STAGE 1 IMPLEMENTATION FINAL REPORT

Project title: Drone Medical Package Delivery for Improved Transportation and Better Patient Outcomes Grant number: 69A3552341006-SMARTFY22N1P1G54

Recipient name: Accomack-Northampton Planning District Commission

Fiscal year of award: 2022

Period of performance: 07/15/2023 – 03/15/2025

Organization(s) preparing the Implementation Report:

Accomack-Northampton Planning District Commission, Riverside Health System, DroneUp, Old Dominion University/Virginia Institute for Spaceflight & Autonomy (VISA), and Virginia Innovation Partnership Corporation (VIPC)

Date of Implementation Report Submission: July 15,2025

TABLE OF CONTENTS

LIST OF ACRONYMS

1. ADSB, Automated Dependent Surveillance Broadcast
2. A-NPDC, Accomack-Northampton Planning District Commission
3. ATP, Authority to Proceed
4. API, Application Programming Interface
5. ATA, Advanced Technology Applications
6. BVLOS, Beyond Visual Line of Sight
7. C2, Command and Control
8. ConOps, Concept of Operations
9. CRM, Customer relationship management
10. DAA, Detect And Avoid
11. EMS, Emergency Medical Services,
12. ESCC, Eastern Shore Community College
13. FAA, Federal Aviation Administration
14. HIPAA, Health Insurance Portability and Accountability Act
15. HDC, Historically Disadvantaged Communities
16. HPSAs, Health Professional Shortage Areas
17. IRB, Internal Review Board
18. JWTs, JSON Web Tokens
19. MAAP, Mid-Atlantic Aviation Partnership
20. NOTAMs, Notice To Airmen
21. MUAs, Medically Underserved Areas
22. mTLS, Mutual Transport Layer Security
23. ODU, Old Dominion University
24. OEM, Original Equipment Manufacturer
25. PIH, Patient Identifiable Health
26. PCHC, Peninsula Community Health Collaborative
27. RBAC, Role-based access control
28. ROCC, Remote Operational Control Center
29. RSMH, Riverside Shore Memorial Hospital
30. Rx, Medication prescription
31. SATCOM, Satellite Communications
32. SDS, Safety Data Sheets
33. SMS, Safety Management System
34. SRM, Safety Risk Management
35. STCC, Standard Transportation Commodity Code
36. SOC, Secure Operation Center
37. UAS, Uncrewed Autonomous Systems
38. UTM, Unmanned Traffic Management
39. URSA, Unmanned Robotic Systems Analysis
40. VIPC, Virginia Innovation Partnership Corporation
41. VISA, Virginia Institute for Spaceflight & Autonomy
42. VLOS, Visual Line of Sight

EXECUTIVE SUMMARY

The Drone Medical Package Delivery for Improved Transportation and Better Patient Outcomes planning and prototyping grant involves five partners, including Accomack-Northampton Planning District Commission (A-NPDC), Riverside Health System, Old Dominion University (ODU), Virginia Institute for Spaceflight & Autonomy (VISA), Virginia Innovation Partnership Corporation (VIPC), and DroneUp. The partners worked together to address access, safety, reliability and sustainability for medical and emergency response package delivery via drone; specifically, where the use of aerial drones could lead to better patient outcomes and improved safety and emergency response.

The goal of the project was to develop an operational prototype that would evolve into a self-sustaining delivery service, significantly improving health care outcomes for vulnerable populations, and ensuring direct access for underserved populations. This includes people living on the rural Eastern Shore of Virginia, as well as Tangier Island, which is located in the Chesapeake Bay, 17 miles from the closest hospital. The structure of this report is comprised of two parts with the first half focusing on Stage 1 prototype results and findings and the second half focuses on data supported benefits of at-scale implementation, operational lessons learned and deployment readiness for Stage 2.

In Stage 1, the project achieved significant milestones in management, implementation, workforce development, and public outreach. The team successfully launched the project with clear goals, metrics, and concept of operations. Collaboration with the FAA secured necessary approvals for drone operations, and demonstration flights were conducted to showcase drone technology in real-world scenarios. Data collection supported a comprehensive business case analysis, ensuring technical feasibility and economic sustainability. Additionally, workforce development was initiated using the Talent Training and Development program at Eastern Shore Community College (ESCC) to prepare a skilled workforce for Uncrewed Autonomous Systems (UAS) operations. Public outreach played a crucial role and included media coverage and engaging local stakeholders through public meetings and demonstration events. These efforts helped to build community support and an understanding of the project's objectives among pilots, health care providers, and the general public.

Looking further ahead, the awareness and acceptance of drone delivery service will be a key driver of adoption for at-scale implementation of this project. Comprehensive evaluation of the future value of the program has been performed and addresses this critical factor within the feasibility evaluations. Utilizing the DOT's BCA spreadsheet template for Discretionary Grant Programs to analyze this proposal, the Benefit to Cost Ratio for this program is greater than 3.6, with a net present value of more than $8.6 million, which indicates the operational sustainability of the proposed project.

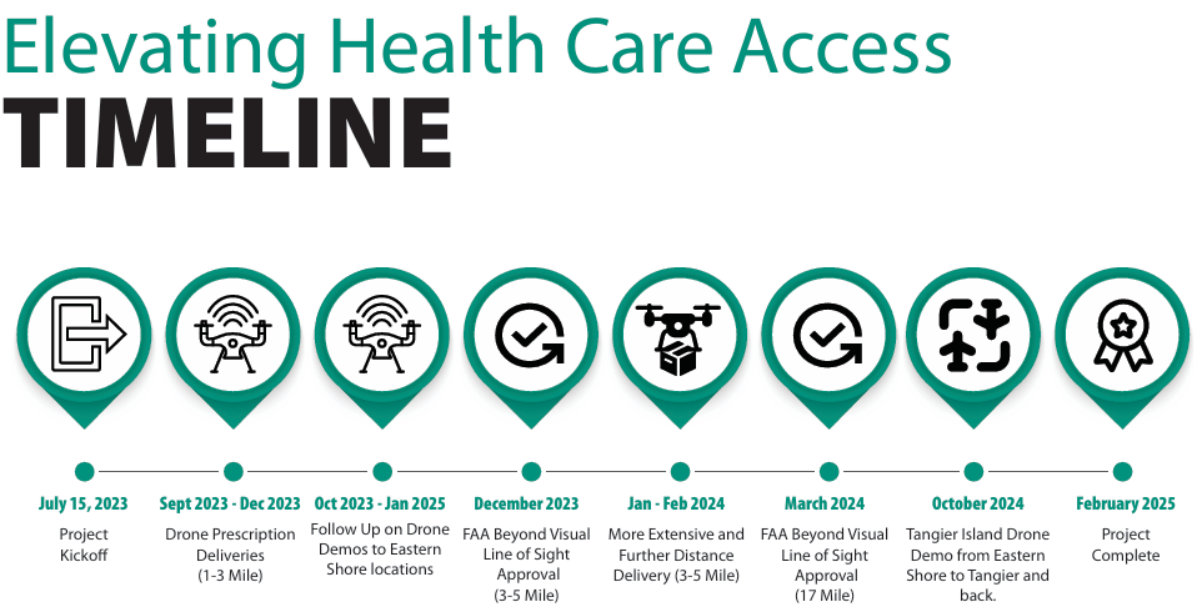
Additional project information and data can be found online at: https://dataverse.harvard.edu/dataverse/DroneDOTSMART and https://visaatodu.org/elevating-health-care-access-project/

Project Milestones and Achievements

The team's objectives in Stage 1 were successfully accomplished which included:

- ✓ Gathering the right data and tracking performance metrics to validate if this technology can sustainably improve business operations, patient outcomes and accessibility.
- ✓ Performed the necessary data analytics, modeling, and simulations to determine most effective and efficient hub locations, routes, corridors, etc.
- ✓ Engaged the community to build support, acceptance, and buy-in; and obtain all approvals needed for the Stage 2 operational proposal.
- ✓ Demonstrated prescription delivery flights to very selective targets to start the process of determining outcomes.
- ✓ Established BVLOS corridor, delivery flights to Tangier Island, built confidence and ensured approvals for BVLOS operations.
- ✓ Strategically defined and establish focused internships and/or workforce development opportunities.
- ✓ Develop required partnerships to grow operations on the Eastern Shore and other rural locations in Virginia as well as key team members for the Stage 2 proposal.

The project was executed within budget and the duration was July 15th, 2023, to March 15th, 2025. The project closeout was updated from January 2025 to March 2025 with a no-cost period of performance extension, which was approved by the Department of Transportation. All major risk reduction, public engagement, workforce development, partnership development milestones, and project reporting deliverables have been completed. Stage 1 high level milestones are highlighted in the project timeline below.



The extension allowed for additional time for the project team to complete the documentation of all modeling and simulation efforts, as well as business case analytics. This ensured project readiness to implement the proposed scaleup and sustainability efforts in Stage 2.

UNDERSTANDING OF THE PROBLEM TO BE SOLVED

PROJECT DESCRIPTION

The impact of the pandemic, combined with the current limitations of both roadway and maritime transportation systems, has created challenges for health care systems to meet the increasing need for specimen, pharmaceutical, and medical supply shipments. These issues are even more challenging across the historically disadvantaged Eastern Shore of Virginia, which includes Accomack and Northampton counties, and particularly the very remote community of Tangier Island in the Chesapeake Bay. In fact, the rural geography of the region results in extended shipping and diagnostic turnaround times, posing a significant challenge for urgent deliveries between hospital facilities, labs, and pharmacies. Such delays can negatively impact patient outcomes and mean the difference between life and death.

This project began with the exploration of drone delivery of medications, including delivery of patient prescriptions across rural areas of the Eastern Shore of Virginia. Transportation innovation with the use of uncrewed autonomous systems (UAS) for medical package deliveries could enable health care systems to meet the demands of rural patients on the Eastern Shore and other rural areas in the Commonwealth of Virginia. In addition, public safety and emergency first responders can use drones to ensure quicker response times, better access, and more accurate assessment of hazardous or dangerous accidents and crisis situations. It will also allow for quicker response to an ever-changing supply chain and support the needs of the public safety and emergency response communities.

The demonstration project was conducted in rural and remote areas that present unique response times and access issues for public safety and emergency response officials on the Eastern Shore of Virginia. Similarly, Tangier Island is also part of Riverside's service area and involves complicated supply latency issues, particularly when the regular ferry service is impacted by inclement weather, rough water, or tidal conditions. Public transportation does not have widespread coverage in these areas, and door-to-door transportation for hire is expensive. Additionally, in inclement weather, someone who lives a long distance from the highway might experience flooding or downed trees blocking access to the highway for several days, which can keep them from running needed errands such as picking up medications. Even more complicated is the access to 'mainland' towns from Tangier Island in inclement weather.

PROJECT GOALS

Once operationalized to at-scale implementation, this project will provide direct, measurable benefits to the transportation and health indicators of the Eastern Shore's historically disadvantaged communities. Patients will get the medicine they need consistently, without bearing the burden of the region's transportation obstacles.

Project goals include:

- Improved medication access for patients experiencing transportation challenges.
- Increased patient medicine adherence and improved health outcomes.
- Scaled user growth and adoption corresponding with drone delivery infrastructure expansion across the Eastern Shore.
- Validated modeling and simulation results pertaining to increased patient access,; as well as access to medication, prescriptions and medical supplies to support this application business case.
- Establishment of a robust workforce and talent pipeline that provides adequately trained workers and certified drone pilots to sustain operations following Stage 2 completion.
- Ensure successful project scalability and sustainability efforts/milestones are implemented within proposed cost and schedule.

The Stage 1 demonstration project was accomplished using a crawl, walk, and run approach focusing on small steps to eliminate risks one at a time in a safe and compliant manner.

PROBLEM CRITICALITY

The project addressed the existing challenges in roadway and maritime transportation in order to close the gap for medical and emergency response transportation systems in the rural communities of the Eastern Shore of Virginia. The communities within the project's service area are classified as historically disadvantaged. Historically Disadvantaged Communities (HDC) have been marginalized by underinvestment and overburdened by disadvantages including transportation, health disparities, economy, and environmental indicators. The population of the Eastern Shore health district service area for 2025 (including Accomack and Northampton counties) is 44,047 with a population growth of -0.1% (2020-2025). There are 18,523 total households, the median age is 47.4 years, and the median household income is $53,376.

PROOF OF CONCEPT - PROGRAM BENEFIT AREAS

SAFETY

Airspace Awareness

Project benefits include an approach to increase transparency for the users of this region's airspace and providing notification via NOTAMs of when and where drone delivery operations were occurring enabling early deconflictions. In proof-of-concept stage, operational flights were conducted at an altitude that removed the risk of conflict with other aircraft and provided a consistent route or corridor for BVLOS delivery operations to Tangier Island from Riverside Shore Memorial Hospital. This approach to testing was supported by the assessment on the Airspace Analysis conducted by URSA and ATA which is referenced in this report in later sections.

Roadway Congestion

An additional benefit of this project is a reduction in traffic congestion on a vital roadway. Specifically, this project is focused on Virginia's Eastern Shore where there is one interstate transportation corridor, U.S. Route 13, running north-south. This route is used as an alternative to I-95. Unfortunately, when it is backed up or completely shut down due to an accident, detour options are extremely limited. In fact, any detour will be on secondary or back roads which are ill-equipped for two-way traffic, let alone large commercial vehicles. Therefore, because U.S. 13 is an important segment of highway for East Coast port traffic and other commercial freight movement along the Atlantic Coast, any reduction in non-commercial traffic has the potential to significantly improve interstate delivery routes. In addition to commercial freight, U.S. 13 on the Eastern Shore is shared by school buses, agricultural equipment, tourists, and residents. Here again, any reduction in traffic will reduce the risk of accidents.

Public Safety and Emergency Medical Services

Public safety and emergency medical services can be integrated to provide meaningful input by leveraging the geospatial analyses conducted in Stage 1. This includes hot spot analysis of vulnerability indices to identify areas of high vulnerability and prioritize resource allocation effectively. These indices highlight critical factors such as travel time, elevation, and flood zones that influence service effectiveness. Examples include:

- **Identifying vulnerable communities**: The vulnerability index, which considers age and travel time (VAT), highlights the importance of addressing risks linked to extended travel times. Meanwhile, the VATF index, which includes age, travel time, and flooding, underscores the elevated risks faced by remote, waterfront communities with low-lying elevations, such as Chincoteague, where flood events severely limit access to local pharmacies.
- **Prioritizing resources**: Integration can be achieved by aligning emergency services with findings from indices to prioritize key stations or service areas. For example, the drone station at Riverside Shore Medical Center in Metompkin is identified as a priority under both VAT and VATF indices, due to its high vulnerability scores and significant patient coverage.
- **Tailored interventions**: Public safety efforts can focus on improving infrastructure and emergency preparedness in hot spots, such as low-lying western-coast areas of the Eastern Shore, while medical services can deploy drones or mobile units to ensure uninterrupted access to care.

This combined approach allows for data-driven decisions that enhance the effectiveness and impact of emergency medical responses, particularly in high-risk regions. Further, this analysis was used to identify areas of high vulnerability and lead the team's approach for prioritizing the deployment of potential drone station locations. For more details regarding geospatial analyses, refer to the Delivery Optimization Assessment section of this report.

EMS Stakeholder collaboration: This project can also be leveraged by the EMS community, particularly in hard-to-access regions of the country. To ensure continued collaboration, the project team included the director of the Virginia Public Safety Innovation Center who is connected to the EMS community in Virginia and surrounding states.

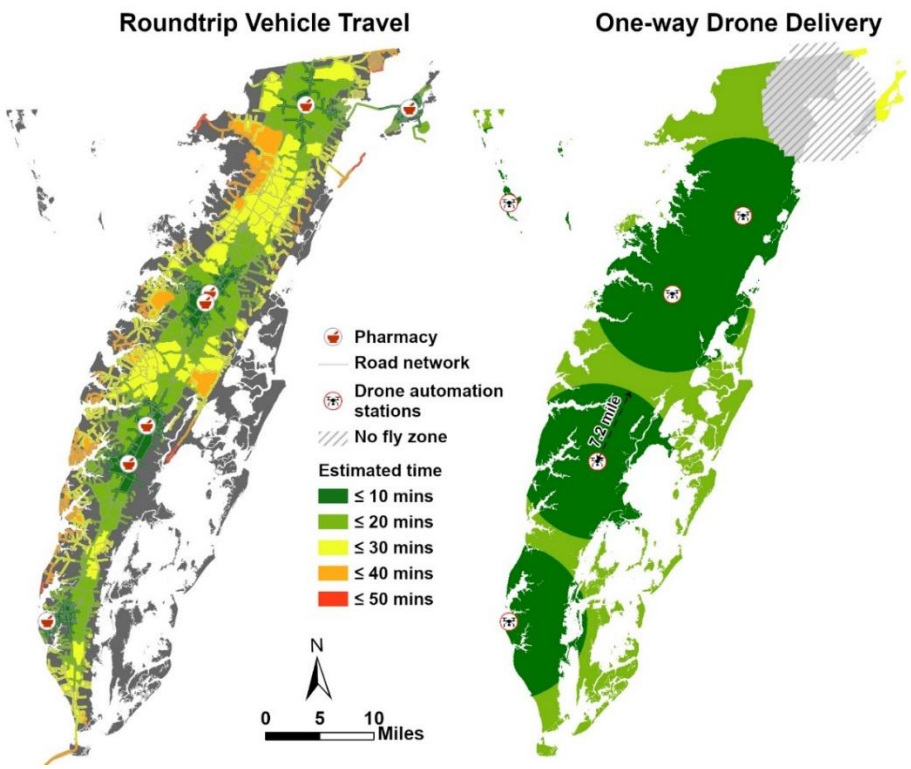
To focus outreach within the community, the team hosted a booth at the 2023 & 2024 Virginia Fire and Rescue Chiefs conferences. These were valuable opportunities to promote the project and build connections to the fire and EMS communities across the Commonwealth. The director of the Tidewater EMS council was also part of the project team to further build connections to the regional EMS units. This resulted in a better understanding of their needs and potential applications. Overall, there are more than 10 contacts and/or cooperative efforts with key local interest, as well as cooperative efforts with other DOT SMART Grant projects, and the American Heart Association projects.

SUSTAINABILITY AND RELIABILITY

This delivery project has the potential to increase the number of transportation pathways in order to create a more robust supply chain. When national emergencies and/or natural disasters occur and limit traditional delivery options for medications or medical supplies, drone delivery provides a viable option.

Data analysis was conducted comparing the difference between automobile and drone delivery times and computing the population within each travel zone. Data collection included estimated travel zones for vehicle-based travel and drone delivery, dasymetric mapping based on census block level, and zonal statistic outcomes for the total population within each travel zone. Vehicular trips accounted for round-trip travel times, while drone deliveries considered only one-way travel from the drone station to the patient's address. Road networks were classified into three hierarchical levels, and a Network Dataset was used to calculate round-trip travel zones for vehicles. Drone delivery times were computed using direct Euclidean distances and operational parameters from DroneUp. Census block data was used to identify total populations, as well as high populations of people aged 60 and over, within vehicle-based and drone delivery travel zones.

The following side-by-side map illustrates the estimated travel zones for car and drone delivery methods on the Eastern Shore. This analysis measures the round-trip driving time to the closest pharmacy compared to one-way drone delivery service. Results indicate that a round trip to the pharmacy would take between 10 and 30 minutes (dark green, light green, and yellow zones) in the study area, with some remote areas taking up to 50 minutes (orange and red zones). Tangier Island is excluded from vehicle travel because there is no direct car access to the Island.



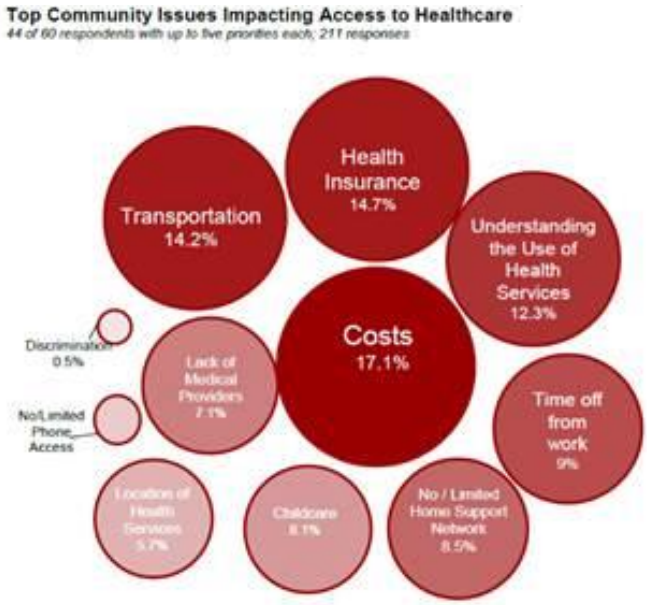
In contrast, most of the Eastern Shore, with the exception of the no-fly zone surrounding Wallops Flight Facility, is within a 20-minute flight from the nearest drone station.

DISPARITY AND ACCESS

As part of a comprehensive Community Health Needs Assessment conducted in 2019, Riverside Health received community input through a joint survey developed by the Peninsula Community Health Collaborative (PCHC). Respondents identified chronic disease services as a top community health service needing to be strengthened. Transportation is a contributing factor

to medication adherence, and not having needed medications negatively impacts health outcomes and health disparity. Transportation was ranked third (14.2%) in the top 11 issues affecting access to health care by PCHC survey respondents.

Further, for Riverside Health's 2022 Community Health Needs Assessment, partnering health organizations on the Eastern Shore participated in the assessment and provided meaningful input. These included the Virginia Department of Health, primary care providers in the Eastern Shore Rural Health System, the regional jail, local law enforcement, and local schools. Assessment results showed that 94% of surveyed stakeholders and 95% of community members named heart conditions as one of the top three most important health concerns; second in importance for adults, and third for children. Additionally, 17% of stakeholders and 20% of community members named transportation as an important improvement needed to keep the community healthy.



Transportation Access

For health care organizations, the transportation benefits include assured delivery of medications to patients, without any concern of transportation obstacles. This is especially important in rural communities, where residents often have to travel greater distances to health care facilities. In fact, the region has a low vehicle ownership rate compared with the rest of Virginia. As a result, the lack of private vehicles, unreliable public transportation, and poor infrastructure all contribute to missed appointments, delayed care, and poor medication adherence, leading to worsening health outcomes. These transportation barriers are more prevalent among the elderly population and children from low-income families; and the impact on health care access is significant for low-income and racially minoritized populations. Addressing these barriers requires multidisciplinary collaboration involving health care providers, urban planners, and policymakers.

For patients within driving distance of a pharmacy, the convenience of drone delivery could translate to improved medication adherence. For patients with limited mobility, no access to transportation, or those far removed from services (Tangier Island), the benefits can cut days, if not weeks off diagnosis times, as well as ensure quicker access to medications, leading to improved medication adherence. On Tangier Island, weather, water conditions, and ferry malfunctions can disrupt regular deliveries of supplies and transporting people to and from the

island. Indeed, this was a problem during the demonstration project when a boat captain became ill and the mail boat was being repaired.

For inter-clinic delivery of medical supplies and specimens, drone delivery can also significantly reduce time and employee hours. Likewise, if implemented in a major metropolitan area challenged with overcrowding or inefficient public transportation systems, redundant delivery systems and even a small reduction in car trips can offer major benefits to the overall transportation footprint.

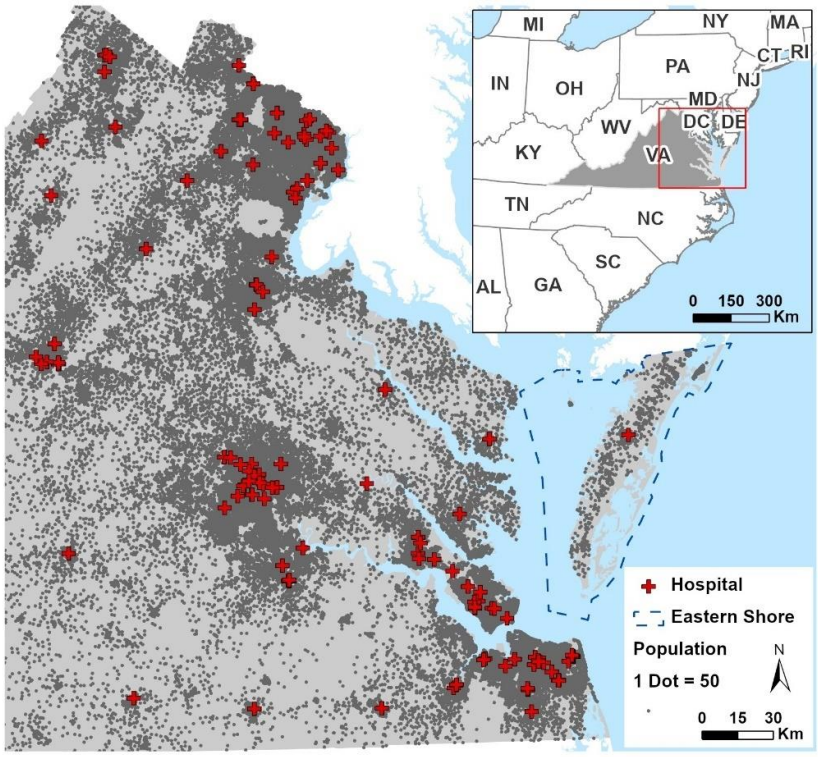
Health Disparity

Poverty and lack of vehicle access directly corresponds with higher rates of primary medication nonadherence and widening gaps in health care disparity. A community health assessment from the Eastern Shore Health District highlights transportation and social determinants of health as major concerns, with plans to address them through education, improved service availability, and targeted interventions.

Further, both Accomack and Northampton Counties are designated as rural Medically Underserved Areas (MUAs) and Health Professional Shortage Areas (HPSAs) according to the United States Health Resources and Service Administration. MUAs are defined as areas having too few primary care providers for the population, high infant mortality, high poverty, and/or a high elderly population. Similarly, HPSAs are defined as having too few primary, dental, or mental health care providers. Riverside Health has some unique projects underway to bring primary care providers to the area, but until that bears fruit, the Eastern Shore will continue to be medically underserved. Poverty and the high percentage of elderly will also continue to be issues into the foreseeable future.

According to various federal metrics, Eastern Shore residents suffer from poor health and limited transportation options. As of 2021, the Health Resources and Services Administration ranked both Accomack and Northampton counties in 3rd and 4th quartiles (i.e. the bottom 50-25%), respectively, of County Health Rankings and Roadmaps Health Outcomes across the nation.

Health Care and Pharmacy Deserts: Health care deserts are areas in which people lack adequate access to key health care resources, including pharmacies and/or hospitals (Nguyen et al. 2021). The following map illustrates the population and hospital density in Coastal Virginia. Each dark-gray dot represents 50 people, based on data from the 2020 Census survey. Hospital locations were sourced from the Virginia Geographic Information Network (VGIN). As can be seen on the map, given its isolation and limited connection to the rest of Virginia, the Eastern Shore (highlighted by a blue polygon) is a clear health care desert, with only one hospital serving the entire area.

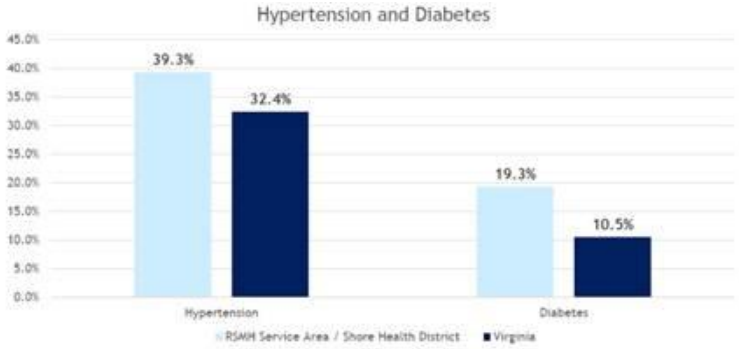


A pharmacy desert is a county where most people have to drive more than 15 minutes to reach a nearby pharmacy. Nationally, approximately 40% of all counties are classified as pharmacy deserts. This includes Northampton County on the Eastern Shore.

By analyzing public data from the US Census and geospatial information from the VGIN, the team analyzed the proximity of each resident on the Eastern Shore to their nearest pharmacy. Based on that analysis, more than 33% of Eastern Shore households are at least 10 minutes away from their nearest pharmacy (i.e. a 20-minute roundtrip). Moreover, compared to younger age groups, people aged 60 or older are more likely to travel even farther to their nearest pharmacy. Based on the project team's analysis, residents aged 60 or older make up approximately 35% of those living within a 30-minute roundtrip to a pharmacy. This same age group comprises 45% of those living within a 30- to 50-minute roundtrip to the nearest pharmacy.

Chronic Conditions: This service area is also at a higher risk for common chronic conditions, when compared to the broader population of the Commonwealth of Virginia. The Virginia Department of Health's health behavior data indicates that chronic disease prevalence rates for the Eastern Shore health district are much higher than rates across Virginia, for both hypertension and diabetes. Prevalence rates for the Eastern Shore were 39.3% for hypertension and 19.3% for diabetes, compared to 32.4% and 10.5% for Virginia, respectively.

Access to medications for chronic conditions and patients' medication adherence are leading contributing factors for improving patient outcomes and reducing unnecessary emergency department visits. According to the Permanente Journal, medication nonadherence impacts 40% to 50% of patients who are prescribed medications for managing chronic conditions such as diabetes or hypertension.



PARTNERSHIPS

Partnerships, through public procurement, were incorporated into the project to facilitate community engagement. Publicly procured partners having executed agreements/contracts:

- Stage 1 DOT SMART Grant recipient: Accomack-Northampton Planning District Commission
- Hospital/Pharmacy, Medical Service Provider and Hospital Facility: Riverside Health System
- Project Management and Data Analysis Provider: Old Dominion University/Virginia Institute for Spaceflight & Autonomy
- Drone Delivery Service Provider: DroneUp
- State Support: Virginia Innovation Partnership Corporation (Unmanned Systems Division and Public Safety Innovation Center)

Stakeholder Engagement: Throughout the project's performance period, community stakeholders continued to be meaningfully involved in determining program benefits. Continuous engagement for the project included public meetings held by the Accomack-Northampton Planning District Commission. The A-NPDC was created by the Commonwealth of Virginia as a regional agency serving Accomack County, Northampton County, and the town of Chincoteague. Its commissioners are members of the Board of Supervisors for both region's counties, local public agency leaders, and the mayors of the region's two largest incorporated towns (Chincoteague and Cape Charles). At these meetings, the public was invited to comment on various aspects of the project.

