefit the airport and community such as cargo delivery, passenger transport and emergency services and what infrastructure and operational enhancements are required to implement them.
    - **Evaluate the existing electrical grid infrastructure** to determine what upgrades are needed, both on the airport and in the surrounding area and identify opportunities to collaborate with utility providers and other partners to support these efforts.
    - **Assess broadband capacity** to facilitate real-time data exchange, autonomous navigation and enhanced safety protocols.
- **Engage stakeholders.** Consider what organizations, in addition to core stakeholder groups, can provide knowledge and perspective on how the airport can both leverage and manage AAM. This

may include regulatory authorities, industry experts and companies working in the AAM sector. Engaging both emerging and traditional stakeholders helps ensure that planning efforts are well-informed and aligned with broader regional and national initiatives. Collaboration with regional airport planning managers (APMs), environmental and planning staff, and AAM experts at NCDOT Division of Aviation and the FAA supports navigation of regulatory requirements and facilitates the approval process.

- **Plan infrastructure development.** Identify and plan for the infrastructure components that will support the AAM operations stakeholders have identified. This may include:
    - **Vertiports** – Some AAM aircraft will need vertiports, while others may be able to use current runways, or existing infrastructure.
    - **Charging stations** – Charging infrastructure will be needed to support electric AAM vehicles, ensuring rapid and efficient turnaround times.
    - **Package and passenger handling** – Specialized infrastructure may be needed to accommodate AAM passenger and cargo operations.



    - **Parking** – Expanded parking may be needed to accommodate additional staff, visitors and additional options for connecting with ground and other modes of transportation.
    - **Hangars** – Additional hangar space may be needed to store and maintain AAM aircraft, which may have unique requirements compared to traditional aviation assets. These differences could include specialized charging infrastructure, temperature-controlled environments and maintenance equipment for electric propulsion systems.
    - **UAS detection** – Airports may need to implement UAS detection systems to monitor and identify uncrewed aircraft operations within their vicinity.
    - **Weather sensors** – Airports may want to add specialized weather monitoring systems to provide accurate, real-time localized weather data required for UAS and AAM operations.

Planning Considerations

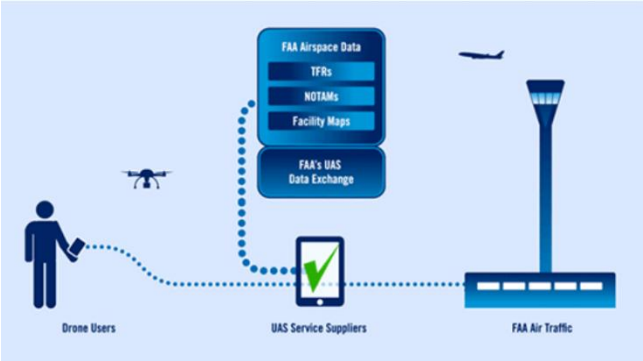
Integrating UAS and AAM into airport operations presents several challenges, largely due to the difficulty of balancing the need for proactive planning with the rapidly evolving nature of these technologies. The pathways of UAS and AAM integration into routine operations are not yet fully defined, requiring continuous adjustments to infrastructure, regulatory compliance and operational strategies to ensure safety and efficiency in an ever-changing aviation landscape.

To navigate this evolving landscape effectively, airports should consider a range of factors that influence the successful integration of UAS and AAM. These include regulatory and safety concerns, infrastructure requirements and airspace monitoring, among others.

Regulatory and Safety Concerns. Navigating the complex and dynamic regulatory environment presents a key challenge to airports seeking to integrate emerging UAS and AAM technologies. Still, airports must ensure new technologies and operators comply with FAA regulations and maintain safety standards. The key: working closely with NCDOT Division of Aviation and FAA to stay informed of the necessary approvals and waivers, such as those under Part 107 and Section 44807, and new regulations expected under Part 108 for sUAS operations.

Infrastructure Requirements. The successful integration of UAS and AAM can require significant infrastructure investment. Airports may choose to develop vertiports, charging stations and other facilities to accommodate these new aircraft. This involves not only physical construction but also ensuring that the infrastructure meets all safety and operational standards set by the FAA and other relevant authorities. For instance, airports with increased sUAS operations could benefit from installing remote ID receivers for better awareness.

Airspace Monitoring. With the introduction of UAS and AAM, monitoring airspace becomes more complex. Airports should be informed and aware of FAA efforts related to UAS traffic management (UTM) which enable complex UAS operations on and around airports. The FAA Reauthorization Act of 2024, Section 932, charges the FAA with initiating rule making for uncrewed traffic management (UTM) and its service providers. Meanwhile, FAA's Low Altitude Aircraft Notification Capability (LAANC) system enables airport operators to coordinate UAS operations at low altitudes near airports for a specified operational period.



In the near term, larger AAM aircraft operations will be crewed aircraft, operating in much the same way as traditional aircraft. Future operations may need advanced air traffic management procedures and solutions that will conform or need to be closely coordinated with air traffic control to ensure safe and efficient operations. For situational awareness, airports, particularly small- and medium-sized untowered airports, may consider installing remote ID receivers or other UAS detection technologies. These tools can help safeguard airport operations from sUAS operating out of compliance with regulations and informing aircraft operators of potential risks.

Public Perception and Community Engagement. Gaining public acceptance and support for UAS and AAM is essential. Airports should engage with local communities to address concerns about noise, privacy, and safety. Effective communication and transparency about the benefits and safety measures associated with these technologies can help build trust and acceptance among the public.

Highlighting the economic and operational benefits—such as increased access to mobility services, enhanced operational efficiencies, new revenue streams and the potential to attract new business and investment—can also strengthen public and stakeholder support. Framing AAM as a tool for regional economic development and improved connectivity can help communities see its value beyond the airport.

Operational Integration. Integrating UAS and AAM into existing airport operations poses logistical challenges. Airports must develop new protocols and procedures to manage these aircraft alongside traditional aviation activities. This includes training staff, updating operational guidelines, and ensuring seamless coordination between various stakeholders. By addressing challenges such as these proactively, airports in North Carolina can position themselves at the forefront of this transformative shift in aviation technology. As with any type of planning, airports should consider how AAM integration strategies will impact and be impacted by evolving technological, environmental and economic conditions.

Emerging technologies. The development and operational pathways of AAM technologies are still emerging and thus master plans and ALPs should be flexible and adaptive, allowing for modifications as new technologies and operational requirements develop. For example, airports may wish to add charging stations and broadband networks in the near term but defer creation of vertiports for a later date when AAM demand

increases. Airports should seek to incorporate scalable solutions that can be expanded or adjusted based on future advancements.

Environmental and community considerations. Address environmental impacts and community concerns throughout the planning process in coordination with NCDOT Division of Aviation. Sustainable practices should be implemented to minimize the carbon footprint of AAM operations and engage with local communities to ensure that their needs and concerns are addressed. This proactive approach helps build public support and ensures the long-term viability of AAM initiatives.

Thoughtful integration of AAM into an airport's master plan and Airport Layout Plan (ALP) helps create a future-ready facility that remains an attractive and vital hub in the evolving aviation landscape. AAM can expand access to mobility services across communities and regions, while reinforcing North Carolina's leadership in innovative transportation solutions.

Pursue

Once an airport has evaluated UAS and AAM technologies and strategically determined which to implement and when, the next step is to secure funding and manage the operational, environmental, regulatory and community impacts these enhancements will bring.

Funding Opportunities

Both new and existing funding streams should be explored when planning for UAS and AAM integration. Traditional airport infrastructure development grants programs administered by North Carolina and FAA offer substantial support for infrastructure and operational upgrades at North Carolina's public airports. New funding sources such as the U.S. Department of Transportation's Strengthening Mobility and Revolutionizing Transportation (SMART) grants provide innovative, targeted funding opportunities for projects that enhance technological capabilities and transportation efficiency.

In addition to federal grant programs, airports should also assess eligibility for existing funding sources such as State Aid, Non-Primary Entitlement (NPE) funds and Airport Infrastructure Grants (AIG). These programs may support infrastructure investments like vertiports, electric aircraft charging stations and sitework associated with advanced air mobility.

Airports should engage early and often with their regional APM and AAM experts at NCDOT Division of Aviation for guidance and technical assistance when planning and seeking funds for infrastructure development for AAM. By partnering with NCDOT, airports can align with the state's leadership in these emerging fields and access state and federal funding opportunities. This collaboration supports the integration of advanced aviation technologies at airports and contributes to North Carolina's air transportation system and economic development. It ensures the State remains at the forefront of innovation while addressing the evolving mobility needs of its communities.

Airports have increasing access to grant funding from federal, state, local and nonprofit sources. These grants may support projects related to transportation, electrical grid infrastructure, economic development and broadband connectivity. To pursue these opportunities, airports should evaluate each grant's relevance, determine how it aligns with airport needs, and identify the stakeholders necessary to develop a competitive application. Examples include:

- Infrastructure Investment and Jobs Act – IIJA has emerged as a cornerstone for significant advancements in AAM. It includes the SMART grant program, allocating $100 million annually over five years to projects aimed at alleviating congestion and enhancing safety across transportation modalities, potentially benefitting electric aircraft charging infrastructure, vertiport planning and development.
- Appalachian Regional Initiative for Stronger Economies (ARISE) – This grant program of the Appalachian Regional Commission (ARC) aims to stimulate economic growth and development in the Appalachian region. It funds large-scale, multi-state projects that drive economic diversification, innovation and regional collaboration. ARISE targets infrastructure improvements, workforce development and business expansion to enhance the economic resilience and prosperity of Appalachian communities. NCDOT is part of a multi-state team that received an ARISE planning grant in July 2024 aimed at modernizing airport infrastructure in the Appalachian region to boost connectivity and infrastructure in rural areas.

- 2024 FAA Reauthorization Act - The FAA Reauthorization Act of 2024 increases funding opportunities for UAS and AAM infrastructure projects, expanding the FAA's Airport Improvement Program to include provisions related to AAM infrastructure. Additionally, the act introduces these new grant programs and enhances existing ones to support UAS into the national airspace:
  - Section 101 Airport planning and development and noise compatibility planning and programs: Increases funding for infrastructure development (including renewable energy generation and storage infrastructure) and noise reduction programs.
  - Section 440 Improving federal aviation workforce development programs: Supports the growth of the aviation workforce for aviation and aerospace sectors.
  - Section 562 Small community air service development grants: Funds improvements to air service in small communities, directly benefiting North Carolina's regional airports.
  - Section 621 Remote towers: Funding remote towers for smaller airports with cost-effective alternatives to traditional control towers, improving safety and efficiency.
  - Section 710 Small airport letters of intent: To secure future funding commitments allowing a small airport to plan large capital projects from the FAA.
  - Section 742 Increasing energy efficiency of airports and meeting current and future energy power demands: Supports airports in efforts to reduce energy consumption and ensure that facilities are prepared for the growing power needs.
  - Section 912 Drone infrastructure inspection grant program: Provides grants for using drones to inspect infrastructure, a potential for inspection activities at airport facilities.
  - Section 960 Advanced air mobility infrastructure pilot program extension: A pilot that explores the future of AAM at airports. This program supports the development of vertiports and other infrastructure necessary to accommodate new AAM technologies.
- Public-private partnerships and industry collaborations – Airports may be able to fund AAM projects by leveraging public-private investments or direct collaborations with industry AAM infrastructure providers. These collaborations can drive innovation and efficiency, providing the necessary resources for infrastructure developments such as vertiports and electric aircraft charging stations. The installation of electric aircraft and ground vehicle chargers at Raleigh Executive Jetport by BETA Technologies serves as an example of an industry collaboration. This collaboration involves BETA Technologies, the state of North Carolina, and the airport, and is part of the state's broader initiative to advance multimodal transportation and sustainable aviation. The project reinforces North Carolina's position as a leader in electric aviation infrastructure, supporting the growth of AAM within the region. By partnering with private-sector companies, airports can maximize funding opportunities and accelerate the implementation of advanced air mobility solutions, ensuring they meet future transportation needs effectively.

Implementation Considerations

Beyond identifying, planning for and funding technology infrastructure enhancements, airports will need to assess and plan for operationalizing AAM as it evolves. These are key components to be considered as innovations are implemented.

Financial Analyses. Airports will benefit from assessing the business case for AAM integration projects to identify the potential long-term gains and justify the investments in infrastructure sustainability. Begin by evaluating the economic benefits of connecting to wider transportation networks, which can enhance regional connectivity and drive economic growth. Performing return on investment (ROI) and internal rate of return (IRR) calculations can help you determine the financial viability of your AAM projects.

Coordination with your regional airport project manager (APM) is recommended to ensure that financial planning and implementation align with federal grant requirements and do not conflict with existing Airport Improvement Program (AIP) assurances. Federal assurances associated with AAM-specific grants may differ from traditional AIP grants and should be reviewed carefully to prevent non-compliance.

Insurance and Risk Management. As airports integrate new AAM technologies and aircraft, managing insurance and risk becomes more important. Initially, insurance premiums for advanced aircraft will be higher, due to the perceived risks and lack of historical data. However, as these technologies prove their safety and reliability over time, premiums are expected to decrease. Airports should regularly review and update their insurance policies to ensure adequate coverage for new risks associated with AAM operations. Implementing comprehensive risk management practices, including safety protocols and emergency response plans, will mitigate risks and potentially lower insurance costs. By remaining proactive with insurance and risk management, airports can protect their investments and ensure the safe integration of AAM technologies.

Operational Planning. Integrating AAM technologies will require new airport protocols and procedures to manage advanced aircraft alongside traditional aviation activities, and depending on the scope of operations, may also require FAA review and approval. This includes training staff on AAM operations, updating operational guidelines and ensuring seamless coordination between stakeholders such as ground services and maintenance teams. Airports should coordinate with their regional APM and relevant NCDOT Division of Aviation staff early in the process to ensure procedures align with FAA expectations and approval pathways.

Training and Education. Airport staff must be well versed in the specifics of AAM technology and operations. Ongoing training programs should be implemented to keep personnel updated on the latest advancements, safety protocols and operational procedures. This includes both initial training for new technologies and ongoing education to adapt to evolving standards and regulations. Special attention should be given to handling electric aircraft, including understanding the specific requirements for battery maintenance, and safety protocols when dealing with potential battery fires. Training in the use of specialized firefighting equipment and procedures for lithium-ion battery fires will ensure safety and preparedness.

Updating Operational Guidelines. Existing operational guidelines should be revised to incorporate AAM-specific requirements. This involves setting new protocols for takeoff, landing and ground handling of new types of aircraft, as well as establishing procedures for UAS operations within the airport's airspace. Clear communication and coordination protocols must be established to ensure smooth operations and mitigate any potential disruptions.