Community leaders also served as keynote speakers at the four demonstration events held to support the project. For the demonstration event in May 2023, engagement from the community included public officials, leadership from nearby NASA Wallops Flight Facility, and local business leaders. The February 2024 event included leaders from the U.S. Department of Transportation, as well as elected officials and business leaders. Additionally, a more focused event was held specifically for local small aircraft pilots to address concerns, discuss potential risks to evaluate, and gain their acceptance. They have all remained engaged in the project by attending several presentations, participating in question-and-answer opportunities, and communicating additional follow-up information to address any remaining concerns.

A number of endorsing stakeholders across industry, academia, and state and local government were integrated into this project. The interest of community partners included the collaboration and inclusion of Virginia Department of Health, Accomack County Airport, Tri-Area Community Health, VCU Health, NASA Wallops, and Rayfield's Pharmacy in project discussions. Additional funding and support for the project's proof–of concept were secured through the Virginia Innovation Partnership Corporation (VIPC).

Key locality stakeholders, potential beneficiaries, and federal approvers were also engaged throughout the POC period of performance. Examples include:

- The Hampton Roads Biomedical Research Consortium was consulted for evaluating the potential benefits
- Virginia Innovation Partnership Corporation provided the initial project funding and was heavily integrated into the project's leadership team.
- Tidewater EMS actively joined the leadership team meetings and provided support in the coordination with regional EMS services
- Board of Pharmacy was engaged in proactive risk mitigation to verify that Stage 1 project prototyping was compliant. Findings resulted in ruling updates in 2023 to consider drone delivery as an authorized delivery service and no longer requiring an innovative pilot waiver for drone delivery of medications.
- Potential beneficiaries (patients eligible for enrollment) were enthusiastic in their support of this project.
- ODU VISA, DroneUp, and Echodyne engaged with NASA Goddard Space Flight Center Wallops to conduct multiple test flights verifying the Original Equipment Manufacturer (OEM) specifications on Range, Mission Endurance, and performance of the long-distance delivery aircraft.
- FAA personnel was engaged by DroneUp to include AFS 700, and AUS 400. This cooperative engagement led to two 14 CFR §§ 107.31 and 107.33 waivers. These waivers allowed the project team to conduct proof-of-concept operations that validated the technology being used for delivery flights.
    - the FAA UAS Operations team consulted for safety and compliance, with a focus on UAS transport of medical packages, including medications and blood draws. Received approval for project, with no additional issues.
- Riverside Health System Foundation was consulted for evaluating long term sustainable program funding and fundraising

INTEGRATION

The team's technology proof of concept was fully integrated between hospital and pharmacy operations, delivery flight operations, patient prescription notification, and delivery confirmations. This provided the benefit of a seamless and well-coordinated successful prescription delivery service for those patients that have transportation and mobility challenges. The integrated technology proof of concept enabled:

- Validated prescription chain of custody through delivery.
- An approved Drone lease approach which provided drones that were tailored to specific mission purpose that employed the latest battery, C2, and flight performance characteristics for faster, better, cheaper deliveries.
- High priority air space awareness of drone flight operation that eliminated incursion risk with manned aircraft flights.
- Flexible delivery scheduling that eliminated weather impacts and any accident dangers to flight operations during marginal adverse weather conditions.

- Efficient cellphone text patient prescription notification that coupled with drone delivery flight operations that reduced the risk of cost and schedule over runs; and finally
- A well-coordinated communications approach that utilized surveys, websites, and public awareness events that brought the public into the project early and often to ensure public acceptance and risk reduction

Modeling Adaptability

To promote connectivity of infrastructure, the geospatial analyses conducted during this project demonstrates significant scalability, as they can be easily applied to other areas of interest. To protect patient health information, the analyses relied exclusively on multi-sector public datasets. The following table provides an overview of the geospatial data sources used, which were retrieved from federal, state, and county-level authorities.

Geospatial data utilized in this project:

Data	Source	Authority Level
Road centerlines	Virginia Geographic Information Network (https://vgin.vdem.virginia.gov/pages/clearinghouse)	State
Parcel	Accomack County GIS Data (https://accomack-county-virginia-open-data-portal-accomack.hub.arcgis.com/); Virginia Geographic Information Network (https://vgin.vdem.virginia.gov/pages/clearinghouse)	County / State
Building footprint	Virginia Geographic Information Network (https://vgin.vdem.virginia.gov/pages/clearinghouse)	State
UAS facility map data	Federal Aviation Administration (https://hub.arcgis.com/datasets/faa::faa-uas-facilitymap-data/about)	Federal
Decennial demographic and housing characteristics data	Explore Census Data (https://data.census.gov/)	Federal
National land cover database	Earth Resources Observation and Science Center (https://www.mrlc.gov/data/nlcd-land-cover-conus-all-years)	Federal
Flood insurance map	Flood Map Service Center (https://msc.fema.gov/portal/advanceSearch)	Federal

Among these datasets, parcel data was the only resource acquired from a county-level authority to ensure the analysis focused specifically on residential land use. All other datasets were sourced from state and federal authorities, facilitating their compilation across the Commonwealth of Virginia. While federal datasets generally provide nationwide coverage, certain data layers—such as road centerlines and building footprints—are typically managed and published by state-level GIS departments, ensuring availability for public use.

By leveraging publicly available data, the analytical framework offers both scalability and adaptability, making it applicable to regions where drone delivery serves as a sustainable and scalable alternative to traditional vehicle travel in medically underserved communities. Additionally, the reliance on public data not only safeguards patient privacy but also ensures that the methodology can be adapted to diverse regions with minimal resource constraints.

WORKFORCE DEVELOPMENT

Development of education and career awareness: To better target the potential workforce in the service area, an expanded curriculum was developed with ESCC through a Stage 1 subcontract task, as outlined in Appendix E. Further education development will help to strengthen the current drone training program (FAA Part 107) typically offered twice a year at ESCC. It will also develop a "blueprint" for an expanded program covering multiple aspects of drone performance, including operations, maintenance, and repair, which could lead to a certificate program. This "blueprint" will be foundational for ensuring a sustainable trained workforce pipeline for drone medical package delivery and other applications of the rapidly expanding drone technology/operations ecosystem (e.g. agriculture). The team worked to build the required partnerships to grow operations on the Eastern Shore and deploy at selected locations across the Commonwealth. Project activities supporting workforce development:

- Assessed project and community needs. Developed and finalized a Scope of Work agreement with Eastern Shore Community College (ESCC) to establish a Talent Training and Development program, which includes training in the various skills needed to ensure the project can be implemented at-scale and sustained (Appendix E).
- Participated in several workforce/educational events including:
    - Career Adventure Day for 10th graders at ESCC on October 18, 2024
    - Aerospace Academy Lab School Eastern Shore (AAES) kickoff event for 8th graders at ESCC on November 15 and November 22, 2024.
- Sponsored the Drone Discovery Day for students, faculty, and the general public on December 9, 2024 at ESCC.
- Assessed project and community needs and developed a comprehensive full-pipeline approach (high school, community college, and university), by Old Dominion University. This Talent Training and Development program will help develop the various skills needed to ensure the project can be implemented at-scale and sustained.

PROOF OF CONCEPT - PROJECT ACTIVITIES AND OPERATIONS

PROOF-OF-CONCEPT FRAMEWORK

The Stage 1 Evaluation Plan with proof-of-concept evaluation questions, performance measures, and performance measure targets are located in Appendix B. Key accomplishments demonstrated in the proof-of-concept stage include completing prototypes of actual medicine delivery by flight ranges of VLOS, EVLOS, and BVLOS.

Visual Line of Sight (VLOS) - short range patient prescription delivery:

General Operating Details:

- Base of Ops: Riverside Shore Memorial Hospital
- Aircraft: Watts Prism SKY
- Payload: Up to 7 lbs
- Delivery Distance: 1 mile (Point to Point)

Key Accomplishments:

- 1-2 mile deliveries started October 2023
- Engaged FAA regarding project and payload classification approvals
- Established the base of operations, technology solutions and workflows to support RSMH medical delivery
- Formalized medicine tracking and hospital operations process
- Established candidate patients
- Formalized delivery paths and operations
- Conducted deliveries, tested and evaluated the technology configuration, demonstrated system reliability, performance and collected flight data parameters
- Repeated delivery plan implemented with lessons learned, used data to refine processes and solutions for increased flight range demos

Extended Visual Line of Sight (EVLOS) – increased range medical supply delivery:

General Operating Details:

- Base of Ops: Riverside Shore Memorial Hospital
- Aircraft: Watts Prism SKY
- Payload: Up to 7 lbs
- Delivery Distance: 5.0 miles (Point to Point)
- Multipoint VOs to hand-off to stay under 107

Key Accomplishments:

- 3-5 mile deliveries started January 2024
- Updated medicine tracking and hospital operations process
- Established additional patient candidates within extended delivery radius
- Formalized delivery paths and operations
- Formulated models and simulations to optimize routes, maximize deliveries, and predict health impacts and disparities by geographical regions
- Collected flight data parameters

Beyond Visual Line of Sight (BVLOS) - Tangier Island medication delivery

General Operating Details:

- Base of Ops: Riverside Shore Memorial Hospital
- Aircraft: Swoop Aero Kite 2
- Payload: Up to 5 lbs
- Delivery Distance:17.2 miles (Point to Point)

Key Accomplishments:

- 5 to 17 mile deliveries to Tangier Island
- Worked with FAA for approvals
- Evaluated Air Volume Awareness to ensure flight safety and Detect and Avoid methods
- Select long flight UAS
- Conducted deliveries, formalized delivery paths and operations
- Collected flight data parameters, and finalized data metric collection methods
- Delivered medical supply packages from RSMH to Tangier Island using UAS
- Established a defined route over land and water that can be followed by visual observers on land and manned chase boat and / or an autonomous surface vessel to track and relay visual verification

PARTNERSHIP AND TEAM STRUCTURE

Stage 1 Project Team Organizational Structure:

Operationalizing Medical Package Delivery in Underserved Localities Using Drones
DOT - SMART Grant Organizational Budget & Work Breakdown

A-NPDC

Budget: $ 34K
- Grant Admin.
- Community Planning
- Community Engagement

RIVERSIDE

Budget: $ 398,200K
- Use Case formulation
- Data Collection
- Operational process improvement changes
- Client interfacing
- Event Planning
- Community acceptance / support

OLD DOMINION UNIVERSITY

Budget: $ 545K (VISA & HRBRC)
- Project Management
- Data Analytics
- Modeling and Simulation
- Performance Survey
- Workforce development program

DroneUp

Budget: $ 899,800K
- Concept of Operation formulation
- Phase 1-3 Flight planning
- Operational Demonstrations
- Tracking, Telemetry, Command, Control
- Routes and corridor
- Distribution Hub development and implementation
- FAA and Locality Approvals
- Drone Operations
- Autonomous Systems deployments

Carilion Health (SW Va.) and Valley Health (NW Va.)
- Advocacy and access to other rural health communities
- Additional Rural health applications
- Additional Technology adopters
- Additional Demonstration locations

*Old Dominion University included the following departments for the project team: Virginia Institute for Spaceflight & Autonomy, Strome College of Business - Department of Information Technology and Decision Sciences, the Center for Geospatial Science, Education, and Analytics, and the Office of Enterprise Research and Innovation (OERI).

Stage 1 Project Team Workgroup Structure:

DOT SMART GRANT Project Team and Functional WBS Structure

1.0
Grant Management Team
Team Lead – ANPDC
Project Management Team
Team Lead – VISA @ ODU

1.2.0 Project Management
1.2.1 Budget and Schedule
1.2.2 Configuration Management
1.2.3 Report Development and Templates
1.2.4 Partnership Development
1.2.5 Coordination with State

1.1.0 DOT Coordination
1.1.1 Grant Administration
1.1.2 Contracting and Sub Grants
1.1.3 Community Planning
1.1.4 Community Engagement

2.0 Patient Outcomes Accessibility, and Business Ops. Team
Team Lead - RHS

2.1 Use Case formulation
2.2 Operational process improvement changes
2.3 Data Collection
2.4 Patient / Client interfacing
2.5 Metric / Performance Measures
2.6 Data Analytics
2.7 Modeling and Simulations
2.8 Business Analysis

3.0 Drone Flight System and Operations Team
Team Lead - DroneUp

3.1 Phase 1-3 demo planning
3.2 Concept of Operation formulation
3.3 Operational Demonstrations
3.4 FAA and Locality Approvals
3.5 Drone Operations
3.6 Tracking, Telemetry, Command, Control
3.7 Routes and corridor
3.8 Distribution Hub development and implementation

4.0 Public Outreach and Communications Team
Team Lead -RHS

4.1. Communications / PR
4.2 Event Demo Planning and Implementation
4.3 Public outreach / acceptance

5.0 Education and Workforce Development Team
Team Lead – VISA @ ODU

5.1 Training and Development Assessment
5.2 Academic engagement
5.3 Camps (9-12th)
5.4 Internships

By WBS # we need to determine costs:
- **Labor (By Category, Hrs/FTE, $)**
- **Procurements**
- **Travel**

UAS SUITIBILITY WITHIN PROJECT LOCATION

In parallel to this project, the URSA's Hampton Roads Virginia Airspace Analysis report was produced and focuses on evaluating a case study for a proposed drone delivery route from Riverside Hospital in Onancock, Virginia, to Tangier Island in Chesapeake Bay. The analysis takes into account airspace considerations, special use airspace, proximate aerodromes, and historical aerial traffic density, and a series of other diverse factors to evaluate operational risk. The approach closely follows the FAA's guidance for Safety Risk Management (SRM) used to evaluate unproven UAS operations for waiver or authorization approval.

Additionally, the authors provide a comprehensive overview of factors affecting UAS delivery within Virginia. This includes an in-depth assessment of existing UAS operations, support infrastructure, historical technology company incubation efforts, economic factors, geographical considerations, weather implications, airspace configuration, special use airspace, air traffic trends, and ground risks to holistically evaluate Virginia's suitability for further promotion and development of UAS delivery enterprises within the Commonwealth. This case study suitability analysis makes use of a combination of publicly available datasets, data fusion techniques using USRA' s proprietary Airspace Awareness Platform, and expert-level analysis from a team of subject matter experts.

The proposed delivery operation presents a near-idealistic scenario that balances strong public need and benefit with relatively low operational risk. The culmination of evaluated factors yielded a favorable to extremely favorable assessment of the project's location which is indicated in the summary of the suitability factors for UAS delivery within Virginia shown in the table below on the right.

SUMMARY OF SUITABILITY FACTORS FOR UAS DELIVERY WITHIN VIRGINIA

Suitability factors	Extremely Favorable	Favorable	Neutral	Unfavorable	Very Unfavorable
Development factors					
EXISTING UAS ACTIVITY		X			
ORGANIZATIONAL	X				
STATE ECONOMY		X			
HISTORICAL DEVELOPMENT SUCCESSES	X				
LIKELY DEMAND FOR UAS DELIVERY		X			
Geographic factors					
TOPOGRAPHY		X			
LAND COVER	X				
POPULATION DENSITY		X			
Climate factors					
TEMPERATURE / FREEZING CONDITIONS		X			
PRECIPITATION		X			
WIND SPEED		X			
Operational Risk					
AERODROMES		X			
AIRSPACE COMPLEXITY		X			
UAS FACILITY MAPS		X			
SPECIAL USE AIRSPACE		X			
AREAS SUBJECT TO TFRS		X			
SPECIAL FLIGHT RULES AREA [SFRA/FRZ]				X	
RECREATIONAL FLIGHT OPERATIONS	X				
HISTORICAL AIR TRAFFIC DENSITY		X			
FLIGHT OBSTRUCTIONS		X			

Table source: URSA, Hampton Roads Virginia Airspace Analysis

The proposed operation location would take place in uncontrolled airspace, with only a small quantity of low-altitude air traffic. The area is largely devoid of complicating airspace or operational factors, thereby reducing overall risk. Strategic UAS routing could largely avoid populated areas and potential ground hazards, by primarily flying over farmland, tributaries, streams and rivers, and the Chesapeake Bay. The relatively mild weather and average temperatures above freezing present favorable conditions for routine UAS operations. The geography of the region is generally flat, with no relevant terrain obstructions. Overall, these conditions as shown in the figure on the right are advantageous for low-risk UAS operations.

As a result of the analysis, the report presents a sample methodology, outlined in the report, to serve as a practical template for conducting future risk assessment for drone delivery operations. This approach offers a valuable resource for companies seeking to navigate the regulatory landscape for routine drone delivery services.

MEDICAL SUPPLY DRONE DELIVERY FLIGHTS

Testing sessions allowed the team to optimize navigation by using advanced route planning software to identify safe and efficient flight paths and avoid congested areas or restricted zones as well as areas prone to weather disturbances. Real-time weather monitoring was implemented with contingency plans in order to avoid flying in adverse conditions such as strong winds, storms, or low visibility. Additional redundancy considerations included adhering to strict protocols for battery management, verifying that the payload and packaging were secure, confirming sufficient communication coverage for flight operations, and ensuring adherence to measures put in place to protect patient confidentiality.

For the proof-of-concept drone delivery demonstrations, insurance considerations for Riverside Health's aviation policy had to be modified by the Risk Management team to accommodate for the drone operations performed by DroneUp. Insurance considerations were also addressed to support the proof-of-concept demonstration events held at Riverside Shore Memorial Hospital and on Tangier Island.

Operations and Technical Feasibility

To minimize risks in drone delivery of medical supplies, rigorous testing and simulations were conducted before full-scale deployment and required careful planning throughout the flight-testing sessions. This included following operational procedures, adhering to regulatory guidelines, obtaining the necessary permits and waivers for drone operations, and monitoring air space by tracking the number of incursion incidences during 1–5-mile BVLOS flights.

The technology scale of the service area was the Eastern Shore of Virginia including Tangier Island. The technology readiness level for the Stage 1 demonstration was TRL-9. The drones used are currently engaged in existing delivery operations with a different application. Operations for these Stage 1 demonstrations occurred within existing FAA part 107 operations.

The operational feasibility of drone technology by distance was also evaluated and is outlined in the ConOps for Stage 1a VLOS, 1b BVLOS, and 1c RSMH to Tangier Island. To determine the appropriate UAS equipment needed for the VLOS and BVLOS delivery flights, DroneUp conducted a broad market survey of Unmanned Aircrafts to identify the most suitable aircraft to conduct delivery operations in the rural environment of the Eastern Shore. DroneUp selected two aircraft models to conduct operations.

- **Watts Prism SKY:** Selected for delivery applications within 1-5 miles of takeoff location. DroneUp has conducted thousands of deliveries using the Prism SKY and is familiar with its operational characteristics, safety record, and reliability for 1–5-mile delivery operations.
- **Swoop Aero Kite 2:** Selected for delivery applications beyond 5 miles. The Kite is already in use in austere environments and has conducted delivery of medications and supplies in Africa. This platform has an outstanding safety record and the required communications link to fly long distances over unpopulated areas.

During this project, the team conducted flights using the Prism Sky and the Swoop Aero Kite 2. A total of 352 actual flights and 93 simulated flights were conducted. The flights fell into two categories of either testing or delivery. Test flights were conducted on both aircrafts and were used to validate system performance, safety, and reliability; as well as conduct training and identify potential issues.

Prism Sky: 259 total flights conducted.

- 200 flights were conducted at DroneUp's test location.
- 59 flights were conducted on the Eastern Shore at or near Riverside Shore Memorial, including:
    - 25 flights testing Command and Control link in delivery area
    - 16 delivery flights
    - 4 temperature probe flights
    - 14 BVLOS flights (non-delivery operations)

Swoop Aero Kite 2: 95 flights and 93 simulated flights conducted.

- 63 flights conducted at DroneUp's test location.
- 19 flights conducted at NASA Wallops Test Facility.
- 13 flights at RSMH to Tangier Island.

Delivery flights: Prism Sky delivery flights ranged from 1.8 miles to 2.5 miles. Delivery time from takeoff to package delivery was an average of 5.1 minutes. The longest time from takeoff to delivery was 7.1 minutes and the shortest was 4 minutes. The Swoop Aero delivery flights were all 36.4 miles. The time from takeoff to package delivery was 15 minutes.

NASA Wallops: 19 flights were conducted at the NASA Wallops test facility. The purpose of the flights was to verify the Original Equipment Manufacturer (OEM) aircraft limitations. The longest flight was 64 miles in total distance, with a mission time of 56 minutes. The NASA test facility gave the team the ability to fly the aircraft over water and away from land-based cellular coverage, allowing for the aircraft to switch over to its SATCOM communications link, thereby validating aircraft performance on both C2 links.

Stage 1 Proof of Concept testing sessions and delivery fights:

Date	Type of Flight	Location	Distance	Aircraft	Number of flights
JUL 23	VLOS	AMA	1-3 miles	Sky	41
AUG 23*	VLOS	RSMH/AMA	1-3 miles	Sky	39
OCT 23*	VLOS	RSMH	1-3 miles	Sky	25
JAN 24*	VLOS	RSMH/AMA	1-3 miles	Sky	11
FEB 24	BVLOS	RSMH	3-5 miles	Sky	5
FEB 24	VLOS	AMA	1-3 miles	Kite	2
MAR 24	VLOS	AMA	1-3 miles	Sky	21
MAR 24	VLOS	AMA	1-3 miles	Kite	27
APR 24	VLOS	RSMH	1-3 miles	Sky	5
APR 24	VLOS	AMA/NASA	1-64	Kite	33
MAY 24	VLOS	AMA	1-3 miles	Kite	3
JUN 24*	VLOS	AMA/Tangier	1-36 miles	Kite	16
JUL 24*	VLOS	RSMH	1-3 miles	Sky	7
JUL 24	VLOS	AMA	1-3 miles	Kite	5
AUG 24	VLOS	AMA	1-3 miles	Kite	1
SEP 24	VLOS	AMA	1-3 miles	Kite	4
OCT 24	VLOS	RSMH/AMA	1-3 miles	Sky	40
OCT 24*	BVLOS	RSMH/AMA	1-36 miles	Kite	7
NOV 24	VLOS	AMA	1-3 miles	Sky	20
DEC 24	VLOS	AMA	1-3 miles	Sky	40

**denotes flights with delivery of medical supply contents*

Identification of Performance Measures: Data was collected during the testing sessions and includes the geospatial files that show the flight path of the drone for the Tangier and Wallops flights. Collected data included flight logs with aircraft, mission time in minutes, distance in miles, mission type flight mode, latitude, longitude, altitude, and air speed. Battery charge and volume were also recorded over the duration of the flight which informed the expected battery needs for at-scale implementation and operational turnaround times. Data is available in the project repository.

Air Volume Awareness Architectures

Initially, this project intended to implement either ground-based or drone-based Air Volume Awareness Architecture to conduct BVLOS flights. However, during the initial stages of applying for a BVLOS waiver, it was determined that the use of shielded infrastructure would be a more suitable method. Shielded infrastructure is achieved when the drone flies at altitudes that are considered too low for crewed aviation. This method was suitable for the proof-of-concept operations conducted and to receive a BVLOS waiver from the FAA during this phase of the project. However, as the scale of operations grows for Stage 2, it is likely that the flights will require a blend of shielded infrastructure and other electronic detection systems.

To understand airspace awareness, the project embarked on a multi-pronged approach. This included a no-cost partnership with VIPC Public Safety and Innovation Center. The team enabled the installation of a Dedrone Inc. detection system trailer (acoustic, small radar, optical, and ADSB sensors). This system was used to understand the magnitude of drone flights being conducted close to Riverside Shore Memorial Hospital and Accomack County Regional Airport. The results of this multi-week study showed periodic drone flights from various locations in the region, but nothing of significance that would impact planned operations or incursions with manned aircraft.

In a no-cost partnership with the VIPC Unmanned Systems Center and the Growth and Opportunities Virginia program through Reinvent Hampton Roads, the team advocated for and secured funding to produce two reports. These reports were entitled: URSA Hampton Roads Airspace Analysis and ATA Hampton Roads Advanced Air Mobility Service Enablement Assessment. The first report assessed the potential risks and performed mitigation analyses for drone flight operations in the Hampton Roads region, including the Eastern Shore. These risks included weather, traffic patterns, locations of airports, and various airspace restrictions. The second study investigated potential options for Air Volume Awareness Architectures needs, and potential critical routes and corridors to support drone delivery operations in Hampton Roads, including the Eastern Shore. The results of both studies were factored in the Stage 1 implementation efforts and planning the proposed approach for at-scale implementation.

From the start of the project, it was critically important to eliminate incursions and deconflict drone delivery operations with manned aircraft operations on the Eastern Shore. The goal was to ensure that drone delivery operations from VLOS through BVLOS would be safe and effective without incident. To meet this goal, the team began discussions with local airport operators, members of the Pilots Association, and Medivac crews to better understand their operations and have the opportunity to explain the potential drone delivery operational plan. It became clear from these discussions that the biggest concern centered around takeoff and landing approaches from the airport runway, as well as from the Riverside Shore Memorial Emergency Medivac landing pad. The altitude of most concern was any drone operations, manned or unmanned, that were occurring simultaneously below 250 ft. The team implemented a fully integrated approach with hospital emergency Medivac flights operations that required all drone takeoffs approved by the hospital operations team to remove any potential conflicts.

Additionally, to mitigate this risk, the team's plan was comprised of three elements:

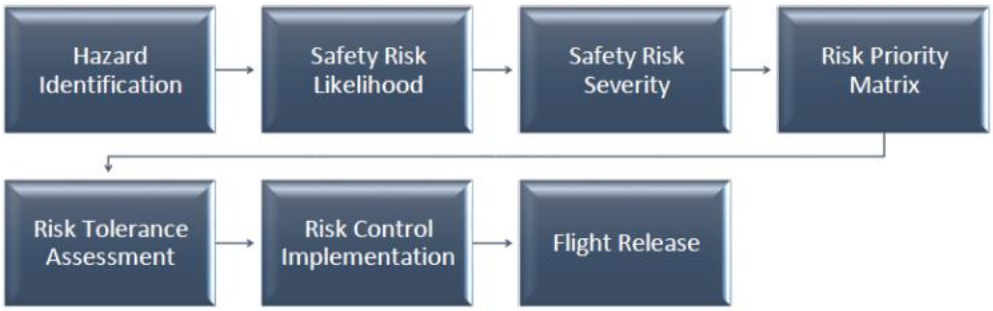
1. **Near Term Stage 1:** Understand the historical flight track data around the Eastern Shore by leveraging previously funded studies by the VIPC Unmanned Systems Center and the Grow and Opportunity Virginia Programs. These studies analyzed flight operations and commercial flight tracks data within the Hampton Roads region, including the Eastern Shore of Virginia, during the day and night, and throughout the year. These studies combined the flight track data, along with FAA flight envelopes and restricted areas, were used to develop preferred routes and corridors in the region. The results of this data and information clearly showed very few flights were occurring on the Eastern Shore that were below 400 ft. Those that occurred on takeoffs and approaches to Accomack Regional and Tangier airports; as well as by fish-spotting planes over the open waters of the Chesapeake Bay. Data also showed no flight tracks below 250 ft over the Chesapeake Bay or over land, except on approach and landing at small rural airports in the region. The drone operational flight altitude was limited to 250 ft as a result of the evaluated findings. In addition, for every drone flight operation, the team filed FAA NOTAMs so pilots could see if drone delivery operations were underway
2. **Near Term Stage 1**: Ensure hospital Medivac operations were well-coordinated with drone medical package delivery operations in and around the hospital. Drone delivery operational procedures required a check-in with hospital facility operations prior to the commencement of drone medical package deliveries. In addition, if an unanticipated Medivac flight was to occur, it was procedurally mandated that all drone delivery operations were to be halted and any drone flights in the air were to land.
3. **Far Term Stage 2**: Employ appropriate (FAA approved) and cost-effective Air Volume Awareness technologies, both on the ground and onboard the drones. This would ensure that the airspace where the drones will be operating can detect and avoid any possible conflicts, both with cooperative (ADSB) and noncooperative (non ADSB) aircraft. The team leveraged a study entitled Minimal Viable Architectures for Advanced Air Mobility, funded by the Virginia Department of Aviation and performed by the Virginia Mid-Atlantic Aviation Partnership (MAAP), an FAA Approved drone test center. The report is not included in this final report because the release has not been made public as of March 1, 2025. The report takes into account several factors, including cost, volume of traffic, location and size of airport operations and infrastructure, sensor technology maturity, and the performance of various types of Air Volume Awareness systems. These included but were not limited to ADSB ping stations, remote ID, ground and airborne optical systems, acoustic, and small and large radar systems. The study clearly defines a minimal viable system architecture for each type of airport, and balances near- and long-term costs with a locality's ability to afford the initial setup and longer-term maintenance costs.

The team used this report to establish a Stage 2 proposed Air Volume Awareness Architecture that was tailored to rural areas. This architecture would create a 1-mile bubble of flight information around an airport via ground-based sensors (ADSB ping station and optical systems). It would also have the flexibility of an on-board optical Detect and Avoid (DAA) system for use outside the airport bubble. This would allow for a cost-effective approach to transitioning from VLOS to BVLOS operations.

Risk Mitigation Process for Drone Flights

DroneUp operates under an industry standard Safety Management System (SMS). Within DroneUp's SMS, a well-defined Safety Risk Management (SRM) protocol is followed for all operations. SRM is the identification and control of risk and is the responsibility of every DroneUp employee. The first goal of risk management is to keep the risk posed by hazards to a low level by establishing independent and effective barriers, controls, and recovery measures. These can include equipment, work processes, standard operating procedures, training, and other means to prevent hazards and limit their consequences should they occur.

DroneUp also utilizes a Safety Operational Risk Management (ORM) process to quantify the risk to the aircraft, environment, and persons; to determine the likelihood of hazard occurrence; and to identify control measures to mitigate each risk.



Hazard Identification: Potential hazards can be identified using a variety of internal and external sources. DroneUp personnel quantify every hazard that can reasonably be expected during aircraft operation, as well as every possible failure condition, emergency, or hazard, regardless of how infrequently they expect it to occur.

Safety Risk Likelihood: DroneUp uses the following table from FAA 2023 Safety Risk Management Policy to determine the likelihood of risk occurrence.