Implementation Guide

This chapter outlines key opportunities and challenges for integrating AAM in the near, mid, and long term. It also provides actionable steps, example applications and links to additional guidance and reference materials.

Airport Business Development

Airport Business Development for AAM Services (Near-Term)

The Opportunity: Airports can position themselves as strategic hubs for future business opportunities within the AAM ecosystem. AAM is in its beginning stages and, as such, early investment may mean a greater return as the market grows. By collaborating with industry stakeholders, airports can attract businesses focused on these innovative transportation solutions, enhancing their economic growth and regional connectivity.

The Challenge: Successfully attracting and developing partnerships with industry requires airports to clearly define use cases, offer competitive incentives and ensure they have the necessary infrastructure and regulatory alignment to support these operations. Not all early AAM companies will successfully implement their business plans, adding a level of risk to early partnerships.

Actionable Steps:

- **Contact your regional APM at NCDOT Division of Aviation.** They will make relevant staff aware of your interest and provide you with contacts that will help in your efforts. Early coordination with your APM ensures proper alignment with state and federal procedures and allows access to planning, environmental, compliance and funding expertise.
- **Identify potential use cases**. Work with innovative industry leaders and local businesses to define specific use cases that align with regional needs. While many of these aircraft will be crewed in the near term, some use cases may transition to uncrewed or autonomous operations over time. The list below provides some examples of AAM use cases:
    - Electrified aircraft training fleets
    - Electrified scheduled/unscheduled air services
        - Business aviation
        - Commuter services
        - Aerial tourism
        - Airport shuttle service
    - Electrified mid/short haul cargo distribution

- **Develop a value proposition.** Clearly articulate the benefits of operating at your airport, such as proximity to key markets, available infrastructure and regulatory support. This includes offering incentives such as reduced fees, access to specialized facilities or streamlined permitting processes. Be mindful, however, that certain incentives may be subject to compliance with FAA grant assurances and other federal obligations. Always consult with your regional APM and compliance staff to ensure that any proposed incentives do not conflict with federal requirements or jeopardize eligibility for current or future funding.
- **Assess and upgrade infrastructure.** Ensure your airport is equipped, and has accommodations for the future, with the necessary infrastructure such as vertiports, electric charging stations and advanced

communication networks to support UAS and AAM operations. Identify any gaps and plan for upgrades to accommodate future needs.

- **Engage with industry partners.** Build relationships with potential industry partners through outreach, networking events and participation in AAM industry forums. This can help position your airport as a leader in AAM innovation and attract investment from key players.
- **Collaborate with local, state, and federal governments.** Partner with government agencies to secure funding, regulatory support and other resources needed to develop and sustain AAM operations. This can include participating in pilot programs or leveraging public-private partnerships.
- **Monitor regulatory changes.** Stay informed about evolving FAA regulations and industry standards for UAS and UAS operations. Ensure your airport's operations remain compliant while advocating for policies that support growth in the AAM sector.
- **Understand infrastructure development requirements.** Any development or equipment installation on airport property—regardless of the funding source—may require coordination for environmental documentation, a Construction Safety and Phasing Plan (CSPP), and FAA Form 7460 airspace review. Work closely with your regional APM and environmental & planning manager to ensure these requirements are met early in the planning process.

Example applications: Raleigh Executive Jetport in Sanford, North Carolina, is expanding its facilities to accommodate increased demand and regional growth. Recent developments include the construction of new corporate hangars, a two-story terminal building and the installation of electric aircraft charging stations, positioning the airport as a hub for both traditional and sustainable aviation.

Dallas Fort Worth International Airport (DFW) has partnered with Overair to explore the integration of electric vertical takeoff and landing (eVTOL) aircraft operations within the Dallas-Fort Worth Metroplex. This collaboration aims to assess the feasibility of implementing passenger eVTOL services, potentially enhancing urban air mobility and providing advanced point-to-point electric air transit options in the region.

References:

- Advanced Air Mobility (AAM) Implementation Plan. Federal Aviation Administration
- Advanced Air Mobility Infrastructure. Federal Aviation Administration

Using UAS to Improve Airport Operational Efficiency

Integrating UAS into airport operations presents an opportunity to enhance efficiency and safety. From runway inspections to wildlife management and perimeter security, UAS offer innovative solutions that reduce operational disruptions, lower costs and provide data for decision-making. While the benefits are clear, the challenge lies in navigating regulatory requirements, ensuring proper training and integrating UAS with existing systems. This section provides a practical guide to help airports implement UAS technologies, making their operations more efficient and future ready.

UAS for Airport Infrastructure Inspections (Near-Term)

The Opportunity. UAS can improve the efficiency of airport infrastructure inspections such as runway surface inspections, runway safety checks and instrument landing systems inspections by reducing the time needed and minimizing disruptions to airport operations. UAS provides high-resolution imagery and real-time data, allowing for faster identification of issues such as surface damage, debris and lighting faults.

The Challenge. Regulatory and operational requirements and the need for proper training are essential for safely integrating UAS into runway inspection routines. Coordination with air traffic control or coordination with airport users is critical to avoid interference with crewed aircraft operations. Make sure the sensor(s) and GPS being used with the UAS is adequate to capture the information you are seeking. For example, if you are looking to detect millimeter cracking in your pavement, you will need a sensor that is sub millimeter per pixel. If you need a horizontal accuracy of less than three feet, you may consider a UAS with real-time kinematic (RTK) capability.

Actionable Steps:

- **Contact your regional APM at NCDOT Division of Aviation.** They will make relevant staff aware of your interest and provide you with contacts that will help in your efforts.
- **Assess current inspection processes.** Evaluate the current runway inspection procedures and identify areas where UAS can enhance efficiency and accuracy.
- **Identify the technological requirements.** Assess your requirements for inspections. Make sure your UAS and sensor will meet or exceed your data collection needs.
- **Select appropriate UAS.** Choose UAS equipped with high-resolution cameras and sensors tailored for inspection requirements within your budget limitations.
- **Coordinate with air traffic control and airport users.** Establish protocols for UAS operations that minimize interference with air traffic, ensuring safety and compliance.
- **Train personnel.** Provide necessary training to personnel on UAS operation, data collection and analysis.
- **Develop a maintenance schedule.** Use UAS data to create a predictive maintenance schedule, reducing the likelihood of unexpected runway closures.

Example applications: Hartsfield-Jackson Atlanta International Airport partnered with Michael Baker International to utilize drones for runway inspections, significantly reducing inspection time and minimizing operational disruptions. Thales has demonstrated that UAS-based Instrument Landing System (ILS) inspections can save airports time and money in infrastructure maintenance, as evidenced by on-airport ILS inspections at Syracuse Hancock International Airport. Additionally, airports like Edmonton International

Airport have employed specialized drones to conduct runway safety checks, enhancing operational efficiency and safety

References

On Airport Unmanned Aircraft System Operations. Federal Aviation Administration

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UAS for Wildlife Management (Mid-Term)

The Opportunity. UAS can enhance wildlife management by providing a safe and efficient method to monitor and disperse birds and other wildlife from airport areas. UAS can access hard-to-reach areas and provide real-time data, reducing the risk of wildlife strikes and improving overall airport safety.

The Challenge. Wildlife management with UAS requires careful coordination to ensure that UAS operations do not inadvertently attract wildlife or interfere with airport operations. Compliance with FAA regulations is also necessary.

Actionable Steps:

- **Contact your regional APM at NCDOT Division of Aviation.** They will make relevant staff aware of your interest and provide you with contacts that will help in your efforts.
- **Identify wildlife risk area.** Use UAS to monitor high-risk areas where wildlife frequently gather such as ponds or grassy fields near the runway.
- **Implement deterrent strategies.** Deploy UAS equipped with noise or visual deterrents to safely disperse wildlife away from critical areas.
- **Monitor wildlife patterns.** Use UAS to track wildlife movements and patterns over time, allowing for data-driven decisions on habitat management.
- **Coordinate with air traffic control.** Ensure UAS wildlife management operations are safely integrated with airport activities.
- **Collaborate with wildlife experts.** Work with wildlife biologists to develop humane and effective UAS-based deterrent methods.

Example applications: Southampton Airport has implemented an innovative bird control strategy using a drone designed to mimic the appearance and flight of a predatory bird. This approach reported a significant reduction in bird strikes compared to previous years, enhancing airport safety and operational efficiency.

References:

- FAA Letter to Airport Sponsors about Using UAS to Disperse Wildlife. Federal Aviation Administration
- On Airport Unmanned Aircraft System Operations. Federal Aviation Administration
- Wildlife Strikes to Civil Aircraft in the United States 1990 – 2022. Federal Aviation Administration
- Responses of turkey vultures to unmanned aircraft systems vary by platform. National Library of Medicine
- Integrating Unmanned Aerial Systems for Enhanced Wildlife Hazard Assessments within Airport Environments. National Academies

UAS for Perimeter Security (Mid-Term)

The Opportunity. UAS provides a flexible and efficient solution for enhancing perimeter security at airports. They can cover large areas quickly, access hard-to-reach locations and provide real-time surveillance, reducing the need for manual patrols and increasing overall security.

The Challenge. Integrating UAS into existing security systems requires ensuring interoperability with other technologies such as cameras and alarms. Additionally, privacy and regulatory concerns must be addressed, particularly in monitoring sensitive areas.

Actionable Steps:

- **Contact your regional APM at NCDOT Division of Aviation.** They will make relevant staff aware of your interest and provide you with contacts that will help in your efforts.
- **Assess security needs.** Identify key areas around the airport perimeter that would benefit from UAS surveillance, such as fences, entry points and remote areas.
- **Implement surveillance protocols.** Develop and deploy UAS patrol schedules, focusing on high-risk times and locations.
- **Integrate with existing systems.** Ensure UAS data feeds are connected to the airport's central security system for real-time monitoring and response.
- **Train security personnel.** Equip security teams with the skills to operate UAS and interpret the data effectively.
- **Address privacy concerns.** Establish clear guidelines for UAS use to protect privacy while ensuring security.

Example applications: The Transportation Security Administration selected Miami International Airport (MIA) as the initial site to test drone detection technologies aimed at identifying and tracking unauthorized UAS entering restricted airspace. This initiative seeks to enhance airport security by mitigating potential threats posed by unauthorized drones.

References:

- On Airport Unmanned Aircraft System Operations. Federal Aviation Administration
- Guidance for Integrating Unmanned Aircraft Systems (UAS) into Airport Security. Safe Skies
- Evaluation of Unmanned Aircraft Systems for Airport Perimeter Inspections and Surveillance. Federal Aviation Administration

Detecting and Identifying UAS

Airports can benefit significantly from developing the capability to detect and monitor UAS operations near their facilities. Although the FAA discourages drone operations near airports and crewed aircraft without proper authorization, systems for detection and identification are becoming essential. With the increasing prevalence of UAS and AAM activities, these technologies enhance situational awareness for airport operators. Integration with systems like the FAA's Low Altitude Authorization and Notification Capability (LAANC) can further streamline operations by enabling real-time airspace authorizations, ensuring safer and more coordinated UAS activity near airports.

Remote Identification Technologies (Near-Term)

The Opportunity. Implementing UAS remote ID detection at airports can enhance safety and compliance for both crewed and uncrewed aircraft operations. Currently there are over 350 approved UAS Original Equipment Manufacturers (OEMs) and Remote Identification (RID) broadcast modules issued FAA compliant certifications which became law in September 2023 and started to be enforced by the FAA on March 16, 2024. By leveraging the federally mandated remote ID requirements and enabling real-time identification and tracking of UAS, airports can improve situational awareness, mitigate security risks, and ensure regulatory compliance. This technology is relatively affordable, making it an accessible option for airports of various sizes. The ability to monitor UAS activity around the airport enhances the safety of airspace operations and aids in the prevention of unauthorized drone activities.

The Challenge. The regulatory environment for UAS is continually evolving, posing a challenge for airports adopting remote ID technology. The FAA may, in the future, introduce requirements for UAS to be networked, potentially through cellular networks, which could render current remote ID infrastructure redundant. Additionally, the limited range of remote ID broadcasts from UAS could necessitate a larger footprint of networked receivers to be effective, increasing the complexity and cost of implementation.

Actionable Steps:

- **Contact your regional APM at NCDOT Division of Aviation.** They will make relevant staff aware of your interest and provide you with contacts that will help in your efforts.
- **Assess current infrastructure**. Evaluate the existing broadband and IT infrastructure to determine compatibility with remote ID receivers. Evaluate the needed coverage and potential locations to install the potential infrastructure.
- **Install remote ID receivers**. Strategically place remote ID receivers to cover key areas within the airport perimeter to meet your airport's operational requirements.
- **Integrate with airport systems**. Ensure remote ID data is integrated with existing airport monitoring and security systems.
- **Assess the accessibility of information.** Determine the targeted audience for the information being collected. Access will be dependent on the airport's operational level. A non-towered airport, for example, may provide a portal for pilots and flight crews to access for situational awareness prior to operations. Airport staff may have access to data to coordinate airport operations or after-action reporting. Larger airports may keep the data internal for compliance monitoring.
- **Train staff.** Review and revise the airport's standard operating procedures to include remote ID data access and management. Conduct training sessions for airport personnel on the use and benefits of this data.

- **Budget.** Allocate funds for the purchase, installation and maintenance of remote ID receivers. Assess the potential for federal, state, regional and local grants and funding avenues.
- **Collaborate.** Work with remote ID service providers and technology vendors for seamless integration and support.

Example applications: In March 2021, the FAA selected five airports to participate in the Airport UAS Detection and Mitigation Research Program. The chosen airports are Atlantic City International Airport (New Jersey), Syracuse Hancock International Airport (New York), Rickenbacker International Airport (Ohio), Huntsville International Airport (Alabama), and Seattle-Tacoma International Airport (Washington). This initiative aims to evaluate at least ten technologies or systems capable of detecting and mitigating potential safety risks posed by uncrewed aircraft, with testing expected to continue through 2023.

References

- Remote Identification of Drones. Federal Aviation Administration
- Getting Started with Remote ID. Federal Aviation Administration
- Federal Efforts to Address Unauthorized Drone Flights Near Airports. U.S. Government Accountability Office
- Part 89 – Remote Identification of Unmanned Aircraft. Code of Federal Regulations

UAS Detection Technologies (Mid-Term)

The Opportunity. UAS detection technologies provide comprehensive monitoring capabilities, using a combination of active and passive detection systems. They include remote ID receivers, automatic dependent surveillance-broadcast (ADS-B) receivers, optical camera detection, radio frequency (RF) detection, acoustic detection and radar. These systems offer a longer range compared to standalone remote ID receivers or any combination of these sensors. They may also require a smaller infrastructure footprint than remote ID receivers alone.