Determine the likelihood that the predicted event will occur. Determine this using a scale that ranges from Extremely Improbable (G) to Frequent (A). Table 6-1 : Likelihood Definitions (Flight Hours)

Likelihood Category	Less than	Greater than or Equal to	Calendar-Based (Order 8040.6A)
Frequent - A	1	$1x10^{5}$ (1 per 100,000)	Expected to occur more than once every 4 days
Infrequent - B	$1x10^{5}$ (1 per 100,000)	$1x10^{6}$ (1 per 1,000,000)	Expected to occur <one time every month
Extremely Infrequent - C	$1x10^{6}$ (1 per 1,000,000)	$1x10^{7}$ (1 per 10,000,000)	Expected to occur <one time every year
Remote - D	$1x10^{7}$ (1 per 10,000,000)	$1x10^{8}$ (1 per 100,000,000)	Expected to occur <one time every ten years
Extremely Remote - E	$1x10^{8}$ (1 per 100,000,000)	$1x10^{9}$ (1 per 1, 000,000,000)	Expected to occur < one time every 100 years
Improbable - F	$1x10^{9}$ (1 per 1, 000,000,000)	$1x10^{10}$ (1 per 10,000,000,000)	Not expected to occur in the life of the aircraft
Extremely Improbable - G	$1x10^{10}$ (1 per 10,000,000,000)	0	Expected to occur < one time every 1000 years

Safety Risk Severity: Once the risk has been identified and the probability assessed, the severity of those risks is determined, based on the expectation of potential outcomes. Risks are assigned values between (1) Catastrophic and (5) Minimal.

Severity	Meaning	Value
Catastrophic	An expected unintentional effect that includes any of the following: • 3 or more fatalities; or, manned aircraft hull loss with at least 1 fatality.	**1**
Hazardous	An expected unintentional effect that includes any of the following: • 1-2 fatalities without manned aircraft hull loss; or • Manned aircraft hull loss without fatalities; • 3 or more serious injuries.	**2**
Major	An expected unintentional effect that includes any of the following: • 1-2 serious injuries; or, 3 or more minor injuries; • substantial damage to manned aircraft; • Hull loss to unmanned aircraft weighing at least 55 pounds. • Significant damage to persons, properties or critical infrastructures	**3**
Minor	An expected unintentional effect that includes any of the following: • 1-2 minor injuries; Minor damage to manned aircraft; • Substantial damage to the unmanned aircraft system where there is damage that must be repaired prior to further flight • Damage to property, other than the unmanned aircraft. • A lost control link event resulting in Fly-away, or Execution of a pre-planned/unplanned lost link procedure.	**4**
Minimal	Negligible safety effect.	**5**

Derived from [FAA 2023 Safety Risk Management Policy]

Risk Priority Matrix: The risk priority matrix is used to determine the priority of risk as a product of the severity of the hazard and its probability of occurrence.

	Risk Severity					
Likelihood	Minimal (5)	Minor (4)	Major (3)	Hazardous (2)	Catastrophic (1)	
Frequent (A)	A5	A4	A3	A2	A1	1×10^{-1}
	A5	A4	A3	A2	A1	1×10^{-2}
	A5	A4	A3	A2	A1	1×10^{-3}
	A5	A4	A3	A2	A1	1×10^{-4}
	A5	A4	A3	A2	A1	1×10^{-5}
Infrequent (B)	B5	B4	B3	B2	B1	1×10^{-6}
Extremely Infrequent (C)	C5	C4	C3	C2	C1	1×10^{-7}
Remote (D)	D5	D4	D3	D2	D1	1×10^{-8}
Extremely Remote (E)	E5	E4	E3	E2	E1	1×10^{-9}
Improbable (F)	F5	F4	F3	F2	F1	1×10^{-10}
Extremely Improbable (G)	G5	G4	G3	G2	G1	1×10^{-11}

FAA (2023) Safety Risk management Policy

Risk Tolerance Assessment: The risk tolerance assessment tables are used to determine the required action to be taken after a risk has been prioritized. Risks are reviewed by flight crew personnel and/or DroneUp management before a flight can be conducted.

Risk Category	Risk Tolerability	Required Action
A1, A2, A3, B1, B2, C1 *(refer to the power in matrix)*	**High Risk (Red)**	Severity and likelihood map to the red cells in the risk matrices. The safety risk requires mitigation, tracking, and monitoring, and it can only be accepted at the highest level of management; Accountable Executive, COO and CTO (see table 6-4)
A4, B3, B4, C3, C2, D1, D2 *(refer to the power in matrix)*	**Medium Risk (Yellow)**	Severity and likelihood map to the yellow cells in the risk matrices. Although this safety risk is acceptable without additional mitigation, tracking and monitoring are required; (see table 6-4)
A5, B5, C4, C5, D3, D4, D5, E1, E2, E3, E4, E5, F1, F2, F3, F4, F5, G1, G2, G3, G4, G5 *(refer to the power in matrix)*	**Low Risk (Green)**	Severity and likelihood map to the green cells in the risk matrices. This safety risk is acceptable without restriction or limitation: hazards are not required to be actively managed, but they must be documented and reported; (see table 6-4)

Table 6-4: *Risk Tolerance Assessment*

Initial Safety Risk Level	UAS Safety Risk Acceptance
High Risk (Red)	Accountable Executive, COO and CTO
Medium Risk (Yellow)	All Part 119 Management Officials and Vice-Presidents with operational control authority
Low Risk (Green)	Appropriate Management official or RPIC who has the positional responsibility and authority for the issue or change being assessed.

Risk Control Implementation: After all risks are identified, quantified, and prioritized, flight crews and operations personnel implement appropriate risk controls in order to reduce all foreseeable risks posed by the operation to an acceptable level.

Flight Release: Flight Crews are NOT AUTHORIZED to continue an operation until a flight release is granted, and the ORM form is signed by the appropriate entity capturing every operation.

Pharmacy Operations and Patient Prescription Deliveries

RSMH does not currently offer 'last mile' delivery to patients for non-specialty medication prescriptions. Specialty pharmacy prescriptions are available by FedEx or courier services and patients are able to pick up their prescription medications from the inpatient pharmacy onsite at RSMH or from several other retail pharmacies within the area.

The proof-of-concept project specifically focused on patients using antihypertensive medications. This patient population was chosen for the initial project design due to measurable medication compliance, drug weight and size within drone payload limits, manageable

temperature variations, and regulatory clearance for safe delivery of medication. For this project FAA medication clearance was derived from Section 14 of the medications Material Safety Data Sheet (MSDS) which provides specific details for shipping, handling, and care. If there were no specific requirements for shipping, the product was deemed safe for transport. Health outcome metrics associated with patients prescribed antihypertensive medications will be studied in Stage 2 such as blood pressure monitoring and visits to the emergency department.

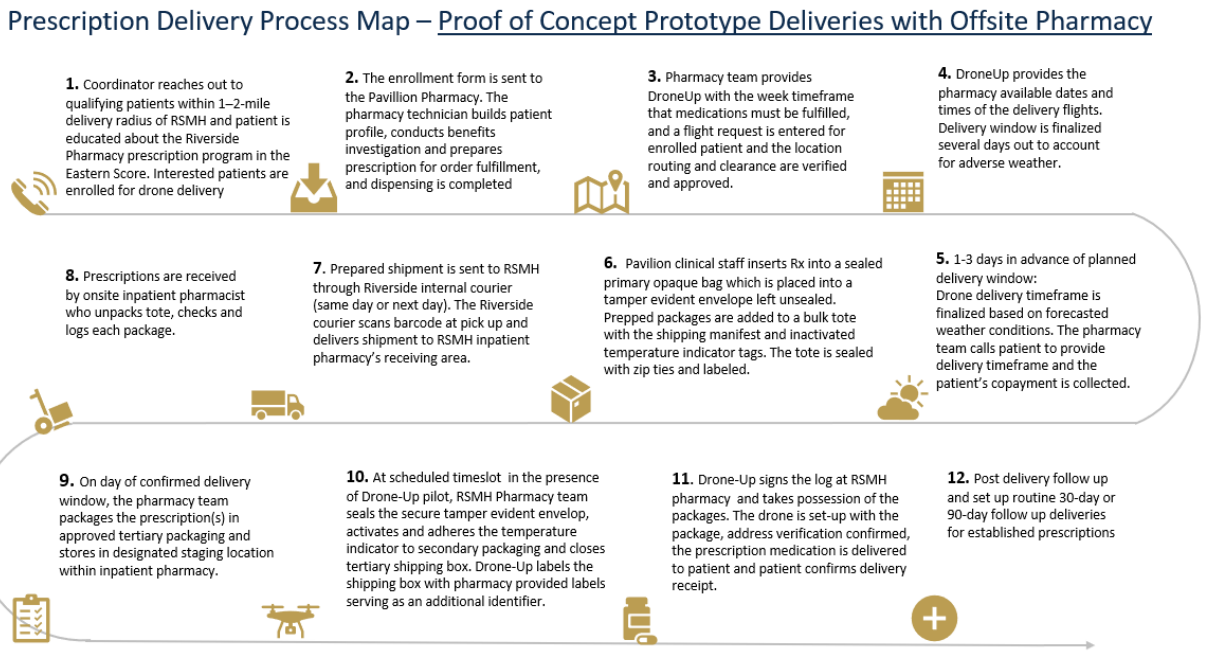
In Stage 1, five patients were enrolled to receive reoccurring prescription refills from October 2023 until January 2025. Numbers were small due to the small eligible population living within the VLOS flight area around the prototype flight base location. The reoccurring deliveries allowed the team to walk through the process for integrating UAS into the workflow as well as test delivery flights throughout seasonal variation.

Three of the five patients enrolled in the drone delivered medication trial program provided feedback at the conclusion of the program in January 2025. The responses were very positive indicating that they found the delivery service to be very reliable, that the service improved access to medications and they reported no issues. A summary of the responses received are available in Appendix D, Drone Delivery Program Exit Survey Responses.

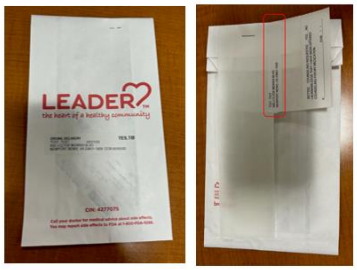
Process and workflow considerations: To accommodate the shift of delivery to the patient's residences, the team performed an operational process mapping and gap analysis of technology integration. In the workflow, Riverside Pavilion Pharmacy dispenses medications, collects copayments, places the prescriptions in a paper prescription bag, and seals the bag. The pharmacy then sends the prepared prescriptions, along with a manifest, in a serialized bag with a WarmMark temperature tag that ensures the medications have been maintained at the manufacturer's required temperature. The prescriptions are sealed in a tote to send via Riverside courier to Riverside Shore Memorial Hospital. The tote is bar coded and tracked through the courier delivery process to ensure chain of custody.

Once the sealed tote arrives at RSMH, the pharmacist opens the tote and records the time of receipt and serial numbers on a log to be signed by the drone pilot once he assumes responsibility for the package. After the RSMH pharmacist has accurately received all prescriptions, the individual prescription bags are sealed in a serialized tamper evident pouch and placed in a drone delivery box. The drone pilot confirms the delivery address, then affixes a QR code to the box to provide traceability without compromising the patient's privacy

The process steps for the demo deliveries to enrolled patients are mapped below.



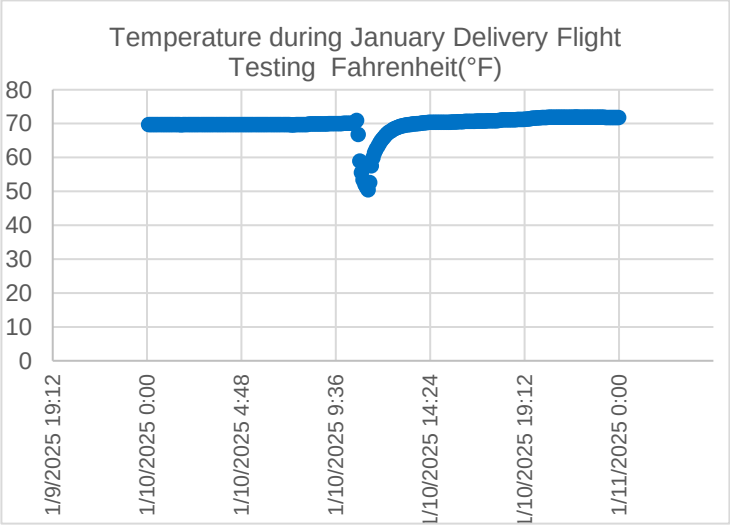
Payload and packaging: The workflows were updated with the findings identified during these testing sessions. The packaging systems utilized for the deliveries had to be updated with considerations to patient privacy, chain of custody, and ensuring temperature control was within acceptable range. The updated packaging is outlined below:

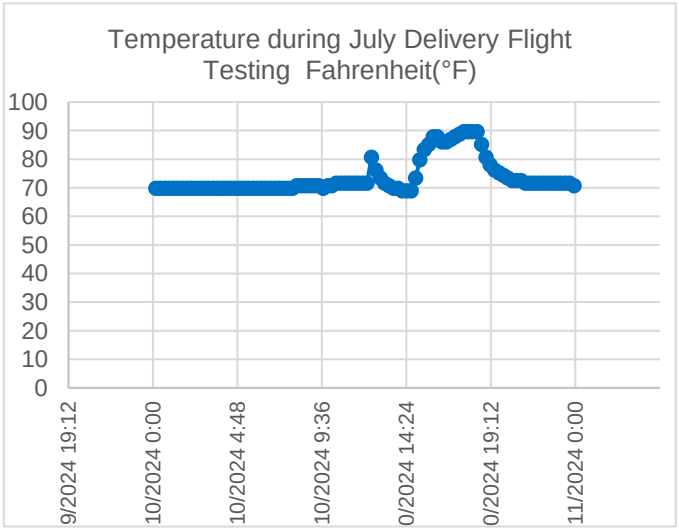
Packaging system for proof-of-concept prototype prescription medication deliveries			
Primary packaging: Labeled and sealed opaque bag The sticker outlined in red is placed on the box for drone delivery		**Tertiary packaging:** Cardboard carrier box with PHI compliant labeling	
Secondary packaging: Tamper evident envelope with temperature indicator tag		**Bulk packaging for internal carrier:** Plastic tote with barcode and shipping manifest	

Temperature control: A key consideration for delivering controlled substances, such as prescription medication, is the avoidance of extreme temperatures once the medication has left the pharmacy. In Stage 1 of this project only medications shelf-stable at ambient temperatures were included in the study and refrigerated medications requiring cold storage will be studied during Stage 2.

For medications considered shelf-stable, the United States Pharmacopoeia (USP) recommends that medication storage temperatures be maintained between 15 degrees C and 30 degrees C (59 degrees F to 86 degrees F). Minor excursions are acceptable for short periods of time. Data was collected as part of the proof-of-concept medication deliveries to confirm that temperature control was sufficient for prescription medications during drone delivery flights. On the day of the delivery, the temperature probe, Lascar High Accuracy Thermistor Probe Data Logger with LCD with NIST Calibration, was used to log the temperature every five minutes. The probes were stored with the prescription medication deliveries in a temperature-controlled area until the time of the delivery window. Multiple temperature probes were placed in the same packaging that was used for medication deliveries, and a test flight was performed during the testing session. Every flight-testing session for medication delivery included the temperature probe package and testing sessions were performed throughout the year to account for seasonal temperature fluctuation.

Data collected demonstrated that the temperature range experienced was within the allowable range and duration. A sampling of the temperature probe data for delivery days: 1/11/24, 4/10/24, 7/10/24, 10/10/24 and 1/10/25 is included in the project data repository.





For the BVLOS demo flights distancing 17 miles from RSMH to the Tangier clinic, sample payloads included non-patient specific Lidocaine (Xylocaine) to replenish the clinic's floor stock on the flight to the island and lab samples for routine testing on the return flight to the hospital. The inclusion of lab samples which were packaged with a water-based ice pack, allowed for further testing of temperature control for delivery flights. The lab samples utilized for testing are

considered routine and include comprehensive metabolic profile (CMP), complete blood count (CBC), Prothrombin time (PT) and Partial thromboplastin time (PTT). These routine tests were selected because if there are no known pathogens in the blood drawn, it can fall under the 107 waiver. The team reviewed the U.S. DOT's guidelines for Transporting Infectious Substances Safely and the FAA was consulted prior to the test deliveries of labs. There were no 10736 implications since standard lab/blood supplies were not classified under hazmat and there are existing procedures and policies at Riverside in place for handling and shipping these lab samples from the Tangier clinic to the hospital. The payloads were reviewed by DroneUp's compliance team prior to the demo deliveries and flight-testing sessions were conducted before any of the deliveries were performed.

To summarize, the project activities that supported application prototyping involved the development of standardized drug packaging and drug chain of custody monitoring processes. Staff training was implemented for the outpatient pharmacy team following patients, managing refills, and dispensing the medications. Training was also provided to the inpatient pharmacy staff receiving the medications to hand off to the drone pilots. Development of QR coding from DroneUP allowed for package delivery to correct patients and addresses after appropriate sign-off and collection from the inpatient pharmacy team. This process allowed for deidentified sealed packages to be safely and securely delivered to the correct patients.

DATA ANALYSIS, MODELING AND SIMULATIONS

The data team accomplished the following objectives:

- ✓ Conducted research which included community needs assessment, identified opportunities and applications, strategy alignment, established research questions to investigate, industry best practices and case studies, and identified planned metrics.
- ✓ Tracked performance metrics to determine if a high potential payoff case can be made for this technology to improved business operations and improved patient outcomes and accessibility
- ✓ Perform the necessary data analytics, modeling, and simulations to determine most effective and efficient hub locations, routes, corridors, etc.

A comprehensive list of data sources used for the modeling and simulation are outlined in the Data Management Plan located on https://dmptool.org/, https://doi.org/10.48321/D1F723D6D2

The data generated from this project is available in the project data repository: https://dataverse.harvard.edu/dataverse/DroneDOTSMART, https://doi.org/10.7910/DVN/GETYAP

During Stage 1, the approach required rescoping due to data limitations. The team pivoted and focused on establishing modeling that was scalable and adaptable. In Stage 2, Patient Identifiable Health (PIH) data will be available, and the model created was designed to incorporate this data seamlessly into the analysis. Publicly available datasets were used for the entire United States and a procedure was developed for analyzing the data. This allowed the team to quickly produce a baseline model for any U.S. location. When PIH data becomes available, it can be incorporated into the model to allow for more detailed and precise results. The Hub distribution model developed is scalable to any geographical region. The geospatial model developed has been incorporated in a scientific article in the review process to be published at an open access journal, methodology is outlined in section 2 of report “Drone-Based Medication Delivery for Flood-Prone Coastal Communities”

Preliminary baseline data collected in Stage 1 for an evaluation of at-scale implementation included:

- Census block data from Census Bureau
- Health data from CDC PLACE at census tract level
- Percentages of populations for multiple domains of health outcomes
- Building footprint from VGIN

Data limitations: This proof-of-concept prototype is limited in demographic information. At a census block level, there is only information regarding age, sex, and race. At the census tract level, more detailed health information can be accessed, including hypertension crude prevalence. However, this data is often too coarse, especially for rural areas like the Eastern Shore, making it less useful for precise health analysis and interventions.

Data expansion: This analysis highlights communities (census blocks) with a high probability of hypertension issues, alongside travel time to the nearest pharmacies and drone stations. The data used in this prototype is available for the entire United States and allows for the same procedures to be followed for any community.

Data privacy: To ensure all stages of this work would be compliant with human subjects, research protections, including HIPAA for data collection, analysis, storage, and communications, the team reviewed applicable privacy, compliance, and Internal Review Board (IRB) protocols. This helped to inform the Data Management Plan that was submitted on December 15, 2024. Only publicly available data was used for Stage 1 of the project.

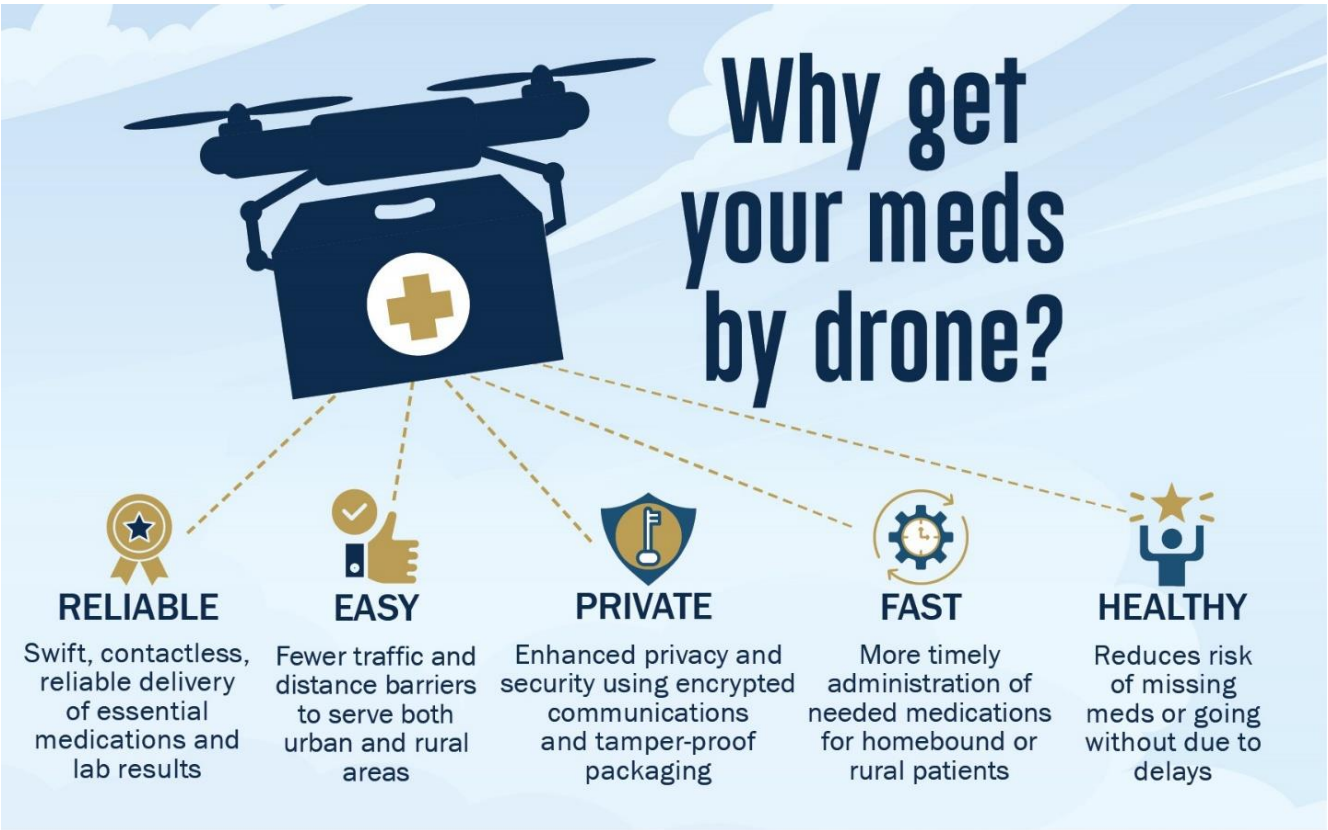
PUBLIC OUTREACH AND COMMUNICATIONS

Contents

SUMMARY

This project focused on testing the feasibility of drone medication delivery to rural communities on the Eastern Shore of Virginia and Tangier Island and developing an operational prototype that would evolve into a self-sustaining delivery service for vulnerable and underserved populations. In doing so, two components were critical to the success of the Stage 1 USDOT SMART Grant: **effective public outreach and communication.** Given the innovative nature of this initiative, a strategic marketing and outreach plan was developed to inform, engage, and build trust among key stakeholders, including:

- ✓ Residents
- ✓ Local aviation community
- ✓ Health care providers
- ✓ Policymakers
- ✓ General public

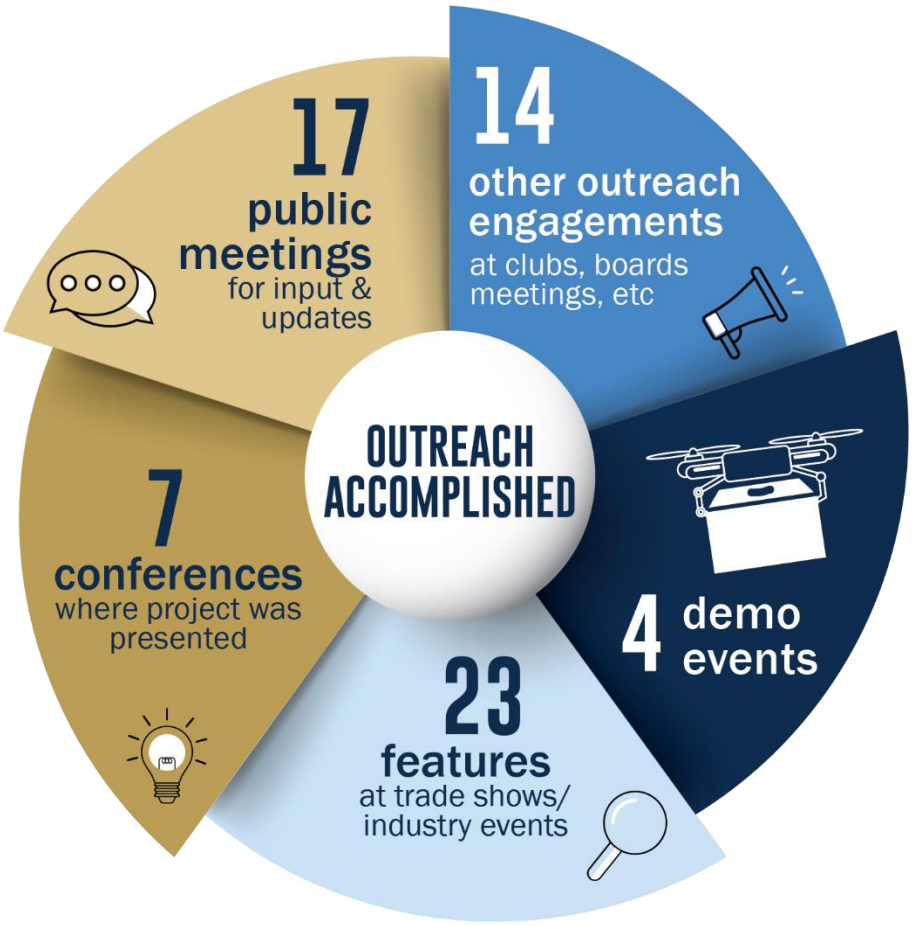


This section outlines the various efforts undertaken to educate and involve the community throughout the project's lifecycle. From early stakeholder engagement—including surveys, focus groups, and public meetings—to the execution of a targeted content strategy, multiple channels were leveraged to ensure transparency, address concerns, and highlight the potential benefits of drone delivery technology.

Key public outreach initiatives included a series of community demonstration events, participation in industry conferences, and strategic media engagement resulting in broad awareness and positive reception. Additionally, project collateral such as infographics, informational rack cards, and other promotional materials played a vital role in enhancing public understanding.

As the project moves toward potential at-scale implementation, ongoing marketing efforts will focus on increasing enrollment and continuing to improve public perception. The insights gathered during Stage 1 will directly inform future outreach strategies, ensuring that this innovative health care solution is positioned for long-term success.

KEY OUTREACH ACCOMPLISHMENTS



STAKEHOLDER ENGAGEMENT & PUBLIC INPUT

An indispensable component of the Stage 1 USDOT SMART Grant project was engaging key stakeholders and the broader public to gather input, address concerns, and build community acceptance for drone medication delivery. The input phase consisted of three primary efforts: **focus groups, surveys, and public meetings**. These efforts allowed the project team to gain valuable insights, refine the implementation strategy, and develop an informed outreach plan.

FOCUS GROUPS WITH AVIATION STAKEHOLDERS

Given the project's intersection with airspace operations, several focus groups were conducted with local small aircraft pilots, airport operators, members of the Eastern Shore Pilots Association, and medivac crews. These discussions provided an opportunity for aviation professionals to voice concerns, evaluate potential risks, and better understand the proposed drone delivery operational plan.

Key concerns raised during the discussions included airspace safety, potential interference with existing flight operations, and emergency response coordination. In response, the project team worked closely with participants to develop mitigation strategies, ensuring that drone operations would not disrupt existing aviation activities. Engagement remained ongoing, with aviation stakeholders attending multiple presentations, participating in Q&A sessions, and receiving follow-up information to address any lingering concerns.

COMMUNITY & HEALTH CARE PROFESSIONAL SURVEYS

To gauge public perception and refine outreach efforts, the project team conducted targeted surveys via Facebook in June 2024. One survey was geared toward health care professionals on the Eastern Shore, while the other gathered input from local residents. A total of **102 community members** and **98 Riverside Shore Memorial Hospital team members** participated in the surveys.

Key findings included:

- **Familiarity with Drone Delivery:** RSMH team members were more familiar with drone delivery applications compared to community members.
- **Initial Reactions: 68%** of health care professionals responded positively, compared to **43%** of community respondents.
- **Perceived Benefits:** Both groups recognized improved access for homebound and rural residents as a top benefit. Health care professionals also prioritized faster delivery times, while the community valued reduced transportation costs.

- **Concerns:** The most cited concerns were **safety of delivered items, potential drone malfunctions, and privacy issues**, with privacy ranking third.
- **Comfort Level: 69%** of health care professionals expressed comfort with receiving medications via drone, compared to **52%** of community members. Many community respondents indicated conditional acceptance, answering, “It depends.”
- **Likelihood to Use Drone Delivery: 68%** of health care professionals expressed willingness to use the service, compared to **51%** of community members, with **17%** of both groups remaining neutral.

Survey findings directly influenced the project’s outreach and content strategy, focusing on increasing public awareness and acceptance, addressing safety concerns, and reinforcing the reliability of the service. Survey results are available in Appendix C.

PUBLIC MEETINGS & ONGOING ENGAGEMENT

The Accomack-Northampton Planning District Commission, which served as the lead organization for the grant, hosted a series of **17 public meetings** throughout the project to encourage dialogue and solicit community input. These meetings, widely advertised to maximize participation, provided an open forum for residents to ask questions, express concerns, and offer feedback as the project evolved.

Several smaller meetings with interested community groups also took place throughout Stage 1. Among these groups were local Rotary clubs, chambers of commerce, VA Space, the Virginia Rural Health Association, and Project Horizon.

By maintaining a consistent and transparent engagement process, the project team was able to:

- ✓ **Address skepticism**
- ✓ **Incorporate stakeholder insights** into implementation strategies
- ✓ **Foster broader community acceptance** of drone medication delivery as a viable solution for rural health care challenges.

Strategy Development for Public Awareness and Acceptance

Based on stakeholder input, the project team developed a comprehensive outreach strategy to address concerns, build public awareness, and encourage enrollment in the drone medication delivery service. The strategy emphasized **education, trust-building, and personal outreach**, recognizing that the target demographic—older residents who are less familiar with new technology—would require clear, accessible information and reassurance.