The integration of multiple detection methods ensures that even non-remote-ID-compliant UAS and other aircraft in the vicinity are detected and tracked. This robust detection capability can support future operations such as AAM and expanded UAS activities such as UAS cargo and package delivery, enhancing overall airport safety and situational awareness.

The Challenge. Despite their advantages, UAS detection systems can be costly to purchase, install and maintain. The integration of sensor fusion varies among providers, potentially complicating the selection and deployment process. Furthermore, the technical complexity of these systems may pose challenges for airports, necessitating specialized training, maintenance contracting and support to ensure effective operation and upkeep. Additionally, the regulatory environment for UAS detection is continuously evolving, and future changes may require updates or modifications to the detection systems, potentially adding to costs and operational complexity.

Actionable Steps:

- **Contact your regional APM at NCDOT Division of Aviation.** They will make relevant staff aware of your interest and provide you with contacts that will help in your efforts.
- **Conduct needs assessment**. Evaluate the specific detection needs, based on airport size, traffic volume and surrounding environment.

- **Identify the requirements of the data**. Assess any potential liability of the information being collected at the airport. Identify any potential federal, state or local laws that may apply to the data collection and address any potential sensitivities.
- **Select technology providers**. Research and select reputable providers who offer comprehensive UAS detection solutions. Consider conducting industry requests for information and demonstrations to assess the effectiveness.
- **Plan installation**. Work with the supplier to develop an installation plan, including the optimal placement of sensors for maximum coverage. This may include additional coordination with federal agencies such as the FAA and the Federal Communications Commission.
- **Integrate systems**. Ensure seamless integration with existing airport security and monitoring systems.
- **Assess the accessibility of information.** Determine the targeted audience for the information being collected. Access will be dependent on the airport's operational level. A non-towered airport, for example, may provide a portal for pilots and flight crews to access for situational awareness prior to operations. Airport staff may have access to data to coordinate airport operations or after-action reporting. Larger airports may keep the data internal for compliance monitoring.
- **Train personnel**. Review and/or revise the airport's standard operating procedures to include the UAS detection data access and management. Conduct training sessions for airport personnel on the use and benefits of UAS detection data.
- **Budget.** Allocate funds for the purchase, installation and maintenance of remote identification receivers. Assess the potential federal, state, regional and local grant and/or funding avenues.
- **Collaboration.** Work with remote identification service providers and technology vendors for seamless integration and support.

Example applications: TSA has initiated testing of drone detection technologies at Miami International Airport (MIA) and Los Angeles International Airport (LAX). These tests aim to detect, track, and identify UAS that enter restricted airspace, enhancing airport security measures. The data collected from these tests will inform the development of effective solutions to mitigate risks posed by unauthorized UAS operations in the national transportation system. In North Carolina, airports such as Raleigh-Durham International, Charlotte/Douglas International, and Washington-Warren have installed UAS tracking systems to improve situational awareness and security.

References

- UAS Detection, Mitigation, and Response on Airports, Federal Aviation Administration
- On-Airport UAS Operations and UAS Detection & Mitigation Systems Updates, Federal Aviation Administration
- Unmanned Aircraft Systems Detection and Mitigation Systems Aviation Rulemaking Committee, Federal Aviation Administration
- Blue Ribbon Task Force on UAS Mitigation at Airports Final Report, October 2019

Infrastructure Enhancements

The evolving nature of AAM integration requires airports to implement flexible infrastructure, ensuring compliance and readiness for new aircraft technologies, while fostering innovation and maintaining operational efficiency. This includes infrastructure to accommodate landing and takeoff of new types of aircraft, electrification and connectivity with remotely piloted and autonomous aircraft.

Upgrading Broadband Networks at Airports (Near-Term)

The Opportunity: Upgrading broadband networks at airports is essential to support the growing demands of AAM, UAS and any other connected technologies supporting the operators, airport operations and customers. Enhanced communication infrastructure can enable real-time data exchange, autonomous navigation and advanced traffic management, ensuring safety and efficiency. These upgrades also improve passenger experience by providing reliable Wi-Fi and support for modern amenities.

The Challenge: The process could involve significant investment and integration with existing systems. Coordination with multiple stakeholders, including service providers and federal or state broadband infrastructure incentives to address these challenges.

Actionable Steps:

- **Contact your regional APM at NCDOT Division of Aviation.** They will make relevant staff aware of your interest and provide you with contacts that will help in your efforts.
- **Assess current infrastructure.** Evaluate the airport's existing broadband network capabilities to identify areas needing improvement.
- **Plan for high-speed connectivity.** Ensure the network can support high-speed data transfer for real-time communication and automation, particularly for supporting future customer demands and advanced aircraft operations.
- **Assess cybersecurity needs.** Evaluate cybersecurity needs for the current system and future needs. Include them in your upgrade plans.
- **Upgrade ground-based systems.** Enhance ground communication systems, including broadband, fiber optics and 5G, to meet the demands of next-generation aircraft and passenger services.
- **Check federal and state broadband incentive programs.** Airports may be eligible for alternative programs such as The North Carolina Digital Equity Plan https://www.ncbroadband.gov/ and other federal programs that help with funding.
- **Collaborate with service providers.** Partner with telecommunications providers to ensure reliable and expansive coverage across the entire airport.
- **Integrate smart technologies.** Incorporate smart grid technologies to manage energy distribution for connected devices and ensure efficiency.
- **Ensure compliance and security.** Ensure all upgrades meet regulatory standards and incorporate robust cybersecurity measures to protect critical systems.

Example applications: In 2024, Virginia's Department of Aviation initiated investments to upgrade infrastructure at its 65 public-use airports, aiming to support AAM operations and stimulate economic growth. Similarly, AT&T announced a $10 million project to enhance Dallas Fort Worth International Airport's connectivity by deploying a private 5G network and upgrading public Wi-Fi, thereby improving operational efficiency and passenger experience.

References

- Communications, Information, and Network Programs (CINP). Federal Aviation Administration
  The North Carolina Digital Equity Plan. North Carolina Broadband

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Electric Grid Assessment (Near-Term)

The Opportunity. The transition to electrified aircraft technologies, including both crewed and uncrewed aircraft, as well as electrified ground transport, presents a significant opportunity for airports to future-proof their operations. By preparing for these advancements, airports can position themselves at the forefront of aviation innovation, ensuring they are equipped to handle the demands of next-generation aircraft. This proactive approach can also open alternative funding avenues, as the integration of multiple modes of transport aligns with various federal, state and local initiatives aimed at promoting sustainable transportation solutions.

The Challenge. Assessing and integrating emerging technologies that are not yet fully proven requires a forward-thinking mindset and a willingness to invest in potentially high-cost infrastructure projects. Additionally, the regulatory environment for electrified aircraft is continually evolving, necessitating ongoing collaboration with federal, state, local, aircraft original equipment manufacturers (OEMs) and power supplier entities. These collaborations are essential to secure the necessary upgrades to both the airport's electrical infrastructure and the connecting grid. The extensive nature of these upgrades, coupled with the high costs and regulatory uncertainties, presents a significant hurdle for many airports.