To enhance public perception and acceptance, the project team engaged a **content strategy contractor** to develop a targeted communications approach. This strategy focused on **two key phases**:

PHASE 1 – Prelaunch: Awareness, Education & Acceptance

- **Primary Audience:** Community members, health care professionals, local organizations, and civic groups
- **Goal:** Build community buy-in and foster acceptance of drone delivery as a valuable and viable health care solution
- **Approach:** Leverage trusted local voices, including community leaders, medical professionals, and faith-based leaders, to promote the project through word-of-mouth and personal interactions

PHASE 2 – Project Launch: Education & Enrollment

- **Primary Audience:** Patients, caregivers, and family members
- **Secondary Audience:** General public to maintain awareness and support
- **Goal:** Encourage eligible individuals to enroll in the service
- **Approach:** Use direct outreach through **health care providers, pharmacists, social workers, and caregivers** to drive enrollments, ensuring that potential users receive information from sources they trust

Targeted Outreach and Promotional Tactics

Given the audience's preferences, the marketing strategy focused on **traditional media and community-driven engagement** rather than digital-heavy outreach. Proposed tactics included:

- **Newspaper & Print Advertising:** Local newspapers and community bulletins featuring educational articles and testimonials to help normalize the concept of drone delivery.
- **Radio Spots:** Ads crafted using **music and cultural references** familiar to the target demographic to resonate with their experiences and lifestyle.
- **Billboards & Signage:** Placements in high-visibility areas along the main Route 13 corridor, to reinforce awareness and provide positive messaging about the service.

- **Community Endorsements:** Education for doctors, pastors, caregivers, and neighbors with encouragement to personally recommend the service to patients who could benefit.
- **Demonstration Events:** Four community demonstration events provided firsthand exposure to the technology and addressed public concerns.

Building Long-Term Public Trust and Support

By integrating **personal connections, familiar media formats, and high-visibility demonstration events**, the project successfully **increased public awareness and acceptance** of drone medication delivery. As the project moves into future stages, continued focus on **trusted messengers, clear educational outreach, and firsthand demonstrations** will remain key to driving participation and scaling the service across the region.

Community Demonstrations

Demonstration events played a crucial role in fostering **community support, awareness, and confidence** in drone medication delivery. Each event provided an opportunity for residents, health care professionals, and public officials to see the technology in action, ask questions, and better understand how drone delivery could improve access to essential medications in rural and remote areas. These events featured **keynote speakers, live drone flights, and interactive discussions**, reinforcing the project's commitment to transparency, safety, and community engagement.

Pre- and Post-Event Promotion

To maximize public engagement, extensive promotional efforts were conducted before and after each demonstration event. These efforts included:

- **Media Advisories & Press Releases:** Sent to regional, state, and national news outlets to generate awareness and encourage coverage.
- **Event Flyers & Invitations:** Distributed digitally and in print to local stakeholders, community organizations, health care facilities, and government agencies.
- **Social Media Posts & Community Outreach:** Shared on various platforms to inform the public about event details and the significance of drone delivery technology.
- **Event Photography & Videography:** Captured high-quality photos and videos for media use, social media recaps, and future outreach efforts.
- **Post-Event Coverage & Press Engagement:** Follow-up with journalists, additional press releases, and sharing of event highlights ensured continued visibility and public engagement.

Demonstration Event Details

May 2023: Eastern Shore Drone Demo

The first community demonstration introduced drone delivery technology to residents, public officials, and business leaders. Engagement from **NASA Wallops Flight Facility leadership** and **local business leaders** helped reinforce the legitimacy and importance of the initiative. Following the event, a press release, media recaps, and social media posts featuring event footage and testimonials were shared widely.

February 2024: Eastern Shore Drone Demo

Building on the momentum of the first event, the February 2024 demonstration served to update stakeholders on the project's progress. It targeted **state and federal stakeholders**, including **U.S. Department of Transportation officials, elected representatives, and local leaders**. Leading up to the event, a media advisory was sent out and information was posted on several of the partners' social media pages. A press release, as well as event videos and photos, were widely circulated post-event to continue driving public awareness and acceptance. Event Video | Event Photos

October 2024: Tangier Island Drone Demo (Culmination Event)

This event marked the completion of Stage 1 project goals. It was attended by **Virginia's Chief Deputy Secretary of Commerce and Trade, Juan Pablo**, along with community leaders, health care providers, and residents. Over **75 community members, including all local schoolchildren**, attended.

Promotional efforts for the event included:

- **Comprehensive media push**, including a media invite and a press release, distributed to local, state, and national media outlets.
- **Direct community outreach**, leveraging local churches, the Island's medical clinic, and the Tangier Town Council to encourage attendance.
- **Printed Flyers**, tailored to reach residents who do not regularly engage with digital media.

The event successfully showcased the 17-mile flight from Riverside Shore Memorial Hospital to Tangier in just 16 minutes**,** reinforcing the project's impact on health care access.

The event generated significant media attention, with multiple high-profile pickups, including:

- **Eastern Shore Post:** View PDF
- **13 News Now:** Watch Video | Full Story
- **Stat Trade Times:** Read Article
- **Yahoo Finance:** Read Article
- **Shore Daily News:** Read Article

REGIONAL

Tangier gets closer to drone med deliveries

BY JANET DERBOSKY
Eastern Shore Post

Flying at a speed of 60 mph, 200 feet in the air, a drone made the 17-mile flight across the Chesapeake Bay to Tangier Island in just 16 minutes.

The flight marked the start of a project where drones will routinely serve the medical needs of the island and other remote areas on Virginia's Eastern Shore.

The historic event occurred on Wednesday, Oct. 23, a bright, sunny day perfect for such a flight, and was well-attended by local residents and school children, who cheered and applauded as the drone landed at the Tangier Medical Center.

Riverside Shore Memorial Hospital partnered with DroneUp, a Virginia Beach-based aerospace company, on the project.

In 2023, it was awarded a U.S. Department of Transportation Strengthening Mobility and Revolutionizing Transportation grant to literally get the project off the ground.

The Elevating Health Care Access project, as it is called, began making drone deliveries of hypertension prescription medications last spring in neighboring communities near the hospital with smaller drones.

DroneUp's Kite B drone, which flew from the hospital to Tangier, is much larger and has a cargo hatch to keep medications safe and dry while in flight.

An emotional Tom Walker, DroneUp's CEO and founder, told the crowd he remembers seeing a drone in Best Buy years ago that possibly had "more technology than the space shuttle."

Realizing that drones had the potential to make either a positive or negative impact on the world, he decided immediately that he needed to create a company where drones were used for the betterment of humanity.

"We know that drone delivery to patients in rural areas will not only improve access to medications but also improve patient outcomes and overall health," Walker said.

Someday, it is anticipated that drones will also routinely carry patient lab work from Tangier to Riverside Shore Memorial Hospital, saving valuable time and, perhaps, lives.

This landing marks the end of phase one of the project, with the next phase set to begin in spring 2025.

Pre-grant startup funding was provided by Virginia Innovative Partnership Corporation.

EASTERN SHORE POST/JANET DERBOSKY
A DroneUp employee removes a package from its Kite B drone after its trip to Tangier Island on Wednesday, Oct. 23. The flight marked the start of a project where drones will routinely serve the medical needs of the island and other remote areas on Virginia's Eastern Shore.

34 | Eastern Shore Post | November 1, 2024

These articles and video reports provided widespread visibility for the project and reinforced public trust, governmental support, and industry recognition for the successful implementation of drone health care delivery.

Additional Tangier Island event coverage can be found at the links below:

- Press Release: View Release
- Media Reels: Watch Videos
- Event Photos: View Photos
- Facebook Demo Spot: View Spot
- YouTube Demo Spot: View Spot

December 2024 – Drone Discovery Day at Eastern Shore Community College

The final event of the year expanded the conversation beyond health care and focused on **workforce development and career opportunities** in drone technology. **Students, educators, and the general public** engaged in hands-on experiences with drones, emphasizing the technology's future applications. Leading up to the event, targeted social media campaigns and educational outreach ensured strong attendance. Keynote speakers highlighted the economic and technological benefits of drone operations in Virginia. View Photos

Each demonstration event played a vital role in engaging the public, addressing concerns, and fostering acceptance of drone delivery. By strategically promoting these events through traditional and digital media, community outreach, and post-event storytelling, the project team successfully **increased awareness and built trust** among residents, stakeholders, and decision-makers.

PUBLIC OUTREACH

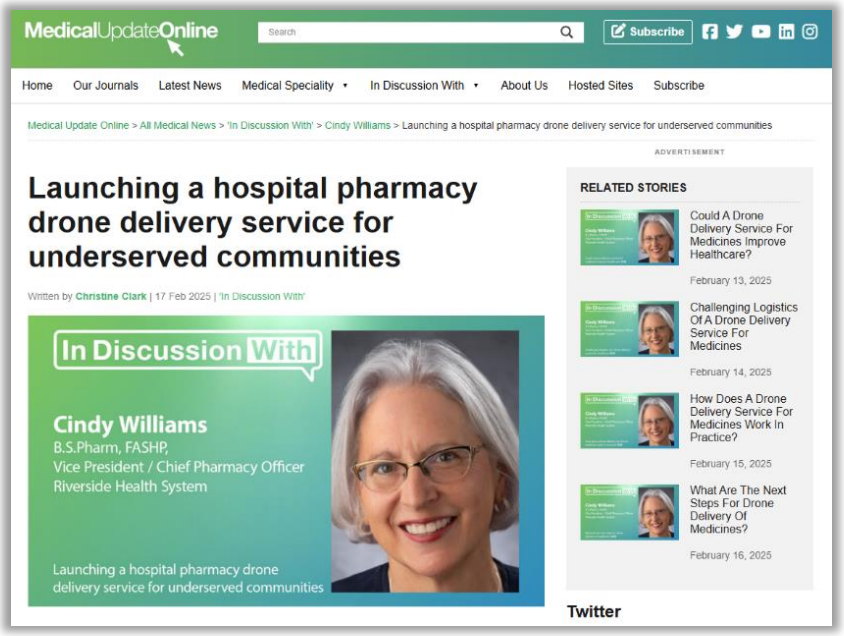
Public outreach efforts paid off by increasing awareness and acceptance of the drone delivery project. Team members actively participated in industry conferences, regional and national events, and direct engagements with other USDOT Smart Grant recipients to share insights, promote project successes, and foster collaboration.

Industry Conferences & National Events

Throughout the project, team members **presented at seven major industry conferences** (see Events List table below), providing a platform to showcase the innovative approach to drone medication delivery.

Additionally, the project was featured at dozens of regional, state, and national events, where team members staffed booths to engage attendees, answer questions, and distribute project materials. (The full list is included in the Events List tables below). Notable events included **Aerospace Day at the Virginia Capitol** (View Photos) in January 2025, where project team members engaged with legislators and industry experts. In November 2024, the team participated in **Middle School Career Day** at ESCC, where eighth-grade students had the opportunity to learn about the drone initiative and ask questions of project team members.

One particularly impactful outreach effort took place at a national conference where the project garnered international attention. Following the American Society of Health-System Pharmacists (ASHP) Conference in December 2024, the **International Medical Information (IMI), a British medical podcast and publication**, produced a four-part video interview series featuring Cindy Williams, Vice President & Chief Pharmacy Officer with Riverside Health. These videos were distributed across IMI's social media platforms through **Pharmacy Update Online** and **Medical Update Online**, significantly expanding the project's reach beyond the U.S. View Here.



The project was also featured on the statewide Virginia Hospital & Healthcare Association (VHHA) **Patients Come First Podcast** on November 14, 2024, where Nick Chuquin, President of Shore Memorial Hospital was interviewed about the initiative. Listen here.

Engagement with Other USDOT Smart Grant Recipients

Recognizing the value of shared experiences, the project team proactively engaged with other USDOT Smart Grant recipients to exchange best practices and lessons learned. Team members met with several grant teams, including:

- **Tri-Area Health** (Appalachian Region of Virginia)
- **North Dakota Tribal Drone Project**
- **Maryland–Eastern Shore Initiative**
- **ELSA-M3 Johnstown PA DOT SMART Grant Team**

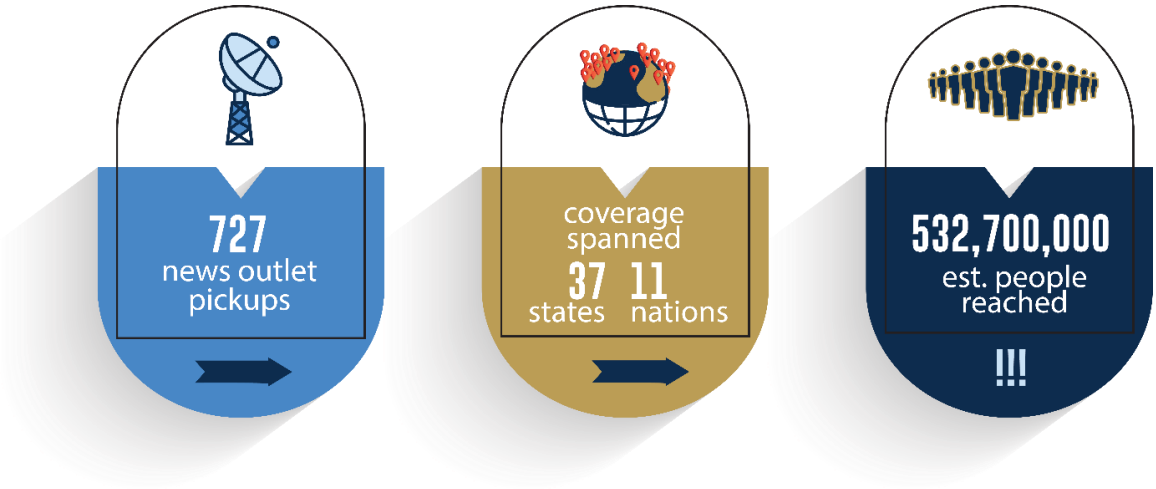
These discussions focused on overcoming implementation challenges, refining operational strategies, and exploring opportunities for future collaboration. By sharing insights from the Eastern Shore and Tangier Island pilot program, the team helped other regions integrate drone technology into their own health care and logistics frameworks more effectively.

In addition to collaborating with other USDOT Smart Grant teams, the project team engaged in discussions with the **Virginia Department of Health** about deploying this technology in other key rural parts of the Commonwealth. Potential areas of collaboration were identified for exploring use cases and increasing visibility and public awareness.

MEDIA COVERAGE

The project captured significant media attention at local, regional, national, and even international levels. This widespread coverage was instrumental in raising awareness, fostering public trust, and demonstrating the real-world impact of drone medication delivery.

Press releases, media advisories, and social media campaigns effectively amplified key project milestones and showcased the project's broad appeal and significance:



National and International Recognition

One of the most impactful media moments occurred after the **February 2024 demonstration event**, when a press release was picked up by **over 200 news outlets** across multiple regions. The project's groundbreaking approach to health care delivery also made international news, with coverage extending to **the UK, Canada, and other international markets**.

Additionally, attendance at a national health care conference led to a feature in the **International Medical Information (IMI)**, a British medical podcast and publication. Their coverage included the four-part video interview series featuring Cindy Williams (previous section), further expanding the project’s international reach.

Project Website & Digital Engagement

To support public outreach, a dedicated project website was launched in October 2023. This website served as a hub for updates, media materials, and community engagement efforts. Additionally, social media promotions and partner organization outreach contributed to significant engagement and provided detailed metrics on impressions, clicks, and interactions, as seen in the table below.

METRICS	2023	2024
Public Relations Totals		
Number of outlets	265	462
Unique visitors per month	160,322,374	372,425,202
Advertising value equivalency	$1,482,981.69	$3,444,933.12
Website Totals		
Users/Sessions	1,508	3,281
Views	153	6,352
Social Media Totals		
Impressions	82,512	60,393
Engagement	9,397	7,222
Reach	38,410	10,372
Reactions	488	863

** Data included from all partners, where applicable. Website data from VISA and Riverside Health. Social media data from VISA, Riverside Health, and DroneUp.*

Key Media Pickups and Press Releases

The project received notable media mentions from major outlets, reinforcing its credibility and expanding its reach. Some of the most prominent coverage included:

- **Fox5:** New Program Tests Delivering Medications via Drone in Rural Virginia
- **WBOC:** WBOC News at 6 - February 26, 2024
- **WTKR:** Service that Delivers Prescription Meds by Drone Tested on the Eastern Shore
- **WAVY, WFRX, WRIC**: Virginia Partnership Launches First Delivery of Hypertension Medication to Patients Via Medical Cargo Drones

Comprehensive Media Assets

To support media engagement, high-quality visuals and video content were made available for press and public use:
B-Roll Media: Download Here
Testimonial Videos: 16:9 Format | 4:5 Format | 9:16 Format
Photo Gallery of Patient Delivery: View Here

Major Communication Milestones

A series of strategic press releases were issued to highlight key project developments, including:

- **May 2023**: Partnership Announcement & USDOT Smart Grant Award
- **October 2023**: Project Kickoff & First Drone Prescription Delivery
- **December 2023**: VIPC Airspace Study Announcement
- **January 2024**: DroneUp Receives FAA No-Observer BVLOS Approval
- **February 2024**: USDOT Demonstration Event Press Release (View Coverage)

The project's strategic media engagement ensured **maximum visibility**, reinforcing its success and demonstrating the real-world benefits of innovative health care solutions.

PROMOTIONAL COLLATERAL

Throughout Stage 1 of the project, various collateral materials were developed to educate stakeholders, raise awareness, and build public trust in drone medication delivery. These materials were primarily used at industry events and public demonstration events to introduce the concept, address concerns, and highlight the benefits of the program.

Stage 1 Education & Awareness Collateral

The first phase of collateral development focused on providing clear, engaging, and informative materials to a broad audience. These included:

Rack Cards

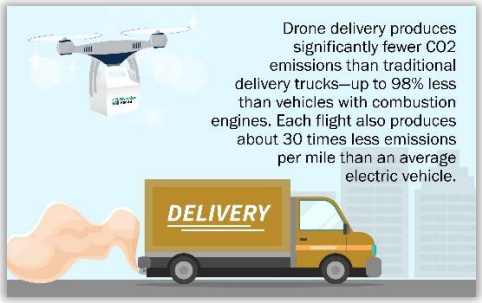
500+ printed and distributed by partners at public events, clinics, and industry conferences to provide a concise overview of the program.

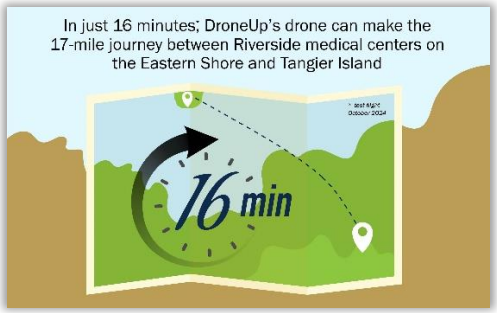
Banner Stands & Tablecloths

Branded materials used at health care, technology, and community events to create a strong visual presence.

Infographics

Designed to simplify key concepts, such as the drone delivery process, safety measures, and benefits, making them accessible to a wide audience.





Video Loops

Designed to play continuously on a digital photo frame placed on the project table at events to promote the project's progress and accomplishments.

These materials were instrumental during Stage 1 in engaging key stakeholders, including policymakers, health care providers, and the general public. However, as the project transitions into Stage 2, the focus of collateral will shift to patient enrollment and community engagement.

Events List

* *Advertised public meetings*

14 public outreach engagements conducted for the project:

DATE	EVENT	PURPOSE
2/16/23	**Rotary Club meeting**	Presented and explained project
3/21/23	**RSMH Board of Directors meeting**	Provided project updates
5/23/23	**RSMH Board of Directors meeting**	Provided project updates
6/13/23	**Initial meeting with local pilots**	Presented and explained project
6/13/23	**Rotary Club meeting**	Presented and explained project
6/28/23	**Meeting with local pilots**	Followed up on project
8/22/23	**RSMH Board of Directors meeting**	Provided project updates
9/12/23	**Rotary Club meeting**	Provided project updates
10/24/23	**RSMH Board of Directors meeting**	Provided project updates
2/27/24	**RSMH Board of Directors meeting**	Provided project updates
3/26/24	**RSMH Board of Directors meeting**	Provided project updates
4/23/24	**RSMH Board of Directors meeting**	Provided project updates
5/6/24	**Meeting with Virginia Department of Health**	Presented and explained project
5/21/24	**RSMH Board of Directors meeting**	Provided project updates

7 events where project was presented:

DATE	EVENT	LOCATION	NOTES
9/28/23	**2023 Hampton Roads AUVSI** (Association for Uncrewed Vehicle Systems International)- **Advanced Air Mobility Symposium & Aerospace Gala**	Newport News, VA	Project was presented

10/12/23	**2023 Virginia Asian Chamber of Commerce's Transportation on the Move: Innovation Delivered Conference**	Suffolk, VA	Project was presented
11/15/23 – 11/16/23	**2023 Virginia Rural Health Association's annual conference**	Blacksburg, VA	Project was presented at conference and hosted informational table
12/14/23	**Virginia Advanced Air Mobility Alliance (VAAMA) Meeting**	Richmond, VA	Project was presented
6/17/24	**Virginia Advanced Air Mobility Alliance (VAAMA) Meeting**	Richmond, VA	Project was presented
10/9/24	**Governor's Aerospace Advisory Council (GAAC) Meeting**	NASA Wallops Flight Facility, Wallops Island, VA	Project was presented
10/16/24	**NASA Langley/Goddard/Wallops Unmanned Aerial Systems (UAS) Symposium**	NASA Wallops Flight Facility, Wallops Island, VA	Project was presented at meeting to large professional and community audience

23 events attended to support public outreach for the project:

DATE	EVENT	LOCATION
1/25/23	**2023 Virginia Unmanned Systems Center's annual UxS & Advanced Air Mobility (AAM) Stakeholder Meeting and VABA Aerospace Legislative Reception**	Richmond, VA
2/21/23	**2023 Virginia Fire Chief's Association's annual Virginia Fire Rescue Conference**	Virginia Beach, VA
9/21/23 – 9/22/23	**2023 SMART Grantee Summit**	Washington, D.C.
10/25/23	**Bay Consortium Workforce Development Board – Virginia's Eastern Shore Workforce Convening** Note: Informal roundtable discussion held	Wachapreague, VA
2/7/24	**2024 Virginia Unmanned Systems Center's annual UxS & Advanced Air Mobility (AAM) Stakeholder Meeting and VABA Aerospace Legislative Reception**	Richmond, VA

2/13/24	**Project Horizon** Note: Career exploration presentation given to high schoolers at RSMH	Onancock, VA
2/19/24 – 2/24/24	**2024 Fire Chief's Association's Virginia Fire Rescue Conference**	Virginia Beach, VA
6/24/24	**Bay Consortium Workforce Development Board – Virginia's Eastern Shore Workforce Convening** Note: Informal roundtable discussion held	Melfa, VA
6/25/24	**Governor's Aerospace Advisory Council (GAAC) Meeting** Note: Informal roundtable discussion held	Hampton, VA
7/10/24 – 7/11/24	**2024 SMART Grantee Summit, Volpe Center**	Cambridge, MA
9/6/24 – 9/11/24	**2024 NASAO Annual Convention and Trade Show**	Pittsburgh, PA
9/10/24 – 9/13/24	**Future of Flight: Aviation Innovation Showcase, Montgomery County Executive Airport / Game Changer Week**	Virginia Tech
9/19/24	**VDOT GIS Day**	Suffolk, VA
10/2/24 – 10/3/24	**2024 AUVSI-HR AAM Expo, The Commonwealth: Preparing For An AAM Future Advanced Air Mobility Showcase & Demonstrations**	Newport News, VA
10/18/24	**Career Adventure Fair** Note: Event audience was for 10th graders	Eastern Shore Community College
10/25/24	**Virginia Spaceport Authority** Note: Presentation to team members	NASA Wallops Flight Facility, Wallops Island, VA
11/15/24 & 11/22/24	**Middle School Career Day at Eastern Shore Aerospace Academy kickoff event** Note: Presentation and desk demonstration to eighth grade students and teachers regionwide	Eastern Shore Community College
11/19/24	**2024 Rural Health Voice (VRHA) Conference**	Abingdon, VA
11/13/24 – 11/14/24	**2024 Beckers Chief Pharmacy Officer Conference**	Chicago, IL

12/7/24 – 12/12/24	**American Society of Health-System Pharmacists (ASHP) Midyear Clinical Meeting, annual Virginia Reception**	New Orleans, LA
12/10/24	**Virginia Reception in New Orleans at the American Society of Health-System Pharmacists (ASHP) Midyear Clinical Meeting**	New Orleans, LA
1/29/25	**Aerospace Day at the Capitol** Note: Project discussed with delegates and reception attendees. See photos	Washington, DC
1/29/25	**2025 Virginia Unmanned Systems Center's annual UxS & Advanced Air Mobility (AAM) Stakeholder Meeting and VABA Aerospace Legislative Reception**	Richmond, VA

17 A-NPDC regional public meetings held in Accomack, VA:

DATE	PROJECT INFORMATION SHARED
11/9/22	Accomack-Northampton Planning District Commission (A-NPDC) formally adopted a Resolution of Support for the SMART Grant Application*
7/13/23	A-NPDC properly authorized and entered into agreement with USDOT to administer the Drone Medical Package Delivery project, SMARTFY22N1P1G54
8/21/23	A-NPDC Public Meeting*
9/18/23	A-NPDC Public Meeting* – Project financial and administrative update provided
11/20/23	USDOT's quarterly reimbursement was received. Project financial report was submitted. Report was provided on the first community drone demonstration.
12/18/23	A-NPDC Public Meeting* – Project update provided
1/15/24	Grant administration progress was summarized. The public was invited to view the second drone demonstration at Riverside Shore Memorial Hospital in Onancock, VA.
2/19/24	A-NPDC Public Meeting* – Project update provided
3/18/24	Reported on the second drone demonstration.
4/15/24	Discussion of operationalizing delivery flights in the Stage 2 proposal for the project.
5/20/24	Discussed and approved the Stage 2 application budget to operationalize drone medical package delivery on the Eastern Shore.

6/17/24	Adopted resolution to submit SMART Grant application for Stage 2. Reviewed project budget and reimbursement. Gave status of additional medicine delivery flights with a 1–3-mile radius. Project progress report and FY24 performance vs. budget provided.
7/15/ 24	Reported on work with Eastern Shore Community College on drone workforce development initiative.
9/16/24	Reported on workforce programs begun and incorporated into Eastern Shore Community College curriculum.
10/21/24	Report on ODU, Riverside, and DroneUp planned presentations on career opportunities and workforce training at Eastern Shore Community College on 11/15/2024 and 11/22/2024. Summarized the project's presentation to a large professional and community audience at the NASA-Wallops UAS Symposium on 10/16/2024.
11/18/24	Reported on final drone demonstration on Tangier Island to complete Stage 1 of this project.
1/21/25	Communicated USDOT's notification that Stage 2 grant was not awarded.

4 demo events hosted by the project team:

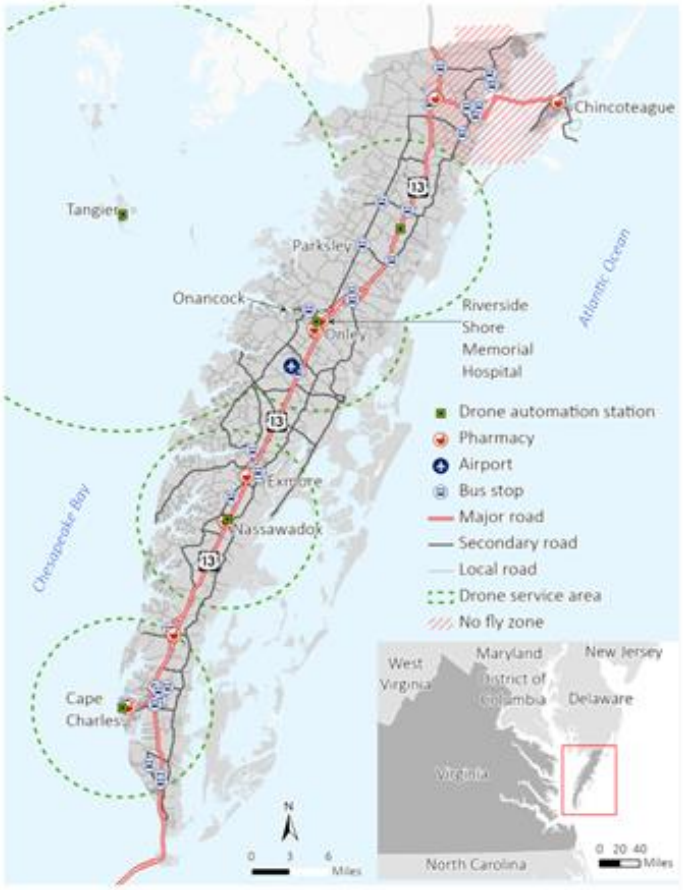
DATE	EVENT	LOCATION	NOTES
10/3/23	**Public Demonstration #1** (drone delivery of 1-2 mile radius) successfully conducted.	Riverside Shore Memorial Hospital	Attendees included residents, officials and leaders from Northampton County, Accomack County, and Tangier Island
2/26/24	**Public Demonstration #2** (drone delivery of 1-2 mile radius) successfully conducted.	Riverside Shore Memorial Hospital	Attendees included residents, officials and leaders from Northampton County, Accomack County, and Tangier Island
10/23/24	**Tangier Live Demonstration**	Riverside Tangier Medical Center	Tangier Island BVLOS Community Event
12/9/24	**Drone Discovery Day**	Eastern Shore Community College	Workforce Development Community Event

AT-SCALE – EXPECTED BENEFITS

PROJECT SCOPE AND SCALE

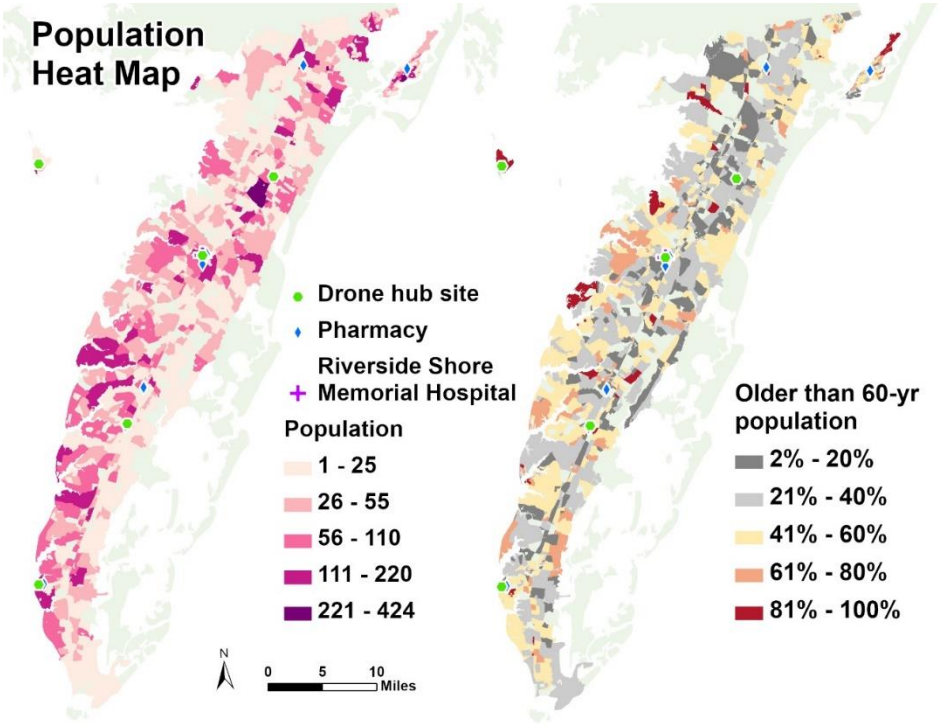
As required in Stage 1, the team assembled a capable data analytics team, equipped with patient demographic data as well as geographical modeling and simulation tools that will optimize the proposed scalability plan. This Stage 2 at-scale implementation plan and cost will balance patient delivery needs with geographical service areas. It will also require infrastructure to enable a new transportation model that can be scaled to other regions, as well as sustained from a maintenance and operational cost perspective. The goal is to minimize service costs for patients and to demonstrate the potential cost, environmental, safety and transportation benefits that can be realized by the operational deployment of this DOT SMART program project. Data collected to date has been focused on parameters that could influence at-scale costs and the implementation approach for Stage 2.

For Stage 2, the technology and processes will be expanded throughout the Eastern Shore and Tangier Island, however this will require FAA Part 135 operational approvals. Part 135 approvals will enable two keys to reducing costs and operating at-scale by increasing drone to operator ratio and flying BVLOS. Four drones will be used during Stage 2, flown from a remote operational control center (ROCC) to the proposed service area. Ground infrastructure will also be introduced, allowing for seamless operations within the hospital system, as well as increased automation. DroneUp is currently a Part 135 operator, one of six drone delivery services in the United States with Part 135 regulatory approval.



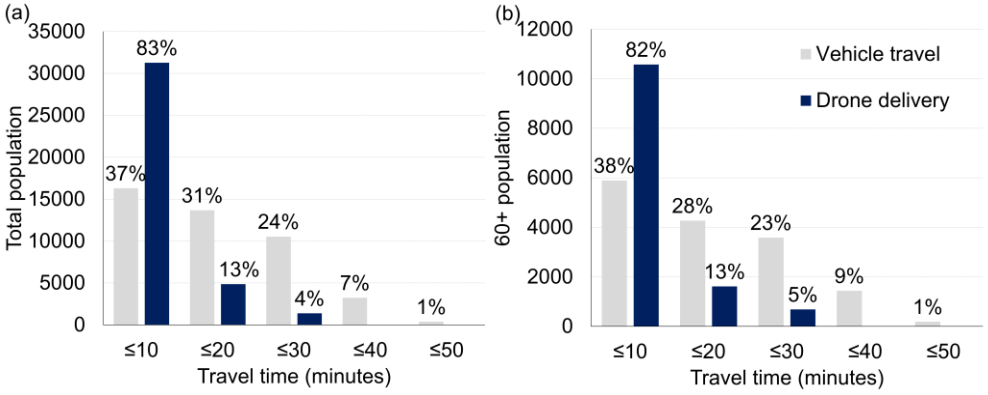
DELIVERY OPTIMIZATION ASSESSMENT

Service Area Population Distribution: The side-by-side map below demonstrates the total population on the Eastern Shore and the percentage of the population older than 60 years of age at the census block level. The total population map shows the spatial distribution relative to drone stations, pharmacies, and Riverside Shore Memorial Hospital (RSMH). The percentage map of the 60-year and older population highlights remote communities with high percentages of older residents who are relatively isolated and face challenges in accessing medical services. The population data is retrieved from the 2020 Census Survey.



To increase probability of compliance, access and optimization, a number of data and demographic variables were evaluated to identify which clusters of patients meet the optimal inclusion criteria to optimize patients served and improve health outcomes. The selection criteria for patients who have a strong probability of adherence was established for hypertension and additional chronic conditions. The data collection included census block demographic data, as well as census tract level CDC PLACES data set for hypertension statistics. Using the Intelligent Dasymetric Mapping (IDM) Toolbox, a precise estimate for populations was conducted. The team compared travel time zones for vehicle-based pharmaceutical trips and drone-based deliveries (for more details refer to the previous section on Sustainability and Reliability). Population data within travel zones were aggregated to analyze and compare the efficiency of drones versus traditional vehicles.

The two histograms below illustrate the estimated total population, and the population aged 60 years and older within vehicle-based (gray bars) and drone-based (navy blue bars) delivery zones. The outcomes showing the benefits of drone delivery for older, more vulnerable patients can be quantified. As shown in the histograms, more than 82% of both the total population and those aged 60 years and older can be served by one-way drone delivery within 10 minutes. This is compared to less than 38% of the Eastern Shore population who can complete a round-trip drive to a nearby pharmacy in the same timeframe. Furthermore, drones can serve over 99% of patients within 30 minutes, whereas approximately 10% of those aged 60 and over would need more than 30 minutes of driving time to reach the nearest pharmacy. Notably, residents of Tangier Island (438 individuals, including 180 who are aged 60 and older) were excluded from vehicle travel calculations, as they are unable to drive to any pharmacies.

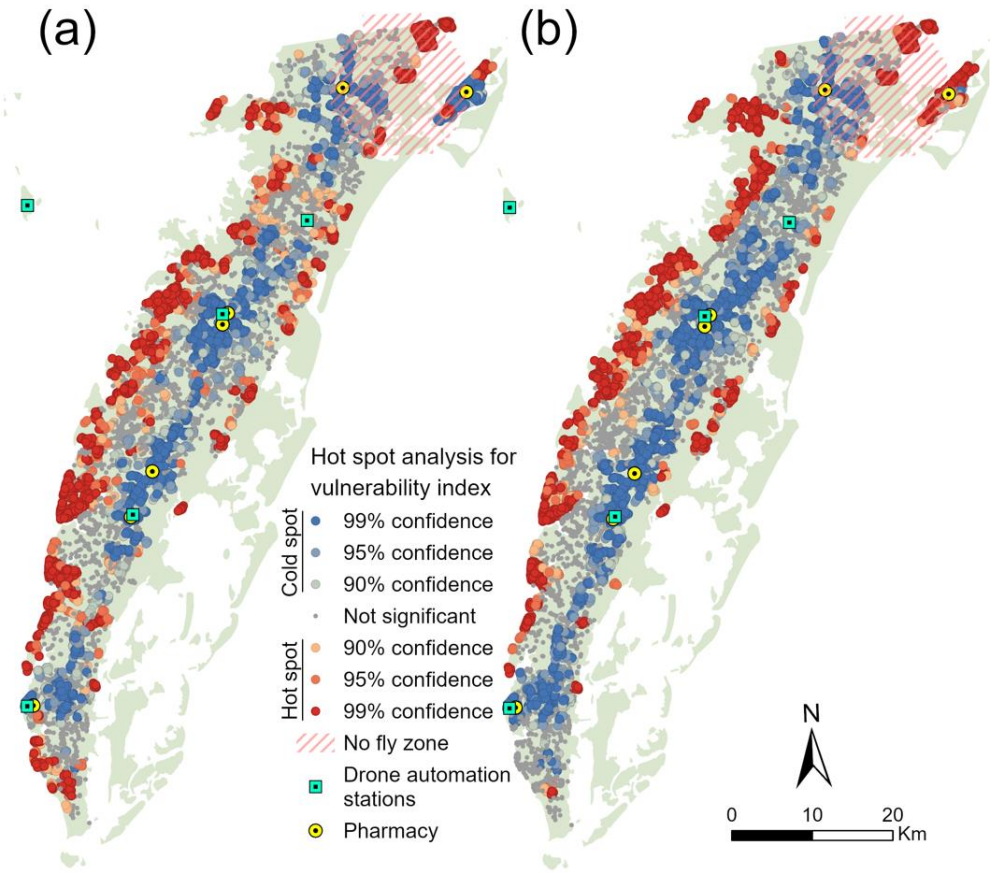


Patient age, vehicular travel time to pharmacies, and flood interruption were also used to assess vulnerability at the building footprint level. Census block data provided population estimates for individuals aged 60 and older and were proportionally assigned to building footprints. Travel times to pharmacies were calculated using a Network Dataset, and FEMA's 100-year flood zones were incorporated to assess flood impacts, categorizing conditions as not affected, detoured, blocked, or inundated. Two vulnerability indices were computed: VAT (age and travel time) and VATF (age, travel time, and flood impact), with higher scores indicating greater vulnerability. A Getis-Ord Gi* analysis identified statistically significant spatial clusters of vulnerability, which distinguished everyday challenges from those exacerbated by flooding.

The following table indicates the scoring criteria for patient vulnerability calculation:

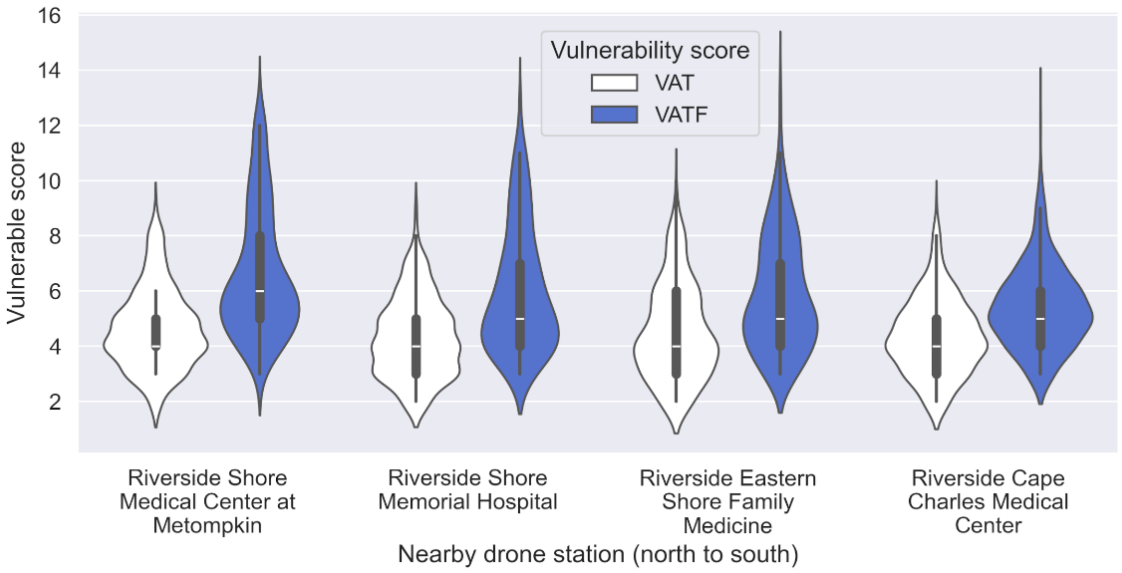
Percentage of population age 60+	Assigned value	Vehicle travel time (Round Trip, Minutes)	Assigned value	Flood interruption condition	Assigned value
≤ 20%	1	≤ 10 mins	1	Not affected	1
21 – 40%	2	11 – 20 mins	2	Detoured by floodwater	2
41 – 60%	3	21 – 30 mins	3	Blocked by floodwater	3
61 – 80%	4	31 – 40 mins	4	Inundated by floodwater	4
> 80%	5	> 40 mins	5		

The following figure showcases results of the Getis-Ord Gi* spatial distribution analysis for the two vulnerability indices: (a) VAT and (b) VATF, with blue indicating low (cold spots) and red indicating high (hot spots) vulnerability clusters. The spatial analysis of VAT and VATF indices highlights distinct vulnerability patterns across the Eastern Shore. The VAT analysis shows greater spatial heterogeneity, while VATF reveals more uniform patterns influenced by relative elevation. VATF hot spots are concentrated along the flood-prone western coast, while cold spots align with higher-elevation areas near U.S. Route 13. Differences are especially notable in Chincoteague Island, where flood vulnerability significantly alters the spatial distribution.



Since drone delivery is an emerging technology, patient adoption may be limited. Prioritizing stations serving the most vulnerable patients is crucial, especially with constrained resources. To guide prioritization, the team calculated the Euclidean distance from each building footprint to the nearest drone station, analyzing how vulnerability indices align with station locations. This approach helped identify stations closest to high-vulnerability areas and enables targeted resource allocation and response efforts.

The following figure shows violin plots of VAT and VATF indices for drone stations arranged from north to south. The white bars represent median values, with thicker lines indicating the interquartile range. The plots show the kernel density estimation boundaries, where wider curves correspond to higher numbers of patients. The northern stations serve more residents than the southern ones, with Riverside Shore Medical Center at Metompkin Station covering the most vulnerable patients, as reflected in the highest mean VAT and VATF scores. Riverside Eastern Shore Family Medicine Station also shows high VAT values, but with greater variability and a larger number of high-scoring patients. In contrast, Riverside Cape Charles Medical Center, the southernmost facility, serves the fewest patients and has the lowest mean VAT and VATF scores.



In summary, to increase compliance, access, and optimization of medical deliveries, a comprehensive evaluation of patient demographics, travel times, and flood vulnerability was conducted. Vulnerability indices (VAT and VATF) were developed using census data, travel times, and flood risks. Analysis revealed that drones can serve more than 82% of the total population, and those aged 60 and older, within 10 minutes, compared to less than 38% for vehicles. Spatial clustering identified hot spots in flood-prone areas and guided drone station prioritization. Northern stations cover more patients and higher vulnerabilities, enabling strategic resource allocation to improve health outcomes for the most at-risk populations.

COST BENEFIT ANALYSIS

The data analytics team curated survey data from residents, geographic modeling, simulation tools, as well as public health and census data, to describe current pharmacy trips by Eastern Shore residents and to predict the impact of drone deliveries on future pharmaceutical trips.

The data analytics team used DOT's Benefit-Cost Analysis (BCA) spreadsheet template for Discretionary Grant Programs to analyze this proposal. Using standard parameters from the DOT BCA template, along with travel projections from 2027 to 2031, the discounted value of costs is less than $3.3 million, and the discounted value of benefits exceeds $11.9 million. This yields a Benefit to Cost Ratio (BCR) greater than 3.6, with a net present value of more than $8.6 million, supporting the operational sustainability of the proposed project. As this section details, the BCA presents validated estimates for current travel trends, and projects conservative estimates for future trips by drone, based on community surveys and public health data. The BCA narrative report is presented as follows.

Two separate formulas are used to estimate the annual household pharmacy trips: the first under the "No Build" scenario, in which households do not have access to drone delivery of medical supplies; and the second formula is used for the "Build" scenario, in which some households use drone delivery to replace vehicle trips to the pharmacy.

For the "No Build" Scenario, the following formula is used:

$$Annual\ Household\ Pharmacy\ Trips_t(No\ Build\ Scenario) = \alpha_t \nu_t \phi_t (1 - \varphi_t)$$

Where the parameters represent for each year (t) considered in the BCA:

- α_t : the number of adults per household,
- ν_t : the number of pharmacy visits per adult,
- ϕ_t : the likelihood of prescription fulfillment at a pharmacy located,
- φ_t: the likelihood of consolidated pharmacy visits on the Eastern Shore.

For the "Build" Scenario, the following formula is used:

$$Annual\ Household\ Pharmacy\ Deliveries\ by\ Drone_t(Build\ Scenario) = \alpha_t \nu_t \phi_t \Delta_t \rho_t \epsilon_t$$

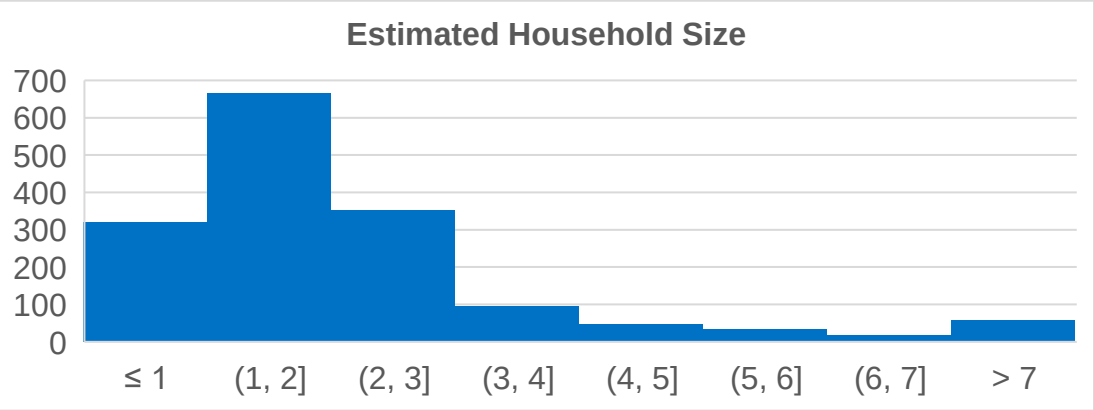
Where, in addition to the parameters outlined above, additional parameters represent for each year (t) considered in the BCA:

- Δ_t : represent, for each yearthe share of prescriptions eligible for delivery by drone,
- ρ_t : the adoption rate of drone delivery by households,
- ϵ_t : an indicator variable for the availability of a drone delivery station to serve that household.

Each of the key parameters identified in the formulas is detailed as follows, with sources cited as the basis for the estimate, as well as validation of the estimate provided where possible.

Number of Adults per Household (α)

The analytics team used geospatial analysis to identify the precise geographic location of all residential housing structures on the Eastern Shore. A single residential structure was associated with each household, as well as the census block in which the structure is located. Using public information from the 2020 census, including the total population per census block, the size of each household size was estimated, as illustrated in the "Estimated Household Size" figure.



The BCA considers only households with an estimated size between one and four members (inclusive). Households with an estimated size of less than one may represent seasonal or vacation properties, while households with more than four estimated members could represent multi-unit residential housing, which may not be amenable to delivery by drone. Of the more than 27,000 residences identified by the analytics team on the Eastern Shore, this analysis focuses on 19,439 households estimated to have between one and four members.

The Eastern Shore Health District Community Health Assessment (2024) estimated 19,476 households on the Eastern Shore, which aligns closely with and validates the team's estimate. Furthermore, this analysis only considers household members aged 18 years or older, given that public data about healthcare conditions and prescription fulfillment focuses on this age group. To ensure that only individuals 18 or older were considered in the BCA, the team used weighted averages. Specifically, the Eastern Shore Health District Community Health Assessment (2024) estimated that 9,336 individuals on the Eastern Shore were under the age of 18, representing 20.4% of the total population of 45,614 individuals. Therefore, 36,278 individuals are aged 18 or over on the Eastern Shore based on the latest Community Health Assessment.

Using the estimates of household size discussed previously, the team's analysis estimated a total population of 43,776 individuals on the Eastern Shore. Excluding 20.4% who are estimated to be under the age of 18 yields 34,846 individuals who are 18 or older. This estimate aligns closely with the values from the latest Community Health Assessment.

According to the most recent Community Health Assessment (2024), the population of the Eastern Shore has remained relatively stable for the past 10 years. Consequently, the BCA assumes no change in population demographics during the analysis period of 2027-2031.

Number of Pharmaceutical Visits per Adult (v)

Valliant et al. (2022) conducted a cross-sectional national study of more than 11.7 million patients between the ages of 18-64, using 2018 IBM Marketscan claims data. Across the entire sample of patients surveyed, the median annual number of pharmacy visits per patient was five. However, the authors showed that patients with multiple chronic conditions, defined as those having two or more conditions from the Elixhauser Comorbidity Index, had a median of 13 annual visits to a pharmacy. For each adult on the Eastern Shore, the BCA considers a range of 5 to 13 annual visits to the pharmacy located closest to that person's residence. Each individual is assigned an estimated likelihood of suffering from multiple chronic conditions, corresponding to a higher number of annual visits to the closest pharmacy.

Using public data from the Virginia Department of Health (VDH) about the Prevalence of Chronic Disease (2023), the BCA estimates the likelihood of an individual on the Eastern Shore having at least two of the following chronic conditions:

Chronic Disease	Eastern Shore (%)	Virginia (%)
Arthritis	30.7	27.1
Chronic Kidney Disease	5.4	4.2
Diabetes	13.5	11.8
Heart Disease	4.8	4.3
High Cholesterol	38.7	39.3
Hypertension	38.2	35.6
Stroke	3.5	3.7

The VDH dataset considers only individuals aged 18 or older who have been informed by a healthcare professional of chronic disease. For example, the Arthritis category reports the percentage of adults 18 or older who have been told by a healthcare professional that they have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia. Note that all chronic conditions listed may be treated with prescription medications, and that all prescription medications used to treat these conditions may be carried by drone. This distinction is critical for

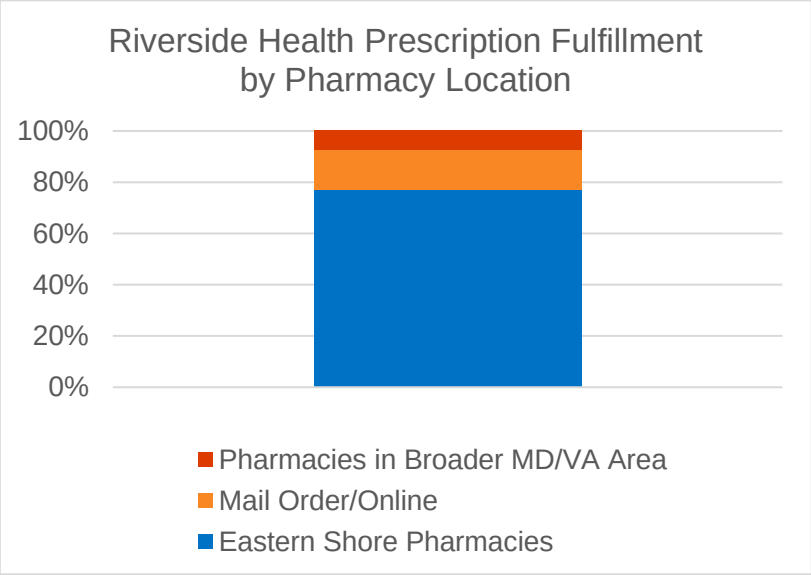
the estimate of the Share of Prescriptions Eligible for Delivery by Drone (Δ) parameter discussed in this section. The total prevalence of all the listed chronic conditions on the Eastern Shore is 134.8%, meaning that at least 34.8% of adults on the Eastern Shore have been diagnosed with at least two of the aforementioned chronic conditions.

For every adult in a given household, the BCA uses a weighted average to estimate the likelihood of that person having multiple chronic conditions (34.8%) that require 13 annual visits to a pharmacy versus the likelihood of having one or fewer chronic conditions (65.2%) which require only five annual visits to the nearest pharmacy.

Likelihood of Visiting a Pharmacy Located on the Eastern Shore (ϕ)

Given the number of prescriptions for each adult in the BCA, a key element of the analysis is to determine how many of those trips will be to pharmacies located on the Eastern Shore. It is possible, for example, that a patient residing on the Eastern Shore visits a pharmacy on mainland Virginia, rather than a pharmacy on the Eastern Shore. This analysis considers trips only to the seven pharmacies located on the Eastern Shore, with drone stations planned to allow delivery for all patients served by those pharmacies. This parameter, therefore, is essential to determining the number of pharmacy trips that could be replaced by drone delivery.

To estimate this parameter, Riverside Health provided aggregated and anonymized data about the fulfillment of prescriptions written by healthcare providers from Riverside for patients in the fourth quarter (October – December) of 2024, which is the latest data available. The “Riverside Health Prescription Fulfillment by Pharmacy Location” figure shows that 77% of all prescriptions written by Riverside healthcare providers were fulfilled at the seven pharmacies located on the Eastern Shore and within the planned coverage area of the drone delivery platform. The likelihood of 77% is used for the entire planning period of 2027-2031 for the BCA.



Pharmacy Trip Consolidation (φ)

Amongst households that have more than one adult, the BCA accounts for consolidated pharmacy trips, whereby an individual retrieves prescriptions for at least one other patient on the same trip. For example, in a household with two adults, one adult may retrieve medications for both adults on a single trip to the pharmacy. A study by Look and Stone (2019) showed that nearly 1 in 5 adults in the United States provide unpaid caregiving assistance to an older adult, including retrieving medications. Given the relatively large share of older adults with chronic conditions on the Eastern Shore, the BCA sets the rate of pharmacy consolidation trips to a value of $\varphi_t = 0.3$ for every year in the performance period, higher than the 20% estimated in the aforementioned study. This value serves to lower the expected number of pharmacy trips, and therefore to reduce the potential benefit of drone delivery.

Note that in the BCA calculations, pharmacy trip consolidation was only considered for households having more than one adult member. For those households, the number of trips to the pharmacy was multiplied by $(1 - \varphi_t)$ to account for consolidation.

Eligibility of Prescriptions for Delivery by Drone ($\boldsymbol{\Delta}$)

Given the number of visits by each household to Eastern Shore pharmacies annually, the parameter in this subsection estimates the number of prescriptions that could be delivered via drone. As discussed elsewhere in this report, medications to treat hypertension and diabetes, among other chronic conditions, have already been approved for drone delivery along the Eastern Shore. Additionally, other sections of this report outline plans to permit the delivery of medications for stroke, high blood cholesterol, and heart disease. The healthcare team at Riverside Health has generated a list of more than 300 prescription medications for which they plan for permission to deliver by drone. Based on the list of current medications approved, and future plans, the BCA estimates 85% of prescriptions to be delivered via drone in the first year of implementation. Thereafter, 95% of prescriptions may be delivered via drone.

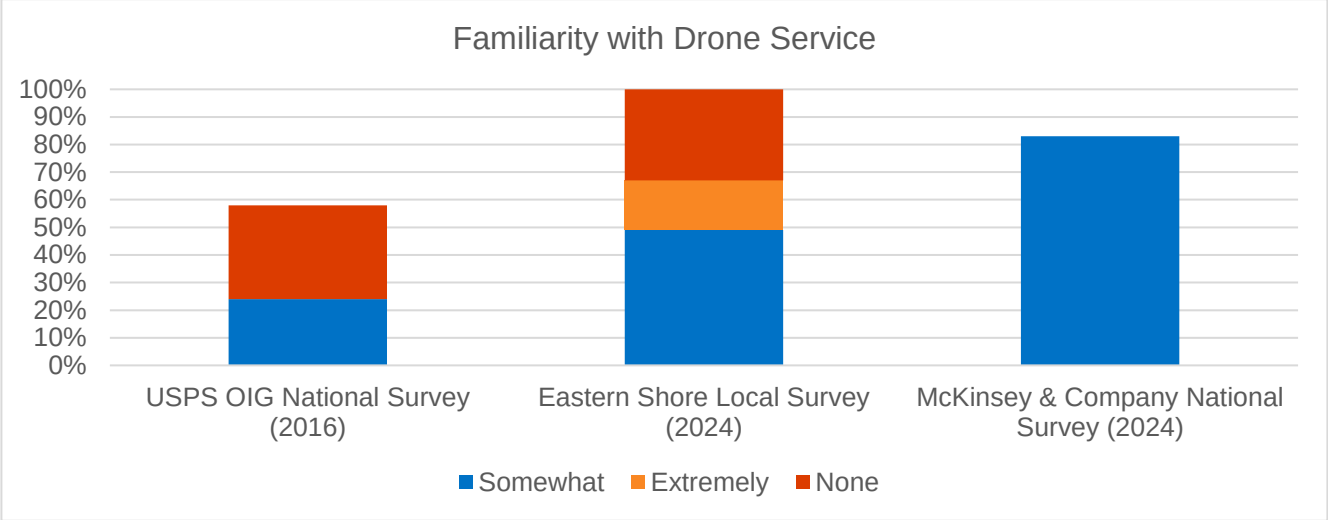
Adoption Rate of Drone Delivery ($\boldsymbol{\rho}$)

To predict the number of community members who would opt in for drone delivery of medication, the project team surveyed 100 residents on the Eastern Shore in June 2024 via Facebook (refer to Appendix C for full survey results). Key findings from the survey showed:

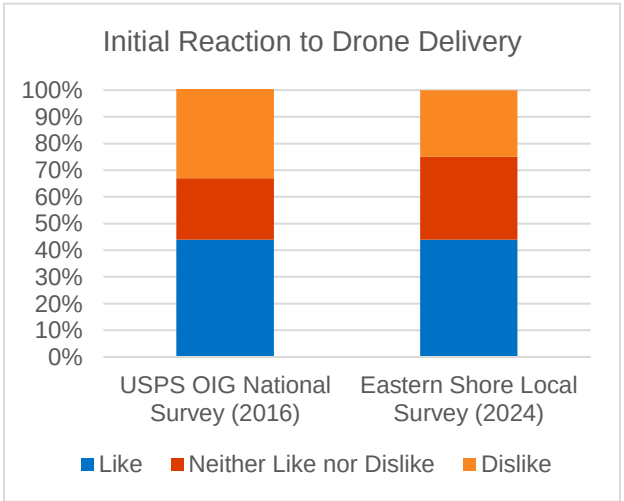
- 67% of respondents were somewhat or extremely familiar with drone delivery of medical supplies.
- 25% of respondents viewed the concept negatively or extremely negatively.
- Approximately 33% of respondents reported being uncomfortable with receiving medical supplies via drone, while 51% reported being comfortable with the concept.

- Approximately 33% of respondents reported that they would be unlikely or very unlikely to use such a service, regardless of whether relevant safety and privacy measures were in place.

To validate these findings, the team compared survey results from the Eastern Shore with two national surveys conducted in the United States. In 2016, the United States Postal Service Office of the Inspector General (USPS OIG) conducted a national survey of more than 1,450 respondents, with data weighted population estimates from the US Census Bureau. McKinsey and Company conducted an international survey (2024) of more than 3,000 consumers, reporting results for those in the United States as well as five other countries. Although each survey used different questions, the "Familiarity with Drone Service" and "Initial Reaction to Drone Delivery" figures below highlight responses to common sentiments across the three surveys.