Actionable Steps:

- **Contact your regional APM at NCDOT Division of Aviation.** They will make relevant staff aware of your interest and provide you with contacts that will help in your efforts.
- **Assess current usage.** Conduct a thorough evaluation of the airport's current electrical consumption.
- **Evaluate grid availability.** Determine the capacity and reliability of the existing electrical grid serving the airport.
- **Forecast future needs.** Estimate the future electrical demands for electrified aircraft and supporting technologies. Collaborate with potential vehicle OEMs and operators to assess the future power needs.
- **Assess and secure funding.** Since the electrical grid infrastructure is shared with the larger community, other stakeholders stand to benefit from these upgrades. This may allow the airport to leverage non-typical sources of grant funds. It may also require the airport to partner with a broader-than-usual group of public and private stakeholders to meet grant requirements.
- **Engage stakeholders.** Collaborate with federal, state and local agencies, as well as utility providers, to plan necessary upgrades.
- **Upgrade infrastructure.** Plan upgrades to the electrical infrastructure and mitigate disruptions.

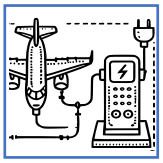
Application examples: Airports are proactively enhancing their electrical infrastructure to accommodate the increasing demand from electric vehicles and future electrified aircraft. Dallas Fort Worth International Airport (DFW) is constructing an electric Central Utility Plant (eCUP) to sustainably power its facilities, aligning with its goal of achieving net-zero carbon emissions by 2030. Similarly, Greenville-Spartanburg International Airport (GSP) has outlined plans for infrastructure upgrades, including a microgrid and terminal expansion, to support anticipated growth and energy needs over the next decade. Los Angeles International Airport (LAX)

is investing $140 million in a new electrical receiving station to establish its own micro-power grid, enhancing energy reliability and capacity.

References

- Airport Infrastructure: Selected Airports' Efforts to Enhance Electrical Resilience, General Accounting Office
- Advanced Air Mobility Infrastructure, Federal Aviation Administration
- Federal Aviation Administration Vertiport Electrical Infrastructure Study. Federal Aviation Administration
- Overview of Potential Hazards in Electric Aircraft Charging Infrastructure. National Renewable Energy Lab
- Addressing Electric Aviation Infrastructure Cybersecurity Implementation. National Renewable Energy Lab
- AA Invests Nearly $92 Million to Help Airports Reach President's Goal of Net Zero-Emissions by 2050. Federal Aviation Administration
- Advanced Air Mobility Takes Flight with New Partnership, National Renewable Energy Laboratory
- Impacts of Regional Air Mobility and Electrified Aircraft on Airport Electricity Infrastructure and Demand, National Renewable Energy Laboratory

Aircraft Charging Infrastructure (Near-Term)



The Opportunity. Implementing charging stations for electric aircraft at airports is a strategic move to optimize operations and prepare for the future of aviation. These stations can be placed on ramps, associated with vertiports, or both, allowing seamless integration into airport infrastructure. Charging stations on ramps for example, may serve a wider range of aircraft configurations such as short takeoff and landing (STOL) and conventual takeoff and landing (CTOL). By leveraging Airport Improvement Program (AIP) funding, as highlighted in the 2024 FAA Reauthorization Act, airports can access financial support to install these critical infrastructures. Effective planning ensures that charging stations are conveniently located, facilitating efficient aircraft turnaround times and enhancing overall airport operations. Additionally, airports can explore various business models for charging stations, such as pay-per-use, subscription services or partnerships with electric utility companies, to generate revenue and promote sustainability.

The Challenge. Planning and installing electric aircraft charging stations presents several challenges. Airports must conduct a comprehensive assessment of their current electrical capacity and future needs to ensure that the infrastructure can support the increased load. The integration of charging stations requires investment, and airports need to justify these costs by evaluating the return on investment (ROI) and internal rate of return (IRR). Furthermore, the regulatory environment for electric aircraft and charging infrastructure is evolving, necessitating continuous adaptation to new standards and requirements. Collaborating with stakeholders, including utility providers, regulatory bodies and technology vendors, is essential to addressing these challenges and implementing effective solutions.

Actionable Steps:

- **Contact your regional APM at NCDOT Division of Aviation.** They will make relevant staff aware of your interest and provide you with contacts that will help in your efforts.

- **Assess current electrical capacity.** Evaluate the airport's existing electrical infrastructure to determine its capacity to support new charging stations.
- **Project future needs.** Estimate future electrical demand, based on projected electric aircraft operations and traffic.
- **Strategically plan for charger locations.** Identify optimal locations for charging stations, on ramps or associated with vertiports, and develop a strategic plan for the placement of charging stations that maximizes accessibility and operational efficiencies.
- **Identify additional infrastructure needs.** This could include advanced metering infrastructure, demand response systems and energy storage solutions that help balance the load and provide backup power during peak demand times.
- **Explore funding options.** Leverage AIP funding and other federal, state and local grants to support the installation of charging infrastructure.
- **Develop business models.** Explore and implement viable business models for charging stations. Collaborate with federal and state regulators to the regulatory landscape.
- **Engage stakeholders.** Reach out to utility providers, technology vendors and regulatory bodies to plan for compliance and effective implementation.
- **Conduct ROI and IRR analyses.** Conduct thorough financial analyses to justify investments in charging infrastructure. This will promote stakeholder acceptance, as well as ensure long-term sustainability and profitability.

Example applications: Airports across the United States are actively installing electric aircraft charging infrastructure to support the emerging electric aviation industry. In North Carolina, Raleigh Executive Jetport in Sanford is the state's first airport with multimodal electric charging stations, designed by BETA Technologies, capable of charging both electric aircraft and ground vehicles. Similarly, Atlantic Aviation is collaborating with BETA Technologies to equip its FBO facilities with electric chargers, with installations already underway at locations such as Elmira Corning Regional Airport in New York. In Florida, Bob Sikes Airport in Crestview has approved the installation of a DC fast-charging station by BETA Technologies, aiming to serve both electric vehicles and BETA's ALIA-250 aircraft. Additionally, Montgomery Regional Airport in Alabama has partnered with BETA Technologies to commission the state's first electric aircraft charging station, marking a significant milestone in sustainable aviation infrastructure.

References

- Airport Improvement Program (AIP) 2023-2025 Supplemental Appropriation. Federal Aviation Administration
- Advanced Air Mobility Infrastructure. Federal Aviation Administration
- Electric Aircrafts Will Need Powerful Ports: An NREL Study Shows That Grid Upgrades Are Needed for eVTOL Charging, But On-Site Generation and Storage Can Help, National Renewable Energy Laboratory

Dedicated Vertiport Infrastructure (Mid-Term)

The Opportunity. Establishing dedicated vertiports provides a significant opportunity to enhance the efficiency of AAM operations. These specialized facilities are designed to handle the unique requirements of electric vertical takeoff and landing (eVTOL) aircraft, enabling streamlined operations and increased throughput. By providing dedicated resources and

infrastructure tailored to AAM technologies, airports can support the integration of eVTOL operations, improve connectivity and foster innovation in urban and regional air mobility.

In the near term, airports may also explore repurposing existing infrastructure—such as helipads, rooftops, runways, taxiways or underutilized lots—as flexible, lower-cost options for early-stage operations. This approach can expand capacity while minimizing upfront investment. As standards and technologies evolve, these facilities can be adapted or expanded into dedicated vertiports. This forward-thinking approach positions airports at the forefront of aviation advancements, promoting economic growth and sustainability.