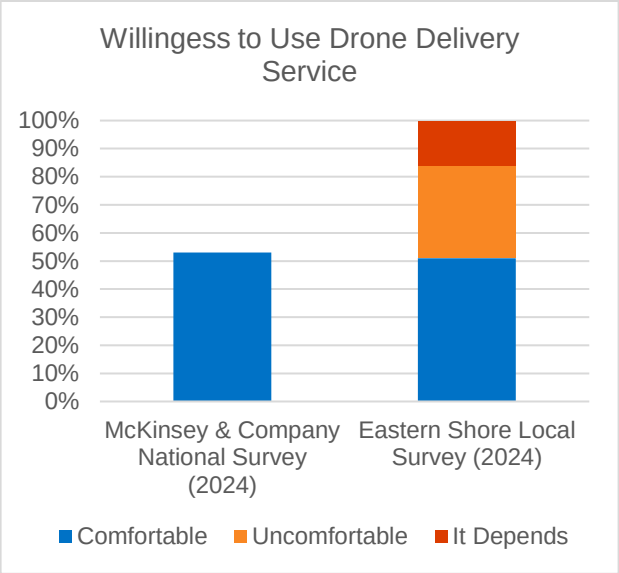


Nearly 50% of Eastern Shore residents are somewhat aware of drone delivery, compared with about 25% of respondents in the USPS OIG survey, and more than 80% of respondents in the survey conducted by McKinsey and Company. Awareness of drone delivery service, as has been described elsewhere in this report, is a key driver of adoption. According to the USPS OIG survey, 52% of those who had not previously seen or heard about drone delivery disliked the concept, while 75% of those who had been exposed to drone delivery liked the concept.

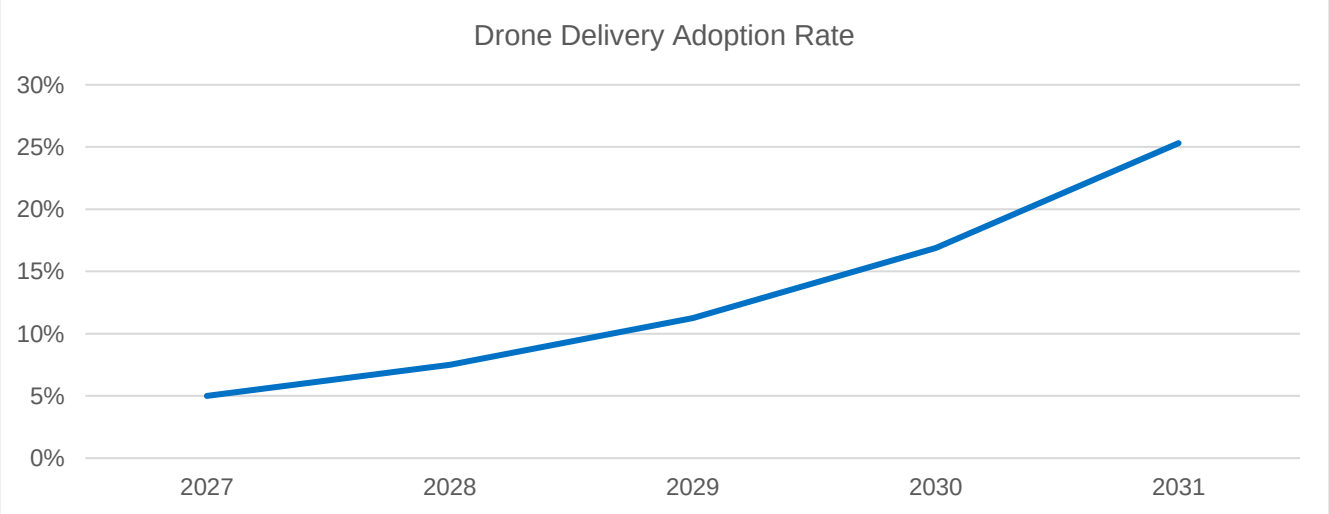


The USPS OIG found that 41% of respondents in rural/remote communities disliked the idea of drone delivery of medical supplies, implying that 59% of residents liked the idea or viewed it neither favorably nor unfavorably. This aligns with the survey of Eastern Shore residents, 75% of whom reported liking drone delivery, or at least neither liking nor disliking the concept.

Additionally, 51% of Eastern Shore respondents reported being willing to use drone delivery service. This estimate aligns closely with survey results by McKinsey and Company, where 53% of respondents reported a willingness to use drone delivery.



The rate of adoption for drone delivery begins at 5% in 2027. Each year thereafter, the rate of adoption increases 50% year over year, culminating in an adoption rate of just over 25% in 2031.

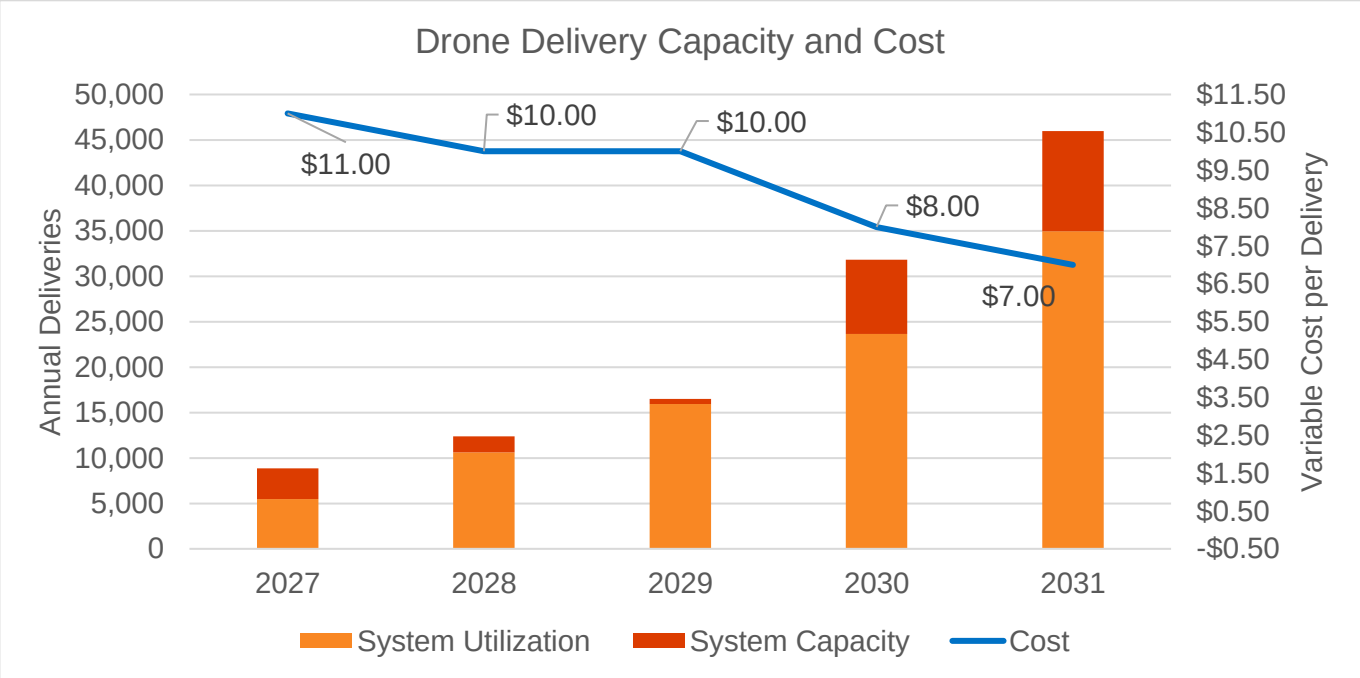


Indicator for Drone Delivery Station Availability (ϵ)

This parameter indicates the feasibility of drone delivery for households based on the availability of a drone station in their vicinity. The proposal calls drone stations (and delivery capacity) to be added gradually, as highlighted in the projected delivery volume below. Deliveries in 2026 are completed on a temporary basis, while the drone delivery system infrastructure is established. Beginning in 2027, three drone stations will be active. By 2028, four drone stations are available for delivery, and 2029 marks the establishment of five drone stations.

Drone Station	Drone Station Range (miles)	Residents within Service Range	Share of Residents Aged 60 or Older (%)	'26	'27	'28	'29	'30	'31
Riverside Shore Memorial Hospital	7.2 - 10	7,873	34.7%	40	2,265	3,797	5,695	8,543	12,815
Riverside Eastern Shore Family Medicine	7.2-10	5,140	38.2%	450	1,441	2,416	3,624	5,436	8,154
Riverside Shore Medical Center at Metompkin	7.2-10	7,239	25.2%	0	1,259	2,111	3,167	4,750	7,125
Riverside Cape Charles Medical Center	7.2-10	3,798	38.3%	0	0	1,254	1,880	2,821	4,231
Tangier Health Clinic	17	438	41.1%	30	526	1,051	1,577	2,102	2,628
Total Annual Delivery Volumes				**520**	**5,491**	**10,629**	**15,943**	**23,652**	**34,952**

The drone delivery system takes advantage of a Remote Operations Control Center (ROCC) where each staff pilot can operate multiple drones simultaneously, improving cost efficiency. The BCA assumes a 30-minute cycle time (for a typical delivery of seven miles), with a single drone at each location that can serve the estimated volume. The system is considered to be underutilized when prescription delivery demand is less than the maximum capacity of flights. We see this as a benefit, allowing for (1) changes in delivery schedules depending on patient demand and (2) higher-than-expected drone delivery adoption rates and (3) new use cases such as emergency response or intra-campus delivery. As those opportunities emerge, the system can handle new proofs-of-concept by leveraging the same infrastructure.



In 2026, first year of full operations, the team will prioritize drone stations that serve the greatest number of residents aged 60 or older. Specifically, the drone stations at Riverside Shore Memorial Hospital and at Riverside Eastern Shore Family Medicine will be active. Combined, these facilities serve more than 13,000 residents within a flight range of seven miles, with more than 36% of residents aged 60 or older. In 2027, three additional drone stations will open at Riverside Shore Medical Center at Metompkin, Riverside Cape Charles Medical Center, and Tangier Health Clinic—all to facilitate faster deliveries in those areas. From 2028 through 2031, the number of annual deliveries will continue to increase, along with higher adoption rates at each drone station. Over time, the service area of drone stations will also increase from 7 to 10 miles, with the station at Tangier Island serving an area of 17 miles to enable more remote delivery operations.

Using the baseline projections and schedule outlined in the “Drone Delivery Capacity and Cost” figure, the team currently projects a delivery cost as low as $7 per delivery, which is well below the $15 target threshold set by Riverside Health. Since Riverside Health does not currently offer 'last mile' delivery to patients for non-specialty medication prescriptions, the $15 target threshold is based on cost comparison with vehicle-based delivery: ground transportation for residential delivery within a 5-mile radius of one hub location ranges from $30 - $75 per delivery.

For Tangier Island, where ground transportation is not possible, there are two delivery methods available. The first option is delivery by a small airplane, which costs $490 per flight to the Tangier clinic from Riverside Shore Memorial Hospital. These flights are performed two times a month. The second option is the Tangier Onancock Ferry, but that is only available in season and, again, only two times a month. The cost of the Ferry is $30 per trip, in addition to the cost to pay an 8-hour labor pool employee.

While the projected adoption rates represent the team’s best estimate for future deliveries, a key advantage of the proposal is flexible scalability. In other words, the drone delivery infrastructure design and capacity will be customized for the actual adoption rate. Faster adoption rates will drive costs lower through economies of scale, for example, by leveraging autonomous logistical solutions for each drone station. Moreover, with an increasing adoption rate of drone delivery, the team will be able to validate several cost simulations for different business cases in order to optimize the drone delivery infrastructure. Even with slower adoption, the pace of technological improvement in the delivery stations along with increasing automation should lower delivery costs.

PROGRAM PRIORITIES

Safety: The project implemented improvements to reduce risks in a safe and compliant manner and to close the gap for access to routine health care. These improvements involved data analysis and modeling for flying restrictions for drones, including no fly zones, operations, and restricted air space. A process workflow was also developed for fulfilling patient deliveries during

demonstrations that complies with the Board of Pharmacy requirements. These include prescription medication chain of custody procedures to ensure safety and compliance of medications, confirmation of receipt of prescription, and assurance of no adverse effects to patient health outcomes.

Transportation Reliability: This project sought to improve reliability by reducing the supply chain variability to address existing latency issues, particularly for Tangier Island. For example, delivery delays by the United States Postal Service can affect the adherence rate of patients to their prescribed medications. Moreover, Accomack County, located on the Eastern Shore, receives an average of 41.7 inches of rainfall annually, and more than 104 days of rain, both of which are higher than national averages. Such excessive rainfall or flooding has the potential to limit roadway traffic. Using a more consistent delivery service via drone could contribute to a more robust supply chain. There is an opportunity to deliver replenishment of medical supplies for first aid/emergency response during peak tourism times which can be explored in Stage 2 as there is planned available capacity built into at-scale operations infrastructure.

Disparity and Access: In order to expand access to underserved and/or disadvantaged populations, five sites for drone stations have been designated for at-scale implementation. These sites were suggested by a modeling framework that optimizes service for underserved and/or economically disadvantaged patients. Establishing these sites will enable delivery to those facing greater risk of medical complications and lack of transportation. In Stage 2, to further refine data modeling that supports targeting disadvantaged populations, the modeling developed will be validated against patient level data from Riverside's electronic health record (EHR) Epic and will include financial status and insurance status. The VAT scores developed in Stage 1 will also be utilized in prioritizing stations for implementation.

Partnerships: Key partnerships were a pillar of this project in order to facilitate community engagement in Stage 1. Strategic partnerships were also established to support increasing scalability and sustainability efforts. This will ensure economic competitiveness and incentivize private sector investments or partnerships. In addition, the project team worked closely with other US DOT SMART Grant project teams to share lessons learned and adoption strategies as a pathfinding project. Some considerations for future collaborations and expansion include:

- Partnering with independent pharmacies and rural public health locations to study the impact on health outcomes
- Adding more Riverside Health service areas, such as Virginia's rural Middle Peninsula
- Engaging EMS for increased emergency services use applications
- Working with the Virginia Department of Health for the potential active management of TB and HIV patients
- Using Tri-Area Community Health to perform proof-of-concept demo flights in mountainous geographic demographics

Integration: While Stage 1 proof–of concept focused on a specific range within the two-county region serving a rural, isolated area of Virginia, the larger implications of the project could dramatically alleviate transportation pain points in metropolitan areas. Drone delivery of medications, medical supplies, medical specimens, and (future state) emergency supplies could also serve as a viable alternative in delivery options, particularly when traditional transportation is compromised. It could also become a primary or preferred option once it is operationalized to large scale deliveries, similar to the shift many have made to Amazon delivery instead of walking into a store.

Workforce Development: Workforce and talent development plans are outlined in Appendix E. Plans to collaborate with schools and colleges in the service area are in progress to promote a skilled and inclusive workforce through training and education programs. For at-scale implementation, there is also potential to create 8-13 full-time permanent positions to directly support operations within the region and additional positions supporting at-scale implementation during State 2's period of performance. Roles would include a focus on drone maintenance, operations and management. These jobs would not replace existing jobs, and all would have salaries that exceed the median household income within the service area. Development of the four-term certificate program, outlined in Stage 1, will provide a robust workforce development opportunity for the medical package delivery application. It will also be applicable to other drone-related markets on the Eastern Shore and in other rural communities, including agriculture, aquaculture, and natural disaster tracking and response.

Developing a strong workforce pipeline was a key focus of Stage 1. The project team partnered with Eastern Shore Community College to enhance their existing drone training program. This involved expanding the program to cover various aspects of drone operations, maintenance, and applications beyond medical deliveries, including agriculture and coastal logistics and sustainability. A blueprint for a certificate program, set to launch in 2025, was also created. The program has already seen success via participation from the Virginia Department for Aging and Rehabilitative Services (DARS). There are also plans for further community engagement, to include events in remote areas such as Tangier Island. The first cohort of this expanded program could include up to eight students.

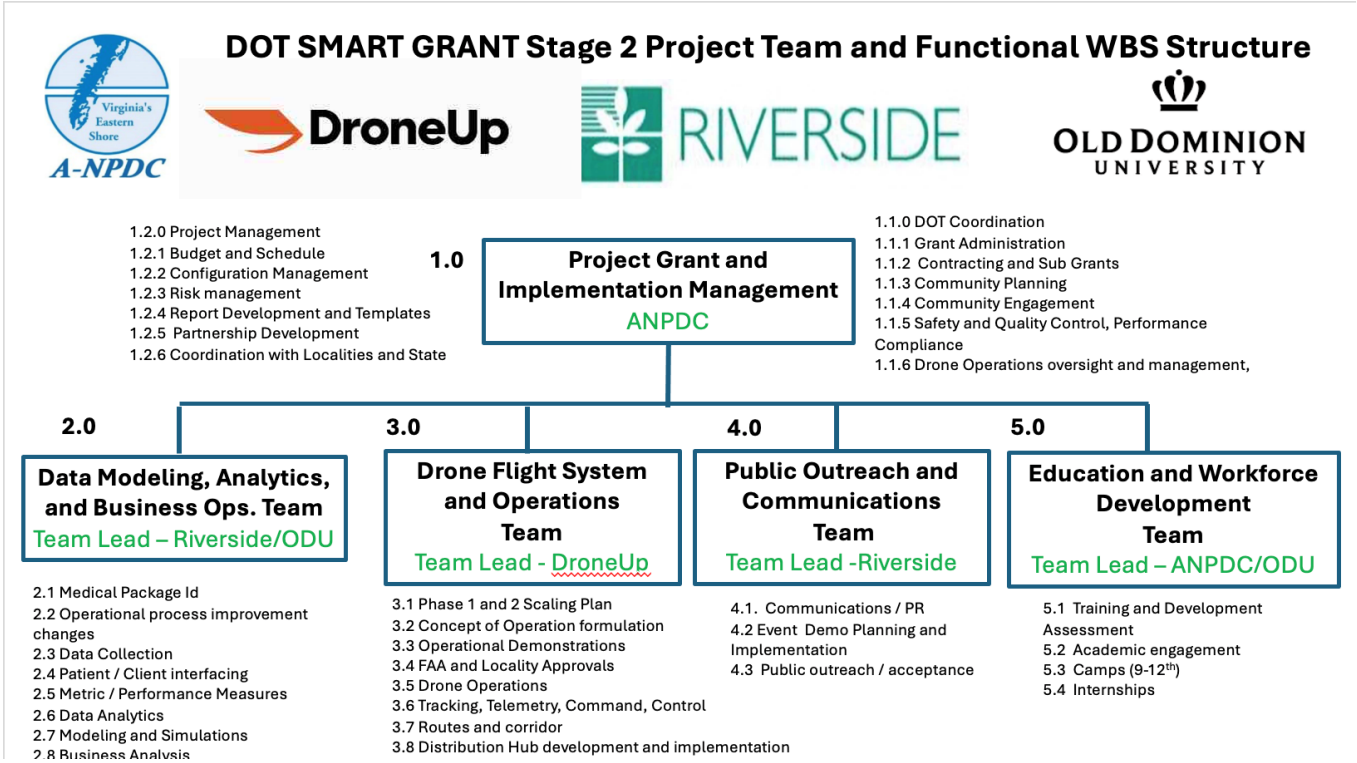
Looking ahead to Stage 2, a well-trained workforce is crucial for project sustainability. Old Dominion University has been selected to lead the lab school at the Aerospace Academy of the Eastern Shore (AAES), which is geared toward students in grades 9 through 12. The Academy, set to open in 2025, will focus on providing underrepresented populations with the skills needed for success in aerospace and related industries, including drones and autonomous systems. This initiative is expected to boost the region's economy by attracting aerospace supply chain businesses and creating a sustainable workforce pipeline. In addition, a partnership with the Virginia Space Grant Consortium will offer STEM training opportunities, further strengthening the workforce. It is anticipated that this will create at least seven new jobs in Stage 2 of the project, again contributing to broader economic growth on the Eastern Shore.

AT-SCALE IMPLEMENTATION OVERVIEW

LEADERSHIP AND PROJECT TEAM

The team proposed for Stage 2 is the same experienced group that successfully led Stage 1, but for at-scale implementation, there are planned modifications to the partnership structure. The organizational chart below reflects plans to strengthen A-NPDC roles and responsibilities. This was developed based on lessons learned from Stage 1 implementation, including the need to ensure the Grantee (A-NPDC) can implement the at-scale Stage 2 project, as well as to ensure a smooth transition to the operational sustainability phase upon completion of Stage 2. These changes include the same Stage 1 roles but now include the additional roles of project and risk management, safety and quality assurance, workforce and talent development and drone operation oversight and management. A-NPDC's staffing plan for Stage 2 will reflect the role expansion with additional team members with the necessary skills sets needed for project success.

Stage 2 Project Team Organizational Structure:



In Stage 1, the team demonstrated a proactive approach, building strong relationships with key stakeholders to ensure all deliverables were met on time and within budget. With the experience gained, the team is well-prepared to manage the scale-up in Stage 2 and achieve the project's goals.

AT-SCALE IMPLEMENTATION WORKPLAN

The lessons learned during the proof-of-concept stage and considerations to address deployment readiness will be incorporated into the at-scale implementation operations. Moving from proof-of-concept to at-scale implementation, the team will address the following priorities:

- Retire the risks associated with this Stage 1 proof-concept to ensure the feasibility to scalable operations
- Build data sets, models, and analytical tools to validate the data collection establishing the groundwork for proving the hypothesis related to patient health outcomes
- Develop appropriate future partnerships and community engagements to enable scalability and regional operational deployments.

Strategies for at-scale implementation project readiness include integrating a phased crawl/walk/run approach. Annual milestones are identified below with a tentative authority to proceed (ATP) planned for Q2 2026. These milestones may be shifted as appropriate based on if/when Stage 2 funding is awarded and available.

Overview of Workplan:

Year 1 (2026Q2-2027Q2) of the project consists of several discrete technology-related deliverables. Intended results and outcomes are briefly described below. The project team will limit risk by establishing cross-functional teams working in unison to ensure operational viability and streamlined workflows. Key market strategies that support technology deployment identified in Stage 1 will be used for patient enrollment and for scaling delivery flights.

A key step in the plan for Year 1 will be Part 135 approval from the FAA. This will unlock extended range for the region via BVLOS flights and provide a path to expanding prescription assortment, ultimately increasing drone delivery utilization. In November 2024, DroneUp was awarded a Part 135 air carrier operations certification, allowing them to conduct delivery operations for compensation and hire in the Dallas-Fort Worth (DFW) metroplex in Texas. This certification was granted using the same short distance Prism Sky aircraft that was used in this program for deliveries around Riverside Shore Memorial. When applying for the Part 135 certification on the Eastern Shore, our team will leverage the same operational and procedural standards from the DFW application. The FAA requires validation of the National Environmental Protection Act (NEPA) for service areas as part of every Part 135 application, which our team will conduct. The estimated timeline for FAA approval of the Eastern Shore Part 135 application is 3-6 months.

The Virginia Pharmacy Board allows drone delivery of prescription medications. Achieving Part 135 approval for an aircraft with onboard DAA and extended range will facilitate operations in other regions outside the Eastern Shore, especially rural areas with similar inequality and transportation challenges.

2026 - Year 1 Activities (ATP + 12 Months) – Full scale implementation with deployment of temporary basis hub locations

- Formalize partnerships needed to ensure scalability and sustainability, RFPs for subcontracts, and initiate procurement process of supplies and equipment
- Staff project teams with hiring of additional team members and restructuring of partner's roles and responsibilities
- Finalize project scope, project plan and timeline with inclusion of lessons learned, identified deployment readiness action items and requirements and delivery volumes targets to align with calculated scaling and adoption rates
- Establish temporary basis hub location (mobile ROCC units) to expedite the start of the health outcomes studies, active drone stations established at Riverside Shore Memorial Hospital and at Riverside Eastern Shore Family Medicine
- Development and submission of applications for IRB and privacy board approval for data studies on medication adherence and chronic conditions
- Expand list of approved medications and enrollment of patients with the following chronic conditions: hypertension, diabetes, stroke, high blood cholesterol, and heart disease
- Deploy communications strategy for community outreach and patient enrollment
- Develop initial software deployment and physical infrastructure to ensure safe operations, patient confidentiality protection, and available delivery hub(s).
- Secure FAA Part 135 operations approval. As outlined in the regulatory requirements, the timeline for approval is expected to be 3-6 months for environmental, regulatory, compliance, and workforce training. Expand data and modeling efforts to predict patient growth and access, tracking medicine adherence, and validate scalability size.
- Refine and improve the business case sustainability prediction for post project completion, further expand our data and modeling efforts to predict patient growth and access and validate scalability size.
- Develop and test longer-range drones to support BVLOS flights and population coverage, ground infrastructure to support payload loading by Riverside partners, and software integration with Riverside's systems to ensure chain of custody requirements are met while supporting automation improvements.

2027 - Year 2 (13-24 months post-ATP) Activities - Deploying System Software, Drones & Ground-Based Infrastructure. Scaling to 3 Locations with continued use of 2 temporary drone stations

- Expand infrastructure to establish three permanent drone stations at at Riverside Shore Medical Center at Metompkin, Riverside Cape Charles Medical Center, and Tangier Health Clinic. Continue utilization of two temporary stations to support health outcomes studies and scaling patient enrollment, three additional drone stations will be active.
- Expand lists of approved medications to include those that are shelf-stable at ambient temperatures and comply with the delivery payload specifications.
- Test and shipping validation studies to expand drone delivered medications to include refrigerated medications requiring cold storage packaging systems.
- Demonstrate further expansion across the Eastern Shore with a focus on inter-state demonstrations.
- Refine and implement the scalability approach, based on lessons learned from the Stage 1 crawl and walk phases, to maintain sustainability and unit delivery cost following project completion.
- Refine cost-benefit analysis based on actual growth of patient enrollment/access and validate scalability.

2028 - Year 3 (25-36 months post-ATP) Activities - Deploying System Software, Drones & Ground-Based Infrastructure. Scaling from 3 to 5 Locations

- Establish infrastructure and operations of five permanent drone stations. All hospital locations will be supported by ground-based automation, system software and remote command.
- Increase the number of annual deliveries with increasing adoption rates at each drone station.
- Support emergency services with expansion of approved medications and medical supplies.
- Expand the drone stations' service areas from 7 to 10 miles, with the station at Tangier Island serving an area of 17 miles to enable more remote delivery operations.

2029 – 2031 (37-60 months post-ATP) - Year 4 through year 5 Activities

- Consider adding partner pharmacies, and expansion of medical supplies and emergency services supported by drone station infrastructure within service area.
- Screen health outcomes for medication adherence for patients with chronic conditions.
- Improve operational efficiency to decrease direct costs per delivery.

BUDGET CONSIDERATIONS

The estimated budget is $14.985 million for Stage 2 at-scale implementation and the project is contingent upon securing further grant funding. The budget narrative is in Appendix F. In support of at-scale implementation, the data analytics team and associated patient demographic and geographic modeling and simulation tools have been built to run various optimization techniques that will enable the most effective scalability plan to be proposed.

In order to meet the maintenance and operating requirements necessary to continue this project, DroneUp will use existing software products and maintenance and workforce training approaches that support delivery facilities in use elsewhere across the country. Technical debt will be limited since all tools are supported by centralized development teams and not deployed in a custom manner.

For this project, DroneUp has a “shovel ready” solution – encompassing software, equipment, and ground infrastructure – ready to deploy once the required technology enhancements and FAA regulatory Part 135 efforts are complete. The proposed solution will allow drone delivery to reach the addressable population of the Eastern Shore of Virginia including Tangier Island. The phased approach can scale up or down based on end-user adoption. Each point of distribution will serve a 7-mile radius, with the potential to expand to 10 miles depending on regulatory approvals. Public surveys have been favorable, especially with healthcare employees, community members and the pilot community.

The phased implementation plan can scale with expected demand and uptake for drone delivery. The budget reflects conservative assumptions regarding adoption rate. Maximum drone flight capacity will be greater than actual demand from Riverside customers, meaning there is drone availability for new use cases such as emergency response. Scaling the platform only requires more drone hardware rather than ground infrastructure or people.

CHALLENGES, LESSONS LEARNED AND DEPLOYMENT READINESS FOR AT-SCALE IMPLEMENTATION

INTERNAL PROJECT COORDINATION

Throughout Stage 1, weekly meetings were held with all project partner leaders, in addition to focused subcommittee meetings. This meeting structure allowed for rapid identification of accomplishments, challenges, and implementation approaches to ensure project success. It also enabled each team to focus on specific responsibilities and validate their efforts across the entire project team. In addition, the team assigned clear action items with a lead identified, as well as a date for completion. These were tracked to ensure issues and decisions were resolved in a timely manner and the project stayed on time and on budget. Finally, this project structure allowed the team to develop innovative processes and solutions that ensured project effectiveness with the appropriate level of reporting and outreach.

Challenges and Lessons Learned: The timeline was impacted by internal and external approvals needed for published content used in the planning and coordination of community outreach and demonstration events. Further, addressing the action items pertaining to data analysis and reporting earlier in the program's scope would have supported with the project's direction and objectives more effectively. This was resolved by bringing in additional team members from ODU's Strome College of Business - Department of Information Technology and Decision Sciences and an additional marketing strategies contractor, Orca Strategies.

Deployment Readiness: An identified opportunity that would improve project coordination would be a shift in roles and responsibilities. To better support Stage 2, modifying the coordination of partners to strengthen A-NPDC's role with additional team members so that they can serve as the lead in project management and have an increased role and expertise to support risk management action items. For Stage 2, the project will maintain clear and transparent communication and coordination with the USDOT and FAA established in Stage 1.

REGULATORY

Controlled Substances – Board of Pharmacy

Challenges and Lessons Learned: Stage 1, integrating drone technology into existing pharmacy processes had to meet the Board of Pharmacy's chain of custody requirements for prescription medications. Per chapter 20 of the Regulations Governing the Practice of Pharmacy 18VAC110-20-275, pursuant to 54.1-3420.2 B of the Code of Virginia:

> Delivery of dispensed prescriptions permits direct hand delivery to a patient or patient's agent or delivery to a patient's residence. A pharmacy may deliver a dispensed prescription drug order for Schedule VI controlled substances. Prescription drug orders for Schedule II through Schedule V controlled substances may not be delivered to an alternate delivery location, unless such delivery is authorized by federal law and regulations of the Board.

In walking through the process workflow for fulfilling demonstration patient prescriptions, the team identified a need to further develop integrated delivery tracking to ensure chain of custody. The pharmacy team documented the dates and times each prescription left the dispensing pharmacy through a barcoded system until received at Riverside Shore Memorial Hosptial's Inpatient Pharmacy, where a signature was obtained and the package was again signed for, and the package contents was logged and checked in by the inpatient pharmacy team. Once logged and packaged for drone flight, the exterior box was paired with a QR code to a delivery address. The address was crosscheck, and the contents of the package were sealed and signed for by the drone pilot. The packages were then taken to the drone flight pad for flight, flight times were monitored by DroneUp and the delivery loop was closed with the inpatient and dispensing pharmacy at the end of all flights.

Deployment Readiness: For full scale operations, the hub and delivery process development will need to meet the statutes in 54.1-3420.2 of the Code of Virginia and comply with the Board of Pharmacy requirements to safeguard chain of custody. Medications can be filled from Riverside Pavilion Pharmacy and delivered to Riverside Shore Memorial Pharmacy with a written contract or agreement specifying the services to be provided by each pharmacy, the responsibilities of each pharmacy, and the manner in which each pharmacy will comply with all applicable federal and state laws. The process will be evaluated to ensure that the following requirements outlined in the Alternative Delivery of Prescriptions in Virginia are met:

- All pharmacies involved in the filling and dispensing of medication must have a procedure in place to maintain dispensing records, offer patient counseling, and provide a means of identification on the prescription label. A policy and procedure must be in place to ensure adequate security and protect the confidentiality and integrity of patient information.
- The pharmacy must ensure accuracy and retain accountability for the delivery process.

- The patient must be informed, and the pharmacy must obtain consent, to utilize this dispensing and delivery process.

FAA Hazardous Materials Regulations

Challenges and Lessons Learned: Consideration must be given to control substance schedule as Virginia regulations only permits class VI medications to be delivered via courier. FAA regulations have guidelines for drone delivery which prevent transport of hazardous substances. The FAA's guidance for biohazard classifications were reviewed to determine which medical supplies would be appropriate for prototype test deliveries in Stage 1. This included consulting FAA personal and review of the U.S. Department of Transportation (DOT) Hazardous Materials Regulations (HMR), 49 CFR Parts 171-180 regulations for hazardous materials. The team opted to use hypertensive medications and routine labs for the proof-of-concept medical deliveries.

Deployment Readiness: As operations expand with the introduction of additional medical supplies incorporated in the program, a thorough review of medication classes and medical supplies will be incorporated into the implementation plan. This will include a checklist consisting of but not exclusively of reviewing the potential HazMat class, Safety Data Sheets (SDS), packaging and labeling requirements, documentation requirements, training to applicable personnel of the identification and classification of hazardous medical items, necessary risk assessments and transportation validation testing if appropriate. The team will also continue to engage the FAA routinely.

Patient Privacy - Health Insurance Portability and Accountability Act (HIPAA)

Challenges and Lessons Learned: Integrating the UAS technology into pharmacy operations required the team to evaluate the dispense and fulfillment process to ensure patient privacy best practices are followed. The United States Department of Health and Human Services, as required by the Health Insurance Portability and Accountability Act (HIPAA), prevents the disclosure of patients' protected health information (PHI). Per 18VAC110-20-275, pursuant to 54.1-3420.2 B of the Code of Virginia: delivery of dispensed prescriptions requires pharmacies to develop a process to protect PHI while delivering prescription medications. For proof-of-concept medication deliveries the team walked through the workflow and identified opportunities to further protect patient privacy.

Deployment Readiness: For the operational workflow, the team will incorporate tamper evident bags into the primary packaging and documentation methods such as QR codes to maintain traceability without compromising the patient's privacy. Process controls include that the process will continually be internally audited as operations are expanded to ensure PHI is protected. All privacy incidents will also be logged in rCare which is Riverside's safety reporting system upon discovery and further investigated. All privacy incidents and data breeches are

reported to Riverside's Corporate Audit and Compliance/Privacy Officer and/or the Director of Internal Audit and Privacy and there are extensive education and training provided to Riverside's team members on HIPAA and safeguarding PHI.

Patient Privacy - Internal Review Board (IRB)

Challenges and Lessons Learned: The decision tool, Am I Doing Human Subjects Research? | grants.nih.gov is used at Riverside to determine if a particular study needs to go through IRB. At the start of Stage 1, the research plan was modified so that the proof-of-concept prototype work would not need to go through the IRB process. Stage 1 was not about tracking individualized patients and their outcomes but collecting metrics regarding processes and data to ensure readiness in Stage 2 for implementation with minimal risk. However, the planned studies in Stage 2 will be required to receive approval from IRB and Riverside's privacy board in order to evaluate the project's impact to patient outcomes.

Deployment Readiness: To study the impact to health outcomes, the Primary Investigator of the project will submit the project to Riverside's Institutional Review Board (IRB) at the start of Stage 2. Once the Stage 2 research study plan is finalized, the team will use this tool and include Riverside's IRB chair to make the determination on required approvals necessary. Additionally, the IRB department works closely with the RHS Privacy Board to ensure all research procedures adequately protect subjects' privacy and confidentiality. All projects that meet the federal definition of Human Subjects Research and qualify for exemption from requirements of 45 CFR 46, must be reviewed by the Privacy Board for privacy and confidentiality concerns. All projects that do not meet the federal definition of Human Subjects Research will be reviewed by the Privacy Board for confidentiality and privacy concerns.

BVLOS – FAA Compliance for Part 135

Challenges and Lessons Learned: In Stage 1, obtaining the proper waivers to conduct Beyond Visual Line of Site (BVLOS) deliveries was one of the first challenges to overcome. Working closely with the FAA, the team was able to obtain waivers to conduct BVLOS flights.

Deployment Readiness: Stage 2 will require continued work with the FAA to extend existing Part 135 certification needed to conduct deliveries BVLOS. DroneUp's Part 135 air carrier certificate and the FAA-accepted training qualification manual are both ready for implementation, with known timelines and deliverables for expansion to the Eastern Shore. DroneUp will meet all required NEPA (National Environmental Protection Act) requirements to extend Part 135 operations to the Eastern Shore, estimated to take 3-6 months. DroneUp will also meet standards to apply for a 44807 exemption, allowing drones to fly BVLOS.

While the team was able to demonstrate BVLOS delivery under the proof-of-concept operations, it is important to note that delivery at-scale must be conducted under Part 135 with 44807 exemptions, or future Part 108 authorizations. The flights conducted under Stage 1

helped to inform and build the safety and reliability case for both the unmanned system being used, and the operator using the system. Stage 2 will continue to build on the Stage 1 flights. This will involve increasing hours and flights to address issues related to the Part 107 waivers identified during Stage 1, with the ultimate goal of operating multiple approved platforms to support the range of distances required.

Federal Compliance – Procurement, Financial Management, NEPA, BABAA, and Civil Rights Compliance

Challenges and Lessons Learned: Throughout the grant's period of performance, A-NPDC demonstrated its responsibility and legal obligation to comply fully with all applicable Federal laws and regulations, including, among others, those prohibiting discrimination and enforcing controls on illegal immigration. Additionally, throughout the duration of the project, A-NPDC ensured compliance with civil rights obligations and nondiscrimination laws, including Title VI of the Civil Rights Act of 1964, the Americans with Disabilities Act of 1990 (ADA), Section 504 of the Rehabilitation Act, and implementing regulations. Upon award, A-NPDC provided a current Title VI plan that had been approved by FHWA.

A-NPDC and its contractors complied with all applicable procurement laws and regulations pertaining to procurement, incorporating the statutory requirements of the 2024 OMB Uniform Guidance for Federal Financial Assistance (2 CFR 200). The purpose of the planning and prototyping project was to demonstrate drone technology to deliver and transport medical supplies in the Eastern Shore region of Virginia. As such, this Stage 1 project did not include a construction phase nor was there any ground disturbance. The Office of Management and Budget revised the Uniform Guidance in 2024, making changes throughout 2 CFR 200. As a result, the project team worked with USDOT to make the necessary adjustments and accommodate the changes. Shifting to the new compliance regulations impacted equipment and supply thresholds as well as the De minimis rate for two contractors. The team learned from and greatly appreciated the guidance provided by USDOT. USDOT’s guidance significantly informed the team’s Stage 2 budget proposal.

Deployment Readiness: The Accomack-Northampton Planning District Commission remained in compliance with all applicable laws, regulations, Executive Orders, and the requirements of 2 CFR 200. In compliance with 2 CFR Part 200, Subpart F, A-NPDC will continue to comply with audit provisions. A-NPDC will ensure that its currently active Title VI Plan with USDOT through the Federal Highway Administration is in force for all stages of the project. Recognizing that Stage 2 will operationalize the project, A-NPDC will document that all environmental due diligence for the project has been performed, including that which is required through the Federal Aviation Administration.

NEPA: A-NPDC will plan, coordinate and perform all public advertisement and outreach necessary for the project. The team found significant value in engaging local governments and requirements were also addressed at the front end.

The Build America, Buy America Act under Title IX of the Infrastructure Investment and Jobs Act (Public Law 177-58): the requirements of this act was discussed as it related to project equipment and will be incorporated in the decision making for Stage 2 procurement. The team evaluated the advantages and disadvantages of leasing versus buying the needed equipment. Overall, Stage 1 clearly revealed the need for key partnerships to collaborate with and move toward at-scale implementation. The team has already begun building partnerships with independent pharmacies, as well as public health departments, in order to expand the geographic eligibility criteria and enable services over a broader suite of medicines and medical supplies. These partnerships will continue into Stage 2.

OPERATIONS AND TECHNOLOGY

For technology suitability and integration with incumbent systems, the team evaluated drone models utilized for medical supplies for a range of flight distances, determined approach to setting up drone operational hubs, and addressed the criticality of comms system for delivery flights in a rural area with limited comms connectivity. Additionally, the team investigated approaches to streamline process efficiencies and ensure chain of custody and patient privacy compliance.

Drones

Challenges and Lessons Learned: Multiple drone models were evaluated in Stage 1 with considerations of improving supply chain logistics. Two different drones were used for Stage 1 execution, as different use cases required different flight distances. The details of each type can be found in “Operations and Technical Feasibility” section of report. The drones utilized in Stage 1 were selected as part of an RFP that was sent to over 40 drone manufacturers. Evaluation criteria included flexible architecture, weather handling, and payload capacity.

Drone technology is innovative and moving quickly, the platforms chosen for Stage 1 were able to complete the required tasks for delivery distance however as the project progressed it was found that significant supply chain, foreign component use and commercial risk were introduced. In addition, exposed delivery payload box designs may not be suitable for future use cases like cold chain requirements, so a drone better suited for medical use cases would create a better outcome for deployment. For example, the Swoop aircraft that was used for Tangier flights has subsequently gone out of business. The key lesson moving into at-scale implementation is ensuring the aircraft that will be selected has limited supply chain risk, firm financial standing and platform capabilities that will support planned demand.

Deployment Readiness: DroneUp will leverage existing drones but recommends enhancements to ensure further flight ranges for at-scale implementation. The takeaway from selecting two different drone models is that moving forward to Stage 2, one drone model should be selected. This is the best way to improve supply chain logistics, lower maintenance costs and drone downtime, and minimize any regulatory risk. Selecting one drone platform also means that design changes is kept to a minimum, which reduces regulatory requirements.

For at-scale expansion, it is imperative that supply chain sustainable capabilities and an America-First approach is taken when selecting a drone model. The preferred drone is made in Michigan and meets the provisions of the National Defense Authorization Act, ensuring NDAA compliance. This model was not available within the procurement timeframe of Stage 1 and will be considered for expanding operations. This drone uses automotive manufacturing techniques and leverages 3D printed parts 100% made in the US, reducing supply chain risk and improving maintenance cost outcomes. The preferred drone will also undergo rigorous 44807 testing as defined by the FAA, controlling regulatory risk.

Aircraft Wings

Deployment Readiness: It is recommended that a single aircraft model be used for this project. It should be capable of making 35-mile round-trip deliveries to Tangier Island, as well as efficient flights between 7 and 10 miles from Riverside Hospital locations. The current drone requires wings to enhance flight distance, allowing full service to all residents on the Eastern Shore. The easily configurable drone in use today will permit these enhancements. To secure a 44807 exemption, FAA requirements dictate that drone configuration be completed, with appropriate documentation, in order to apply for BVLOS approval under Part 135 regulations. DroneUp is familiar with the process of validating drone platforms and associated elements e.g. communications, batteries, software for FAA approval.

Infrastructure Development

Challenges and Lessons Learned: this project utilized a DroneUp mobile command center that is based out of a small pull-behind trailer, equipped with Starlink-enabled internet that allows the crew to connect to the aircraft before, and during flight. While this command center works well for non-sustained operations, a larger, less-mobile structure will be needed for sustained operations. Ideally a structure that is large enough to store aircrafts and batteries, while providing the necessary power, internet, and space to conduct multiple-day operations with multiple aircrafts.

Deployment Readiness: Riverside Shore Memorial Hospital is in an ideal location to operate from initially, due to its central location on the Eastern Shore, as most prescriptions and supplies originate from the hospital. To progress operational expansion, command centers can be placed in other strategic locations to facilitate growth.

Communication Systems

Challenges and Lessons Learned: Communication coverage is critical during drone operations. Capabilities on Tangier Island had to be addressed prior to testing sessions to ensure coverage was sufficient. DroneUp has a system, but it requires Wi-Fi connection on the island, so Riverside's IT team was consulted to troubleshoot comms extension options for hardwiring or Wi-Fi range extension options. The team also evaluated procuring Starlink devices

to equip the Tangier clinic location. Ultimately, DroneUp leveraged temporary Starlink devices to maintain connectivity and ensured the operations were within physical range of the Tangier Clinic's Wi-Fi connectivity so that bilaterial communication was available at all times. To mitigate risk, the comms system connectivity was tested prior to performing any flight testing.

Deployment Readiness: The team plans to leverage a blend of ground-based radar near any high traffic airports, which will support data feeds into DroneUp's Unmanned Traffic Management (UTM) system. In addition to onboard drone DAA solutions, communication coverage for cooperative and uncooperative UAS traffic can be approved by the FAA for planned operational area. For additional hub expansion, communications coverage is critical and needs to be thoughtfully planned. Additional procurement, sourcing equipment, and services may be required for at-scale implementation to increase connectivity surrounding hub locations and infrastructure expansion. This will be evaluated during implementation planning when each hub is made operational.

Pharmacy Workflow and Operations

Challenges and Lessons Learned: Opportunities identified for the pharmacy process include:

Payload and Packaging: In addition to the packaging modifications outlined in the Pharmacy Operations and Patient Prescription Deliveries section above, the team found that insufficient weight of the payload can be problematic. The maximum payload specifications was a key consideration when selecting which medicals supplies should be delivered during the demo flights and the team accounted for the maximum specs of:

- Watts Prism SKY: 11X7X6 and less than 7lbs
- Swoop Aero Kite 2: 7 3/4" x 9 1/2" x 4" and under 5lbs

However, during the initial test flight to deliver a patient prescription, the payload was actually too light. This resulted in the tethering of the drone to not release the payload at its final destination and the delivery was returned to the site of origin. To tackle this issue, a bottle of water was added to the package with the medications which provided sufficient weight to trigger the tether to release the package correctly. This resolved the issue for the remaining patient deliveries during the entirety of Stage 1. The impact of weight will need to be factored in when expanding the types of medical supplies delivered for at-scale operations.

Temperature Control: Increasing the types of medications delivered requires additional packaging considerations to ensure temperature control requirements are met. A cold storage packaging system was procured for further testing of payloads with these requirements. For deployment readiness, the packaging systems identified are ISTA 7E qualified for refrigerated and controlled room temperature shipments and are validated to maintain temperature for a duration of 36 hours. These packaging systems can be used for additional medications, lab supplies and blood products.

Patient Enrollment: An operational change needed is an improved process for patient enrollment and communication. In trial deliveries, the team found that patient enrollment was hampered by an inability to contact eligible enrollees via phone. The team has identified alternative and complementary options to increase communication outreach for at-scale implementation. To ramp up program enrollment, an enrollment coordinator would be employed as well as educating and training Riverside's providers, so that doctors and other care providers are trained to recommend the service to potential enrollees. This would lend credibility, especially for the target demographic, over a cold call to them about the program. Communication could also be supported with the use of a Customer Relationship Management (CRM) system and targeted campaigns for the program.

Delivery Tracking: Stage 1 experiences showed the need to integrate systems for delivery tracking with medication dispensing and patient communication, to confirm receipt of medication and ensure proper chain of custody.

Fulfillment Process Efficiencies: Further optimization is needed for the patient's medication ordering process to accommodate the at-scale volumes anticipated. To scale this method of delivery, an operational process should be adopted that allows Riverside or other pharmacy partners the ability to pack prescriptions and deliverable items, supported by a centralized drone operation that can perform "pickups" of payload and deliver to an end destination. This will limit the number of dedicated drone stations required to support the service area. Additional efficiencies can be gained with software integration to support the FAA compliance rules by identifying controlled or biohazard payload in addition to human-driven procedures.

Internal Carrier System: In the current state, lab samples taken at the Tangier clinic are required to be sent back to RSMH for processing which typically takes several days and delays patient from receiving their results. This is also the case for some of the lab testing at clinics within the area. The ability to decrease the turnaround time for lab results would be a major benefit of expanding to multiple hubs.

With the additional hub locations, pharmacy processes will need to expand to accommodate the direct-to-consumer vs hub and spoke delivery models anticipated. The hub and spoke approach supports an internal carrier system to send payloads to and from the multiple hubs such as lab samples. The onsite staff would require further training in UAS operations because the drones will need to be reset in prep of the return delivery.

Additional considerations for increasing access pathways for patients:

- Community pharmacies serve as accessible locations for patient-centered medication management services that enhance the health and wellness of communities.
- A future goal of this project is to open a community pharmacy on the campus of Riverside Shore Memorial Hospital in order to decrease the time required to fill the prescription at Riverside Pavilion Pharmacy and courier it to the Eastern Shore. Opening a community pharmacy would also provide job opportunities to those in the Onancock community, while serving as an additional access point to life-saving medications and assisting with shorter turnaround time for the last-mile delivery process.
- Expansion of this service will also provide an opportunity to dispense medications to patients discharged from the hospital, allowing them to go home with their needed medications, rather than making an additional stop on the way home. Meds-to-Beds programs reduce patient readmission rates, while also improving medication compliance.

Deployment Readiness: To deploy at-scale, a process will need to be implemented for the patient ordering experience and confirmation of delivery. In particular, the IT needs, timeline impact for integration and interfacing with Riverside's Epic, medication dispense tracking, and a customer relationship management (CRM) system have all been identified for at-scale implementation. Some key considerations for further expansion include additional packaging systems for supplies requiring refrigerated or cold storage, increased methods of communication for enrolled patients, confirmation of delivery tracking, automation within the fulfillment process steps, and workflow updates to support deliveries between the additional hubs.

RISK MITIGATION

BVLOS Operational Air Volume Awareness Architectures

Challenges and Lessons Learned: The Stage 1 service area is rural and highly disadvantaged with limited resources. The approach was to use low-cost, proven systems, such as remote ID, ADSB, and optical systems, to ensure safe operations in the limited BVLOS tests. As BVLOS operations and coverage volumes are expanded, it will be extremely important to not burden localities with expensive Air Volume Awareness Infrastructure. Therefore, the suggested approach is to ensure that no hubs are located near or utilized by small regional airports. This will be done by:

- Educating regional airports to understand the small volume runway approach and departure, using FAA approved ground-based optical cameras, ADSB, and remote ID sensors
- Ensuring that UAS onboard Detect and Avoid systems are validated.

For Stage 2, the team will employ appropriate, FAA approved, and cost-effective Air Volume Awareness technologies, both on the ground and onboard the drones. This will help to ensure the airspace where the drones will be operating can detect and avoid any possible conflicts,

both with cooperative (ADSB) and noncooperative (non ADSB) aircrafts. The team also leverage a study entitled Minimal Viable Architectures for Advanced Air Mobility, which was funded by the Virginia Dept. of Aviation and conducted by the Virginia Mid-Atlantic Aviation Partnership (MAAP), an FAA-approved drone test center. It is not included in this final report because the release has not been made public as of 3/1/2025. This report considers several factors including cost, volume of traffic, the location and size of airport operations and infrastructure, and sensor technology maturity. It also factors in the performance of various types of Air Volume Awareness systems, including, but not limited to, ADBS ping stations, remote ID, ground and airborne optical systems, acoustic, and small and large radar systems. The study clearly defines a minimal viable system architecture for each type of airport and balances near- and long-term costs with a locality's ability to afford the initial setup and longer-term maintenance costs.

The team used this report to establish a Stage 2 proposed Air Volume Awareness Architecture tailored to rural areas. This tailored architecture was derived using results of the URSA and ATA reports, as well as relevant, past performance, and experiences of DroneUp's operational delivery capabilities. Though no delivery hubs or flight operations would be conducted in and around an airport, the team was determined to ensure public confidence and eliminate all possible risk based on the MAAP report. As a result, a 1-mile bubble of flight information will be created around an airport via ground-based sensors (remote ID, ADSB ping stations and optical systems) and with the flexibility of the onboard optical Detect And Avoid (DAA) system for use outside this airport bubble. This would enable a cost-effective approach to VLOS-BVLOS operations.

Additionally, ODU VISA, DroneUp, and Echodyne engaged with NASA Goddard Space Flight Center Wallops to conduct multiple test flights verifying the Original Equipment Manufacturer (OEM) specifications on Range, Mission Endurance, and performance of the long-distance delivery aircraft. Test flights were conducted with manned aviation assets and the EchoShield Radar system to verify detection ranges as stated by the OEM. The Echodyne Radar performed as advertised, however, the decision was made by the team not to include it in the Stage 2 implementation plan. Reasons for this decision included cost, lower altitude operations, a reduced need for longer range and higher altitude Detect and Avoid, and the performance of other lower cost sensor systems. DroneUp was able to certify the aircraft for operations on the test range by passing a rigorous Safety Review Board conducted by NASA Range Test Engineers and Program Management personnel.

Deployment Readiness:

Onboard Detect and Avoid (DAA): This enhancement will create airspace awareness for the delivery drone, using onboard sensors. It will also eliminate the need for costly ground-based sensor infrastructure, which is especially challenging over long distances and in rough or elevated terrain. The onboard sensors will permit both cooperative and uncooperative detection and avoidance. In the near-term, the solution can be used to support the SMART Grant FY23 award "Maryland Eastern Shore Drone Medical Delivery" outcomes and create a regional cluster

for drone delivery. Specifically, we see this as an opportunity to combine Stage 2 funding as a combined regional service for each SMART Grant. For reference, DroneUp is actively operating with two more SMART grant teams on "ELSA-M3" in Pennsylvania and "Cherokee AirCare" in Oklahoma and is utilizing learnings from the Eastern Shore for Stage 1 execution. An onboard DAA-enabled aircraft could support use cases for all of the projects delivering to rural communities. There is also precedent for FAA approval of onboard DAA, as acoustic, optical, and radar onboard solutions have all received approval. DroneUp has a team of experts ready to select an appropriate sensor, implement the solution, and work with the FAA through testing and approval.

DroneUp will deploy it's vertically integrated software solution with the following features. This will ensure compliance with FAA Part 135 regulations and safe flight in congested airspace, a critical DOT need for low-altitude operations with the ability to incorporate multiple operators for future scale**:**

- **4D Path Planning:** The system's 4D Pathfinder component generates collision-free flight paths that are deconflicted across all missions, including potential conflicts with other teams' traffic. This automated path planner ensures that each mission's flight path is both efficient and effective.
- **Centralized Oversight with Federated Controls:** The Uncrew™ Ecosystem provides centralized oversight for all missions while also allowing for federated operational areas and role-based access controls (RBAC). This "hub-and-spoke" model allows for the integration of smaller, more agile bases of operation while maintaining overarching operational governance and control. This distributed control structure is well-suited to the needs of today's commercial sUAS operations teams.
- **Command and Control Interoperability:** The system's robust command and control interoperability allows for seamless control of any sUAS that is based on the PX4 flight control firmware. This ensures that operators can effectively manage and control a wide range of sUAS platforms.
- **Situational Awareness:** Dedicated common operating procedures and secure remote access to comprehensive mission data provides situational awareness for all authorized personnel within a designated area. This ensures that everyone who needs to be aware of the mission's status has the information they need, when they need it.
- **Unmanned Traffic Management (UTM) Integration:** As an Inter-USS contributor, the platform's UTM capabilities include native APIs that allow for seamless integration with external traffic management systems, such as CLUE. This enables the system to publish flight intents to authorized external systems and ingest external traffic data for comprehensive flight deconfliction during both flight planning and in-flight operations. This distributed coordination capability is essential for integrating dispersed bases while maintaining operational agility.
- **Scalable Remote Pilot Operations:** The platform's ability to enable a one-to-many (m:N) remote pilot to UAS ratio significantly enhances the scalability of remote pilot operations.

Adverse Weather Conditions

Challenges and Lessons Learned: Reliable and sustainable drone medical package delivery can be influenced by adverse weather conditions. The main weather conditions that were considered were temperature, rainfall, and wind. The limitations of the drones used in Stage 1 were:

- Does not fly in snow, rain, or fog, or within 5 miles of active thunderstorms
- Max operational temp = 100°F
- Min operational temp = 32°F
- Max wind for delivery = 19.4kts
- Max wind for transit = 30.4kts

In cases of extended adverse weather, there is an increased probability that drone deliveries may need to be rescheduled or canceled. Multiple delivery windows or alternative ground transportation options will need to be included for at-scale implementation, as a risk mitigation consideration. Further, to reduce the risk that the patient will run out of medication, the delivery window is limited to up to one week from the time of insurance verification.

In Stage 1, the patient prescription drone deliveries were scheduled throughout seasonal fluctuations during the proof-of-concept stage and on only one occasion was the use of drones unachievable during the one-week delivery window due to adverse weather conditions. For this instance, the pharmacy maintained constant communication with the patient and ground transportation was deployed for delivery fulfillment.

Regional weather considerations factored into project location: The Commonwealth of Virginia experiences relatively moderate winters, particularly in the Coastal Plain and Piedmont Regions. The Blue Ridge Mountains and Valley and Ridge Regions experience colder temperatures, with more days below the freezing level. Freezing conditions are generally unsuitable for UAS platforms that utilize lithium-ion batteries, particularly for periods of prolonged exposure. In these cases, battery discharge performance is generally degraded, battery charging can be impeded, and the freezing temperatures can damage the battery components. With a rise in elevation, temperatures become even colder, generally 4°F for every one thousand feet. Moderate winters, with fewer days below the freezing level, are generally favorable for routine UAS delivery operations. These conditions exist within the Coastal Region and, to a slightly lesser extent, in the Piedmont Region.

Virginia Days Above Freezing:

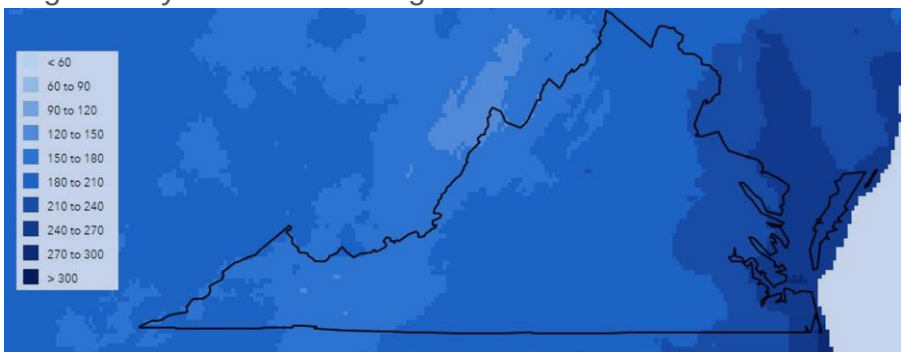


Figure source: URSA, Hampton Roads Virginia Airspace Analysis

With regard to rainfall, Virginia experiences moderate annual rainfall, with the Coastal Plain and Piedmont regions receiving between 1,001 and 1,500mm annually. Precipitation is slightly lower in the Blue Ridge Mountains and Valley and Ridge Regions. Some electric delivery drones may be susceptible to precipitation, which can cause propulsion system or other electrical system failures. Still, annual precipitation levels are generally low within most of the Commonwealth, making it favorable for UAS delivery operations.

Virginia Annual Precipitation (mm):

Figure source: URSA, Hampton Roads Virginia Airspace Analysis

When considering wind speed, it is relatively low in Virginia, as most areas are shielded by the Blue Ridge Mountains, which serve as a windbreak for the low-lying Coastal Plain and Piedmont Regions. Higher than average winds are, however, experienced at the peaks of the Blue Ridge Mountains and Valley and Ridge Regions. High winds can cause stability and control issues for some UAS, particularly if weighed down by delivery cargo. High winds can also adversely affect flight performance. In the eastern portion of Virginia, wind speeds are relatively low, making conditions favorable for UAS delivery operations.

Virginia Average Annual Wind Speed (m/s):

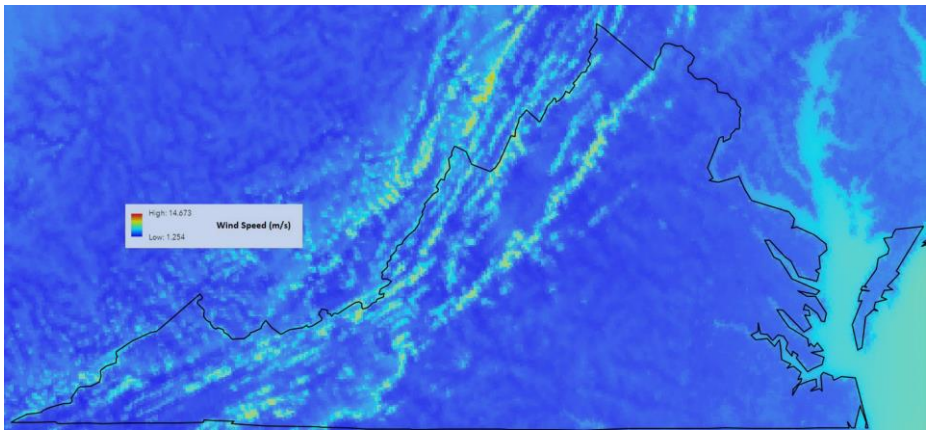


Figure source: URSA, Hampton Roads Virginia Airspace Analysis

Deployment Readiness: This data and analysis validates that weather risks associated with medical package deliveries are low. When combined with flexibility in refilling and timing, any issues associated with weather are essentially eliminated. For at-scale implementation, ground transportation such as a contracted on-call/stat mobile courier has been factored into the support considerations for scaled expansion to additional hubs within the region.

Cybersecurity

Challenges and Lessons Learned: Further development will need to be addressed for at-scale implementation deployment readiness to ensure the security of the operations incorporating UAS technology such as cloud-based software, safety management systems, advanced deconfliction tools, security, compliance and monitoring systems. Industry best practices for health care cybersecurity will also be evaluated and incorporated into the implementation project plan.