The FAA's Engineering Brief (EB) 105A on vertiport design, released in December 2024, offers interim guidance but is subject to updates as technologies and regulations advance. These standards provide guidelines for the location, design and operation of vertiports, ensuring they can safely support AAM vehicles. Key considerations include sufficient spacing, safety areas and charging infrastructure to handle the unique operational needs of eVTOL aircraft.

The Challenge. The regulatory and standards landscape for vertiports is still evolving, requiring airports to stay updated on the latest guidelines and requirements. Additionally, the rapid evolution of aircraft technologies presents uncertainties in planning and infrastructure development. Airports must navigate these challenges while ensuring that their vertiports are adaptable to future advancements and compliant with emerging standards.

FAA Vertiport Lighting, Markings and Visual Aids

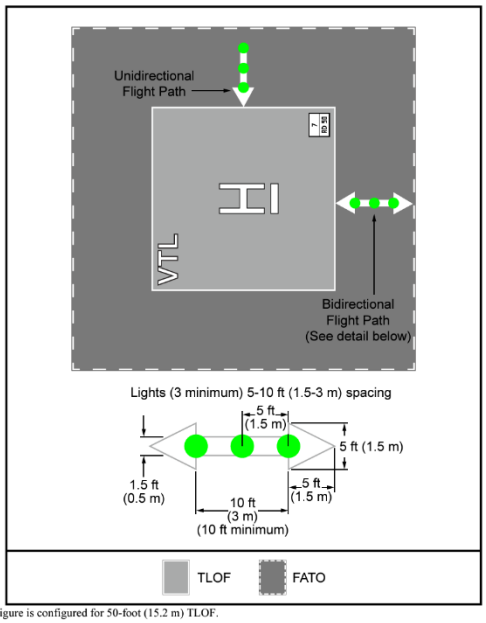


Figure is configured for 50-foot (15.2 m) TLOF.

Actionable Steps:

- **Contact your regional APM at NCDOT Division of Aviation.** They will make relevant staff aware of your interest and provide you with contacts that will help in your efforts.
- **Understand regulatory requirements.** Familiarize yourself with the FAA's EB 105 and other relevant regulations to ensure compliance in vertiport design and operations. Existing FAA regulations on the development of new takeoff and landing facilities also apply to AAM infrastructure. These regulations ensure FAA has the information needed to evaluate the safety of a proposed takeoff and landing facility, its surrounding area, and any impacts to the existing National Airspace System.
- **Understanding the business use cases.** The usage of the vertiport can change the supporting infrastructure greatly. Determining whether the primary uses could be cargo, passenger or emergency services, as examples, could change the location, associated infrastructure and throughput requirements for your vertiport.
- **Conduct needs assessment.** Evaluate the current and future needs of eVTOL operations at your airport, including projected traffic, operational requirements and infrastructure needs.
- **Strategically plan for vertiport locations.** Identify the optimal locations for vertiports, considering factors such as accessibility, multimodal connectivity to urban centers, and integration with existing airport infrastructure. Update your airport's ALP, as needed.
- **Engage stakeholders.** Collaborate with regulatory authorities, industry partners, local governments and community organizations to align vertiport development with broader AAM initiatives.

- **Perform design and engineering.** Work with experienced architects and engineers to design vertiports that meet safety, operational and sustainability standards.
- **Identify and secure funding.** Explore funding opportunities through federal, state and local grant programs, as well as public-private partnerships, to support vertiport development.
- **Future-proof.** Ensure that vertiport designs are adaptable to accommodate future advancements in eVTOL technologies and regulatory changes.

Example applications: Raleigh Executive Jetport in Sanford, N.C., is actively expanding its infrastructure to accommodate AAM operations. Recent developments include the installation of electric aircraft charging stations and the acquisition of additional land to support future growth. Vertiport Chicago, located in the Illinois Medical District, serves as a premier vertical aircraft takeoff and landing facility. Since its opening in 2015, it has been a critical hub for emergency medical services and is preparing to support eVTOL aircraft operations. In Springfield, Ohio, the National Advanced Air Mobility Center of Excellence has been established to advance research and development in AAM technologies. This facility aims to position the region as a leader in the emerging AAM industry.

References

- Engineering Brief No. 105A, Vertiport Design. Federal; Aviation Administration
- Advanced Air Mobility Infrastructure. Federal Aviation Administration

Glossary

As UAS and AAM terminology continues to evolve, airport staff should be familiar with key terms and concepts to effectively engage in this emerging field. Below are definitions of some of the most commonly used terms.

Advanced air mobility (AAM) – A transportation system that moves people and cargo by air between places using advanced technologies, including electric and autonomous aircraft. AAM, which comprises urban air mobility (UAM) and regional air mobility (RAM), offers the potential to serve destinations not conveniently served by surface transportation and underserved by aviation. AAM operations hold the promise for faster, cleaner and more efficient solutions that overcome transportation insecurity and increase resiliency.

Airport Infrastructure Grant (AIG) – A funding program under the Bipartisan Infrastructure Law providing direct grants to airports for infrastructure projects including safety, capacity, environmental sustainability and access improvements.

Airport Master Plan (AMP) – A comprehensive, long-term planning document that outlines the development goals and needs of an airport. It serves as a roadmap for future infrastructure improvements, operational enhancements and land use planning, ensuring alignment with FAA standards and community goals. Airport master plans are developed in coordination with the FAA and NCDOT Division of Aviation and are critical for securing funding and ensuring regulatory compliance for airport development projects.

Airport Project Manager (APM) – A regional representative from the NCDOT Division of Aviation who serves as the primary point of contact for public airports. APMs support airports with planning, project coordination, funding applications, environmental compliance and FAA coordination. APMs also connect airport staff with relevant subject matter experts within NCDOT Division of Aviation, such as planning, engineering, compliance and finance staff.

Beyond visual line of sight (BVLOS) – Operating UAS when the aircraft is out of the direct line of sight of the remote pilot. This capability is essential for expanding the operational range and applications of UAS, such as in infrastructure inspection, delivery services and large-area surveillance. As technology advances, BVLOS operations are expected to blend into AAM operations. Initially, AAM will be piloted, but as confidence in BVLOS technology grows, these operations will likely become more remotely piloted and autonomous, enhancing efficiency and safety in urban and regional air transportation. This technology supports diverse applications from infrastructure inspection to package delivery, aligning with the North Carolina's goals for innovation and economic growth in aviation.

Construction Safety and Phasing Plan (CSPP) – A document required by the FAA to ensure construction activities at an airport do not pose hazards to aircraft operations. It must be coordinated with airport operations and reviewed by FAA.

Conventional Takeoff and Landing (CTOL/eCTOL) – CTOL refers to aircraft that require a runway for both takeoff and landing, such as traditional airplanes. When prefixed with an "e" (eCTOL), it denotes electric-powered aircraft that rely on conventional takeoff and landing methods.

Form 7460 – FAA's Notice of Proposed Construction or Alteration, required for any construction or equipment installation on or near airport property that could affect airspace. The form ensures the FAA can assess potential impacts on navigable airspace and airport operations.

Non-Primary Entitlement (NPE) – FAA grant funds allocated annually to general aviation airports that are included in the National Plan of Integrated Airport Systems (NPIAS). NPE funds can be used for eligible development projects, including infrastructure supporting advanced air mobility.

Part 107 UAS – Small uncrewed aircraft systems (sUAS) operating under Part 107 regulations, commonly used for commercial purposes, including aerial photography, small package delivery (under 55 pounds with non-hazardous materials), agricultural monitoring and infrastructure inspection. These operations are crucial for day-to-day airport functions and local businesses.

Part 108 UAS – Proposed regulations for operations of sUAS BVLOS, expected to be released by the FAA in 2025 with a Notice of Proposed Rulemaking (NPRM) for public comment. Codification of Part 146 *(see below)* will likely take about one year from release of the NPRM. If approved, Part 108 will allow significant expansion, both in scope and range, of Part 107 operations in a given area.

Part 146 UTM – Qualification standards for uncrewed traffic management (UTM) service providers, expected to be released in 2025 with a NPRM for public comment. Codification of Part 146 will likely take about one year from release of the NPRM. These service providers are typically referred to as UAS service suppliers (USSs) or supplemental data service providers (SDSPs). USSs will provide sUAS strategic deconflictions and flight authorizations for safe and reliable operations. SDSPs provide reliable services such as micro weather data, geospatial information, local ordinances on takeoff and landing sites and air surveillance fusion.

Powered-lift aircraft – Aircraft capable of vertical takeoff, vertical landing and low-speed flight, required for many of the more advanced concepts for AAM operations. Powered-lift aircraft can operate in confined spaces, making them integral to both UAM and RAM operations. They include eVTOLs, as well as traditional and hybrid aircraft power systems.

Regional air mobility (RAM) – Transporting passengers or cargo over longer distances, between cities or connecting regional areas not efficiently served by existing transportation networks. RAM uses advanced aircraft technologies such as distributed propulsion, short takeoff and landing (STOL), conventional takeoff and landing (CTOL), powered lift and autonomous systems. For airports in North Carolina, RAM presents opportunities to enhance connectivity between urban centers and remote regions, supporting economic growth and accessibility.

Remote identification (remote ID) – Referred to by some as an "electronic license plate for UAS," remote ID is real-time identification and location data required for qualified commercially operated uncrewed aircraft and their control stations since March 16, 2024. Combined with new sensor technologies that read and identify UAS by remote ID, they help airports, FAA and local and state authorities manage airspace more effectively and support efficient air traffic operations.

State Aid to Airports Program – A North Carolina state funding program administered by NCDOT Division of Aviation to support capital improvement projects at public-use airports, including facility upgrades and equipment purchases.

Section 44807 waiver – FAA-approved waivers for conducting commercial UAS operations that do not fit under Part 107 (UAS above 55 pounds or transporting hazardous materials). These waivers allow for more complex and extensive UAS operations, such as BVLOS flights. Proposed changes under a new Part 108

could replace 44807, potentially streamlining regulations and expanding the scope of commercial UAS operations. This would further enhance the ability of North Carolina's airports to support advanced UAS applications.

Short Takeoff and Landing (STOL/eSTOL) – STOL describes aircraft capable of taking off and landing on shorter runways, making them ideal for operations in constrained spaces or remote areas. eSTOL refers to electric-powered versions of these aircraft.

Uncrewed aircraft systems (UAS) – Aircraft that operate without a human pilot onboard, either through remote piloting or autonomous systems and the systems that enable them. While piloted and remotely piloted aircraft are becoming more common, fully autonomous operations are further from widespread implementation due to the complexity and safety requirements involved. For North Carolina's airports, integrating UAS can enhance capabilities for infrastructure inspection, cargo delivery, and emergency response.

Urban air mobility (UAM) – Conducting shorter trips within a city or between nearby cities to alleviate urban congestion and provide rapid, on-demand air transportation for people and goods. For North Carolina's major cities, UAM offers a solution to reduce traffic, improve air quality and provide efficient transport options within metropolitan areas.

Vertical Takeoff and Landing (VTOL/eVTOL) – VTOL aircraft are capable of taking off and landing vertically, eliminating the need for runways. This category includes helicopters and new electric vertical takeoff and landing (eVTOL) vehicles.

Vertiports – Dedicated areas for the landing, takeoff, taxiing, parking and storage of powered-lift aircraft or other aircraft. Vertiports can be located on airports, structures or other locations not traditionally served by aviation and are essential for the infrastructure needed to facilitate AAM operations. Developing vertiports across North Carolina will be an important element for enabling the seamless integration of AAM technologies.

The North Carolina Department of Transportation Division of Aviation promotes the economic well-being of North Carolina by developing a safe and robust air transportation system.

Division of Aviation

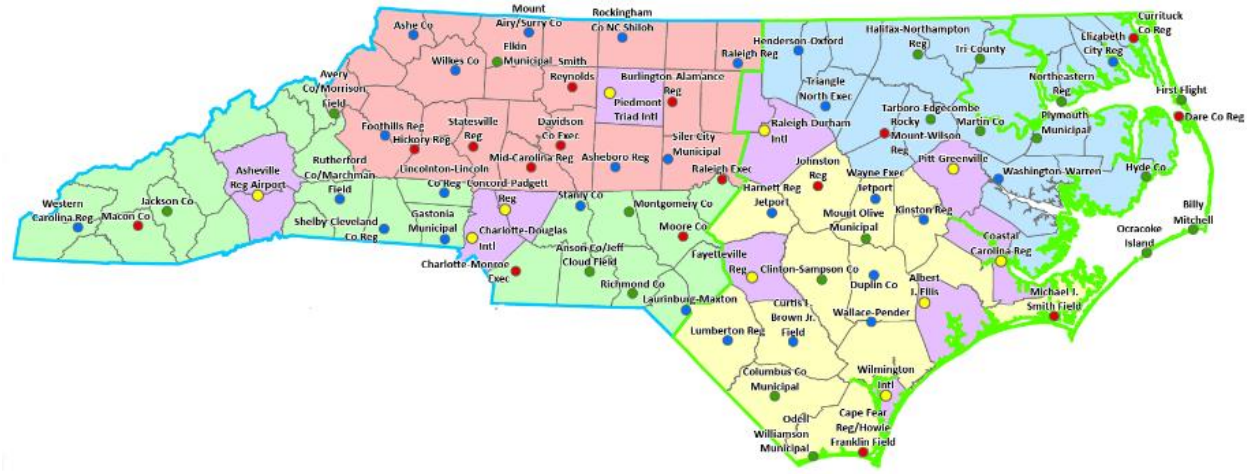
North Carolina Department of Transportation

1050 Meridian Drive, Morrisville, NC 27560

(919) 814-0550

ncdot.gov/aviation

Appendix



Airport Project Manager Contacts		
Eastern Region Lead: Tommy Mann Cell: 984-344-3080 Email: tlmann@ncdot.gov	**Western Region Lead:** Raj Kondapalli Cell: 919-817-9509 Email: rkondapalli@ncdot.gov	**Northeast:** Tommy Mann (interim) Cell: 984-344-3080 Email: tlmann@ncdot.gov
Northwest: Raj Kondapalli (interim) Cell: 919-817-9509 Email: rkondapalli@ncdot.gov	**Southeast:** Tommy Mann (interim) Cell: 984-344-3080 Email: tlmann@ncdot.gov	**Southwest:** Raj Kondapalli (interim) Cell: 919-817-9509 Email: rkondapalli@ncdot.gov
	Commercial Service: Mortaza Habibi Cell: 919-614-8094 Email: gmhabibi@ncdot.gov	