Deployment Readiness:

Cloud-Based Software Solutions: Modern proprietary and vertically integrated software systems, including uncrewed traffic management (UTM), mission planning, fleet management, and logistics platforms, will support enabling seamless drone deliveries within defined service areas. These systems will leverage real-time geospatial data to ensure precise airspace, terrain, and traffic awareness, eliminating the need for predefined corridors or routes.

To support today's FAA Part 135 requirements, the project software will integrate safety management systems and advanced deconfliction tools, ensuring compliance with regulatory standards and safe coordination with other aircraft. The software and security protocols used elsewhere in commercial operations will be applied and improved upon depending on

requirements. Additionally, Delivery Application Programming Interfaces (APIs) can be seamlessly integrated with Riverside Health and other partner platforms to enforce payload compliance and logistics requirements.

Security and Compliance: The software planned for at-scale implementation was developed using modern security best practices and prioritizing data protection and compliance with industry standards, this includes:

- **End-to-End Encryption:** Mutual Transport Layer Security (mTLS) will be implemented to encrypt all data transport across public and private networks, ensuring secure communication between cloud services and internal components.
- **Strong Authentication and Authorization:** API authentication and authorization will utilize signed and encrypted JSON Web Tokens (JWTs) to guarantee data integrity and authenticity. Role-based access control (RBAC) will ensure users are granted only the minimum required permissions.
- **Data Protection**: All data at rest will be encrypted by default, mitigating risks associated with unauthorized access or data breaches.
- **Continuous Security Testing**: Regular penetration testing and vulnerability scanning will be conducted to proactively identify and remediate potential security weaknesses.

SOC 2 Type 2 Compliance: To uphold the highest standards of security, availability, and data integrity, all systems will undergo SOC 2 Type 2 audits on an annual basis. These audits will assess the operational effectiveness of security controls over an extended period of time, ensuring compliance with trust service criteria related to security, availability, processing integrity, confidentiality, and privacy.

Key elements of SOC 2 Type 2 compliance include:

- Continuous Monitoring: Ongoing assessment of security controls to detect and mitigate risks in real time.
- Incident Response and Logging: Comprehensive logging and monitoring mechanisms to detect, investigate, and respond to security incidents.
- Access Controls and Change Management: Strict policies governing access permissions, system changes, and data integrity measures.
- Independent Third-Party Audits: Annual evaluations conducted by independent auditors to validate compliance and ensure adherence to best practices.

DroneUp continues to evolve it’s technology and work with other federal partners in addition to the DOT for plans to adopt security standards as required. A cybersecurity framework consisting of encryption (AES-256), secure APIs (OAuth 2.0), and protection against RF jamming. DroneUp pays close attention to requirements and initiatives like Secure Cyberspace and Critical Infrastructure standards from DoD as guidance.

Health Care Cybersecurity: Riverside employs a comprehensive framework of cybersecurity risk mitigation with security measures to protect the organization’s day-to-day operations and electronic health information of the patients served. Riverside’s strong commitment to protecting

privacy and providing better patient care through privacy is demonstrated daily throughout the health system with the use of FairWarning, a privacy and breach detection system and rCare which is an internal system to report safety incidents. FairWarning allows Riverside to identify inappropriate or suspicious accesses as early as two days from the date of the incident. The existing comprehensive framework and team dedicated to support cybersecurity would be consulted and involved in the planning for at-scale implementation. Policies are in place to evaluate and assess third-party risk management to safeguard patient privacy.

DATA ANALYSIS, MODELING AND SIMULATION

In Stage 1, the team assembled a skilled data analytics team equipped with patient demographic data, as well as geographical modeling and simulation tools, to optimize the planned scalability plan. To transition to Stage 2, the project plan and budget are designed to balance patient delivery needs with the necessary infrastructure across various geographical areas. This approach will establish a new transportation model that can be scaled to other regions while remaining sustainable in terms of maintenance and operational costs. The primary objective is to minimize service and transportation costs for patients while demonstrating the potential cost savings, environmental benefits, and increased transportation network that can be achieved through the operational deployment of this DOT SMART program project.

Data Governance

Challenges and Lessons Learned: Data considerations were addressed at the start of the project. It was determined to restrict use of PHI in Stage 1 and conduct data modeling and simulation analysis with only publicly available data sets.

Deployment Readiness: The team established a robust data management plan, data sharing protocols, and plan for adhering to applicable privacy and IRB approvals to validate findings in Stage 2. This plan includes applicable patient level data to conduct studies for medication adherence and health outcomes. The team has a strong understanding of requirements, considerations, and impact to timeline necessary to support data sharing, storage, and management for at-scale implementation.

Data Limitations and Constraints

Challenges and Lessons Learned: The team was limited to public data after the projects Primary Investigators determined that PHI data from Riverside Health would not be shared with project partners until Stage 2 implementation due to privacy considerations. The data sets used included census tract data from the CDC's PLACES data set which contained statistics on health outcomes. Census.gov block-level data was also used to retrieve basic demographics such as sex, age, and race. While the PLACES data set had statistics on health outcomes related to hypertension, the census tract scale made it difficult to determine where the communities with higher hypertension were located. The census block level data, while limited

to basic demographic information, was at a much finer scale, allowing the team to pinpoint target communities. The team analyzed the efficacy of building footprints but were limited by the accuracy of residential vs commercial properties. Initial modeling developed was validated and refined during Stage 1 and will continue in Stage 2.

Sampling Constraints: Operational scalability in Stage 1 limited the volume of enrolled patients, which prevented a sufficient sample size needed to determine impact to health outcomes. The duration of the Stage 1 period of performance is also insufficient to measure impact to health outcomes as results typically requires two to three years post implementation. Scaled up operations will be needed to enroll a statistically significant sample population to study the impact on chronic conditions. A limited data collection period will also be an important factor in the design of Stage 2, to ensure that meaningful post-implementation data can be obtained. Partnerships with additional retail pharmacies within the region will also help to provide a more robust sample size for health outcome impact studies.

Deployment Readiness: To expand the modeling and simulation in Stage 2, Riverside will provide more baseline data related to individual residents in the community. This should pinpoint any access issues within the community. For a more precise computation, seven pharmacy locations will be used for the Stage 2 analyses. Additional baseline data will be compiled for health outcomes and medication adherence utilizing Riverside's patient level data. The team has confirmed data availability for the anticipated at-scale baseline data, as well as the impacts that could be realistically measured in a short timeframe. The at-scale project plan and timeline will reflect in-progress evaluations of potential impactful baseline data.

Health Outcomes Studies

Challenges and Lessons Learned: Data on the health impact of this project will take 2-3 years or more to track. Community impact is expected to include improvements in the health outcomes of a large percentage of the Eastern Shore population. Specifically, improved access to medications will translate to better compliance, which will ultimately lead to fewer emergency room visits and future health complications. In a population that struggles with heart health, obesity, diabetes, stroke, and COPD, this project has the potential to make a significant positive impact on its residents.

Deployment Readiness: The anticipated outcomes for Stage 2 include increased patient adherence and improved health outcomes. Chronic conditions planned to be studied as part of the initial health outcomes studies include medications to treat hypertension, diabetes, stroke, high blood cholesterol, and heart disease. Separate studies to be set up to study health outcomes based on the chronic conditions identified.

In order to track transportation and access benefits, the patient level data needed will require a very secure yet manageable Data and Analytical approach. This will be incorporated into the Stage 2 Data Management Plan. Additionally, the project's prescription enrollment process will

include completing Riverside's social determinants of health screening for each qualified patient and this data will be stored in Epic. For self-reported adherence measures, the team will use a survey at enrollment then at additional periods after enrollment (e.g. 1 year, 2 years, 3 years) and use a modified ARMS scale that focuses on transportation-related adherence issues.

For expanded data modeling and simulations, it is recommended that the All Payer Claims Data is purchased. This data set can be loaded into Riverside's analytic environment (using Hex). Riverside will house the data given the sensitivity of the data and access will be provided to ODU's analysts after a Business Associate Agreement (BAA) is executed with the organization and individually for students and non-employees. Riverside will have the ability to create customized views based on agreed upon analyses restricting data that is not relevant to the studies safeguarding PHI. Additionally, an oversight committee will be formed and meet regularly to ensure all parties are aware of how the data is being used. Riverside is continually working to reduce and eliminate data transfers across the board to ensure the information remains secure.

COMMUNITY AND PUBLIC OUTREACH

Patient Enrollment

Challenges and Lessons Learned: Stage 1 enrollments involved one-on-one, real-time verbal communications. This was effective in explaining the benefits of the project to the first enrollees, before the general public became more aware of it through the team's publicity efforts. One-on-one communications were appropriate for the small scale of patients in Stage 1. Some of the potential enrollees had already heard about the project through the media, and the vast majority were enthusiastic.

Patient enrollment in trial deliveries was impacted by geographic limitations (patients had to live within two miles of the distribution hub at the hospital), as well as difficulty contacting a large number of eligible patients by phone. Enrollment during Stage 2 can be improved with a widened geographic area and the adoption of the marketing strategy outlined in this report.

Deployment Readiness: In order to automate and make efficient enrollment and delivery notifications, Stage 2 implementation will require adding an enrollment coordinator to the project team and CRM software for outbound patient communications. The most effective outreach to this demographic will likely be a direct referral to an enrollment coordinator from the patient's physician, whom they trust. The use of an enrollment coordinator and collaboration with providers at primary care locations will be essential to early program enrollment.

Ideally, there will be several routes by which patients can enroll, including a consultation with an enrollment coordinator, the online patient portal, Riverside's website, and the call center. The enrollment software selected will also allow for the automated capability to determine eligibility by type of drug, distance from hub, and geographic suitability (power lines, trees, etc.).

Identifying a CRM software platform to handle these tasks will be a focus of scaling up. Riverside's current electronic health records (EHR) CRM will not handle this need currently. A requirement of the CRM will be it can integrate with both EHR and the patient portal. Riverside's patient portal and website administration teams will be involved in selecting the appropriate software that can meet these needs. For inbound inquiries, Riverside has a call center that can address questions in real time.

Public Awareness, Acceptance and Market Capture

In the 15 months that information has been disseminated to the community about this project, the majority of conversations continue to elicit excitement. Likewise, results from a social media campaign that included a survey of acceptance attitudes, have also been very positive.

The project team targeted outreach to local small plane pilots in order to gain their approval. Initially, pilots had many questions about air traffic and threats to their aircraft. Those questions were answered to the pilots' satisfaction. Meetings with the pilot community, as well as the Board of Supervisors and other community groups, all provided positive support for the project. Continued communication was also suggested to ensure public acceptance.

Deployment Readiness: Rising acceptance by the community will be measured using surveys via social media. Data will be measured against the June 2024 survey. The project's Communications subcommittee will deploy a marketing strategy to continue to educate the community on the project's progress and benefits. Marketing efforts will focus on the identified audiences outlined in Public Outreach and Communication section of this report. As the project scales up, word-of-mouth from satisfied enrollees will spread quickly and provide a credible endorsement to drive enrollments in Stage 2. Riverside Health will also launch a series of targeted marketing efforts designed to resonate with the intended audience.

Stage 2 Enrollment and Community Engagement Collateral

As the program moves forward, a new suite of collateral materials will be developed, designed specifically to encourage patient sign-ups, increase community acceptance, and ensure seamless integration into daily health care routines. These materials will have a distinct look, feel, and messaging tailored for patient outreach and enrollment.

Patient Education & Enrollment Kit – Distributed to individuals enrolling in the service, to include:

- Informational brochures detailing the delivery process, safety protocols, and FAQs.
- Links to instructional videos explaining what to expect.

Doctor/Nurse/RHS Staff Education Kit – Designed for health care professionals who are enrolling patients or promoting the program, to include:

- Detailed descriptions of the drone delivery process and safety measures.
- FAQs and a user survey for feedback.

- Enrollment details and contact information for the enrollment coordinator.

Direct Communication Pieces:
- **Direct Mailers** – Sent to potential patients to explain the benefits of drone delivery and address common concerns.
- **Patient/Resident Newsletters** – Monthly email updates featuring success stories, program developments, and answers to frequently asked questions.

Indirect Communication Pieces:
- **Radio Advertising** – Paid ads and interviews on local stations to raise awareness and promote enrollment.
- **Print Advertising** – Paid ads in local newspapers and newsletters to reach community members.
- **Billboards** – Strategically placed ads along the main highway and in town to encourage program participation.
- **Promotional Items** – Custom-branded binoculars for watching drone deliveries, featuring program information on the tag. These will be distributed at senior centers, clinics, churches, libraries, and community events.

With these targeted materials, Stage 2 will shift from broad awareness efforts to actively driving patient enrollments and ensuring that individuals feel confident in using the drone delivery service. The refined approach will serve to foster greater community acceptance while supporting seamless integration of this innovative health care solution.

WORKFORCE

Challenges and Lessons Learned: One of the primary challenges in rural communities is the limited number of participants engaged in new initiatives. This issue is being addressed through community engagement activities that demonstrate how emerging technology can create higher-paying jobs and encourage younger generations to remain in the areas where they grew up. Additionally, rather than replacing jobs through automation, this technology is generating new employment opportunities and industries, promoting smarter work practices, and ultimately contributing to the overall prosperity of rural communities.

Deployment Readiness:

Development of Workforce Pipeline: To ensure a sustainable workforce, A-NPDC will lead the continued effort of workforce development and implementation with support from Old Dominion University (Regions R1 University). This leadership will consist of workforce/talent development efforts for the project through a comprehensive full-pipeline approach (high school, community college, and university) developed in Stage 1. ODU will work across the entire university with entities including: the Center for Educational Innovation and Opportunity, the Aerospace Academy of the Eastern Shore (9th – 12th grades), and the Mechanical and Aerospace Engineering Department, which offers both a Certificate Program and an Interdisciplinary Minor in Uncrewed Aerial Systems. They will continue to work closely with

Eastern Shore Community College and other entities such as the eAviation and Drone Academy (https://flyairmobility.com/) and the various STEM programs offered by the Virginia Space Grant Consortium (https://vsgc.odu.edu/). This includes the subcontract task at Eastern Shore Community College (outlined in Appendix E) that will help develop the various skills needed to ensure the project can be implemented at-scale and sustained. A development plan to ensure a sustainable workforce is outlined in Appendix E.

Establishing a number of internships and new targeted trainings were determined to be more appropriate for the Stage 2 project scope. The anticipated number of new targeted training participants for a UAS Information Technology Certificate is eight students in the first cohort, three adjunct Instructors, and four interns during the Stage 2 period of performance.

Workforce Capacity (e.g., impacts on jobs): In its plan for workforce development, A-NPDC will achieve deployment readiness for Stage 2 of the project, through its partnership with the regional workforce investment board to recruit from the Eastern Shore Community College's UAS certification program. A-NPDC intends to hire six new employees. Riverside Health System plans to hire four new employees, and DroneUp plans to hire up to ten new employees. All new project employees will be domiciled on Virginia's Eastern Shore for the life of the grant. As with Stage 1, new sub-contract employees for Stage 2 will not necessarily be residents of the Eastern Shore region.

Enhancing the workforce program in Stage 2, A-NPDC plans to hold another Small Business/Disadvantaged Business Enterprise (DBE) Outreach Event at the Eastern Shore Community College in late 2025. The event's intent is to provide the tools and connections for small and minority-owned businesses to become DBE-certified suppliers for federally funded projects on Virginia's Eastern Shore. A-NPDC successfully held such an event in late 2023. With the Stage 2 application in mind, A-NPDC will again collaborate with the Virginia Department of Transportation and regional Small Business Administration officials to host the event.

Other uses of drone delivery services for the Eastern Shore include public safety, emergency medical response, and emergency management response to natural and accidental disaster events. These applications will be factored into workforce and talent development efforts implemented in Stage 1 and will carry forward into Stage 2.

PROGRAM LONG TERM SUSTAINABILITY

The factors that were evaluated in assessing opportunities for expanding the technology application include:

- **Scalability** – potential growth in proposed geographic coverage, number of patients, expansion of deliverable inventory and use cases for other meds and health supplies,

additions of key distribution centers/hubs, expansion of operational infrastructure, and expansion to other pharmacy locations.

- **Sustainability** – during and following Stage 2 operational scalability implementation does the initial business case assessment with confidence level show this new transportation delivery system can be sustained on its own by a combination of lower cost pharmacy operations, improved health outcomes that lowers healthcare costs, and paid for deliveries.
- **Geographical Operational Expansion** – while not the same as scalability this is another element to show operational benefits for others and potential future scalability. Examples for our consideration: Maryland Eastern Shore, Riverside Middle Peninsula/Gloucester, Appalachia which would demonstrate a different delivery model and environment.

Program Sustainment: Sustainability risk is expected to be low following Stage 2 completion considering several factors. These factors and risk mitigations are listed as follows:

- Growing and maintain operations will be minimized by ensuring the Grantee has the right staff, skills, abilities, and structure to ensure appropriate management of scale up expansion
- Pharmacy and flight operations workforce/talent development programs are in place to adequately scale up and sustain workforce needs.
- Pharmacy and flight operation approaches and technologies will be deployed in Stage 2 that are standardized and modular approach that will allow easy replication and expansion to other areas on the Eastern Shore of Va. and Md, other rural areas of Va., and rural areas around the country.
- Current plans and locations for hubs and flight operations can utilize and be conducted within the current FAA regulatory environment. This combined with past and planned part 135 approvals and proposed new Drone Flight regulations will only minimize scaleup and sustainability risks.
- Healthcare benefit and Business Case Modeling and simulation tools have been developed and validated to enable, prior to scalable up opportunities, a sustainability assessment to be performed. Current modeling clearly shows appropriate topography, weather conditions, airspace, demographics, and patient healthcare needs to sufficiently sustain the project.
- Sustainable funding – the team has engaged in exploratory discussions with insurers to have them pay the fee for delivery. Early discussions with non-Virginia based Medicaid plans indicated that there is an appetite for delivery fee coverage as a potential option if the program can demonstrate impact to patient health outcomes.

Expanding technology utilization with increased applications:

The team assessed community acceptance of proposed drone delivery operations via a Facebook survey conducted in the community during the POP. Of the 100 respondents, ≥79% cited “Delivery to homebound residents” and ≥65% cited “Improved access to remote or rural areas” as the top benefits of drone delivery, which aligns precisely with the proposed application to improve delivery operations, particularly for elderly patients facing transportation barriers to their nearest pharmacy. The survey also revealed the top three concerns of respondents as

“Potential for drone malfunction or accidents” (≥72%), “Safety of delivered items” (≥61%), and “Privacy Concerns” (≥45%).

A number of potential use applications were evaluated for financial and operational feasibility. Potential use cases were evaluated for factors including:

- ease of adoption,
- alignment with Proof of Concept application,
- operational barriers (non-emergent vs emergent delivery response),
- payload constraints (stability, temperature control, and time critical),
- additional geographic areas and locations,
- regulatory considerations and limitations,
- potential partnerships or collaborations required,
- population demographics,
- existing alternative or substitute products or processes,
- availability of similar or comparable adopted use cases with unmanned systems nationally and internationally.

The same infrastructure supporting the baseline case of delivering pharmaceutical medications via drone may also be leveraged for several additional use cases:

- The service time and reliability of the drone network can support the delivery of emergency medical supplies such as automated external defibrillators for patients suffering from cardiac arrest. Similar networks have been proposed to improve response times for cardiac arrest patients in North Carolina.
- Similarly, drones can be used to deliver naloxone (brand name Narcan) to patients suffering from opioid overdose. Research using EMS data from the neighboring community of Virginia Beach has shown that such a system could improve response times by more than 80%, and increase survival rates by more than 270% (Lejeune and Ma, 2024).
- Riverside Health currently uses in-house and courier services for the intra-facility transportation of blood samples and medications. In addition to delivering to patients, the drones can be used for the delivery of items across the hospital system.
- Drones can also be used to support delivery of food, grocery, and retail items of suitable size by leveraging the same infrastructure to deliver to patients. Improving access to nutritious food to address food insecurity has shown to impact health outcomes for chronic conditions that are typically associated with metabolic disturbances, poor diabetes management, chronic conditions, and complications.[1] Potential benefits of this

application within the baseline service area are supported by findings from a recent community needs assessment.

- Much of the Eastern Shore is comprised of marshes, beaches, small islands, and natural preserves that are inaccessible by paved roads. The United States Postal Service has previously posted a request for information about drone delivery to “remote/difficult delivery points.” The drone delivery platform could be used to transport medication and other goods to patients in nontraditional delivery points, such as a beach.

STAGE 1 WRAP-UP

The suggested Stage 1 solution met the goals and objectives identified in the Stage 1 proposal. The key technology validation efforts; community outreach and engagement efforts; prescription processing; and initial modeling, simulation, and data analytic efforts have all demonstrated readiness to initiate Stage 2. The goals and objectives, as well as the associated milestones, were accomplished within cost guidelines. A No-Cost Extension of the period of performance from January 2025 to March 2025 was approved to allow research papers, reports, and public outreach surveys to be fully documented. This extension also allowed for valuable feedback from the Stage 2 proposal to ensure a comprehensive Final Implementation Plan report. Finally, all modeling and simulation efforts have adequately demonstrated the risks associated with scalability and sustainability in Stage 1. The project proposal deviations are identified in Appendix A.

The Stage 2 proposal balances and optimizes expanded medical package deliveries within current FAA guidelines. It also allows for more refined modeling, simulation, and data analytics to continue while selective waivers and formal approvals are secured for BVLOS deliveries and initiation of at-scale operations. This phased crawl, walk, run approach requires all stakeholders to work together throughout Stage 2 to ensure success. Finally, the proposed Stage 2 approach will allow the team to begin the early collection of data to validate key metrics associated with patient and operational benefits pertaining to safety, reliability, access, sustainability, and partnerships.

A summary of the Stage 1 project implementation achievements include:

- Received valuable input from the FAA team on the overall project.
- Participated in discussions with the FAA UAS Operations team re: safety and compliance, with a focus on UAS transport of medical packages, including medications and blood draws. Received approval for project, with no additional issues. Standard DOT hazardous Materials Classification and Review processes will be followed.
- Finalized Demo #1 planning which included patient delivery candidates and approvals; hospital procedure process documents; drone operation procedures; medicine chain of custody tracking notifications to pilot, community, and regional airport; delivery verifications; and metrics tracking.

- Set a date of 10/3/2023 for Demo #1 – Drone delivery of medications to patients.
- Conducted two medicine delivery flight demonstrations to several patients within the 1–3-mile delivery radius. All flights were successful.
- Tests showed the need for additional flight validation tests in the 3–5-mile range before the 17-mile flight to Tangier Island.
- Initiated Data and Analytics Team work to begin modeling and simulation efforts and prototype data approach, as well as initial modeling and simulations, including business case analysis, to ensure sustainability for Stage 2.
- Completed lease agreement with Swoop Aero for the long-range UAS platform to support Tangier Island Flights.
- Completed Eastern Shore regional altitude-based ADS-B flight history assessment and gathered other key inputs necessary to submit 3-5 Mile BVLOS Waiver to FAA UAS Compliance.
- Conducted two additional medicine delivery flight demonstrations to several patients within the 1–3-mile delivery radius. All flights were successful.
- Completed updates to the project's Data Management Plan and successfully answered questions from DOT SMEs related to the previous project accomplishment report (Oct. – Dec. 2023) regarding DMP and NASA Wallops' planned testing.
- Took delivery of Swoop Aero Kite B UAS and successfully conducted short-range flight tests.
- Finalized all agreements and test plans, as well as all approvals with NASA Wallops in order to conduct long-range flight testing within NASA's controlled air space.
- Tested built pilot operational efficiency with new long-range Swoop Kite UAS, as well as scalability and cost effective Detect, Sense and Avoid Technologies.
- Submitted and obtained approval from the FAA UAS Compliance for 3-5 Mile BVLOS flights.
- Submitted and obtained approval for BVLOS Test and Demonstration flights to Tangier Island.
- Completed several flights in June of 2024.

APPENDIX

APPENDIX A. PROJECT PROPOSAL DEVIATIONS

Proposal Deviations:

- Adjusted initial metrics, goals, and objectives, based on demonstration flights and fitting into FAA regulations and approvals.
- Added, at no cost, additional longer-range flight tests to validate selected BVLOS Aircraft performance at NASA Wallops.
- Added, at no cost, a USDOT SMART Grant demonstration and press event.
- Provided, at no cost, support to other Stage 1 Smart Grant recipients.
- Updated Stage 1 evaluation questions and metrics based on data availability and research findings, original evaluation questions listed in Appendix B.
- Received DOT approved no-cost period of performance extension to allow for project documentation to be completed, including all results from the project modeling, simulation, and business case analytics. Also allowed additional time to assess feedback from the Stage 2 proposal evaluation process.

APPENDIX B. STAGE 1 EVALUATION QUESTIONS

Stage 1 Evaluation Plan: Proof-of-Concept evaluation questions, performance measures and performance measure targets

	Stage 1 Evaluation Question	Performance Measure	Performance Measure Target	Outcome
1	What is the community engagement or awareness of Drone Medical Delivery for Healthcare, Public Safety Applications, and Emergency Response?	Number of focus groups engaged, conference speaker engagements, demonstration events, and address concerns with pilot focus group	3-5 applicable conferences, speaker engagements, focus groups or demonstrations per quarter, meetings with ACR-Airport	Exceeds target
		Public outreach engagement numbers on partner's social and media pick-ups for social media (impressions, likes, comments, shares and clicks), project website (users/sessions, time on page, bounce rate), and PR (active coverage, circulation, online reach and EMV (Estimated Media Value))	Increase from Stage 1 baseline	Exceeds target
2	What is the feasibility of establishing integrated endorsement of routine operational use of drones for this application?	Number of endorsing stakeholders across industry, academia, state and local government/interest with community partners	Target quantity of three letters of support and evaluation analysis of a multistate multi-path operational proposal	Met target
3	Engage key locality stakeholders, potential beneficiaries and federal approvers to obtain their advocacy and support	Applicable waivers for Stage 1 and 2 operational applications	Approved FAA BVLOS waiver and board of pharmacy approval	Met target
4	Has the right application of drone delivery and unmanned autonomous systems innovation been identified as an operationally sustainable and community accepted solution to improve delivery?	Number of potential use applications evaluated for financial and operational feasibility	Stage 1 Implementation Report	Met target
5	How can public safety and emergency medical services be integrated to obtain meaningful input?	Number of engagement opportunities such as demonstrations, focus groups and conferences with applicable subject matter experts	1-2 applicable conferences and speaker engagements per quarter	Exceeds target

6		Number of short, medium and longer-range demonstrations conducted/ number of flights demonstrating varying distances of medical delivery contents	5-15 flights demonstrating varying distances of medical delivery contents	Exceeds target
	What would be key process and operational changes that will need to be revised to accommodate this method of medical delivery?	Operational feasibility of drone technology by distance	Outlined ConOps for Stage 1a VLOS, 1b BVLOS, and 1c Shore Memorial to Tangier Island	Met target
		Number of trial drone deliveries of medical supplies (hypertensive medicine) to enrolled patients' locations	Medical package delivery to 3-10 enrolled patients	Met target
		Operational process mapping and gap analysis of technology integration by use case application	Application process maps of current and proposed workflows	Met target
7	How to ensure all stages of this work will be compliant with human subjects research protections, including HIPAA, for data collections, analysis, storage, and communications about the work?	Review of appliable privacy, compliance and IRB boards	Approval of applicable boards or agencies	IRB approval required for Stage 2 of project
8	How to ensure a sustainable workforce is developed to support Stage 2, and beyond operations?	Number of events for public engagement activities including; demonstrations, educational briefings at local schools, opportunities to fly a drone, etc.	1-3 educational events with relevant attendees	Met target
		Number of internships established of new targeted training/ project participants	1-3 number of available and accepted internships	Target more in line with Stage 2 project scope
~~9~~	~~What would be the key routes, corridors and hubs for extended range and duration operations?~~	Number of population demographics, location and routing characteristics evaluated	Analysis of the service area of potential locations	This question was removed and replaced with the Evaluation Question: To what extent are the methods developed in this project scalable and adaptable to other regions or contexts?
10	How can the probability of compliance be increased to access and optimize	Number of data and demographic variables evaluated to identify which clusters of patients meet the optimal inclusion criteria to	Established selection criteria for patients who have a strong	Met target

	who would receive medical deliveries?	optimize patients served and health outcomes	probability of adherence	
11	How can risks be minimized when implemented and operational?	Number of flights with air space monitoring	Track # of incursion incidences during 1-5 BVLOS flights	Exceeded target
12	Project Performance Metrics	Transport Times & Ground Comparisons	Data tracked for 5-15 flights	Exceeded target
13	Project Performance Metrics	Process turnaround times for refilling patient medications and scheduled delivery	Within 1 week	Met target

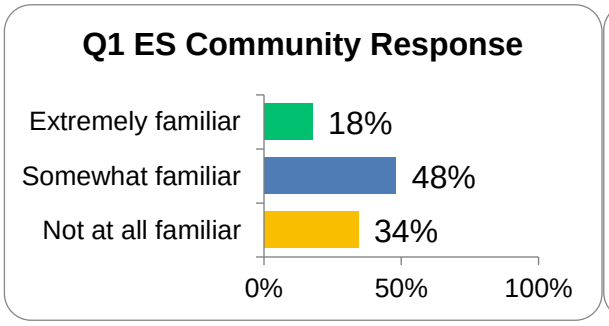
APPENDIX C. CONSUMER PERCEPTION SURVEY RESULTS

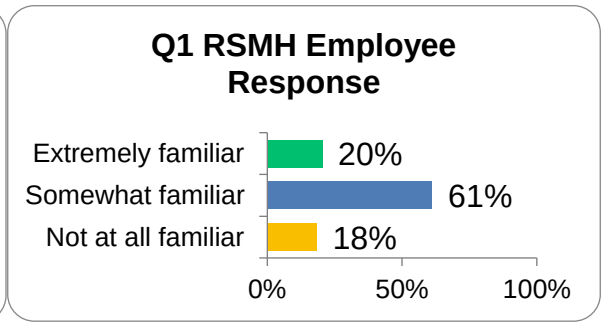
Survey: Consumer Perception of Using Drones for Medicine and Health Supplies Delivery

Overview: Two surveys were conducted between June 13 and June28, 2024 using two sample populations—residents from the Eastern Shore (ES) community and employees from Riverside Shore Memorial (RSMH). The survey was distributed by a direct link in an email to RSMH employees, and by a link on the RSMH Facebook page for community members to access. There were 102 responses from the community survey and 98 responses from the RSMH employee survey. There were six questions and one open-ended question, along with a section for comments on both surveys. The raw data is available in the project repository.

Note: Duplication of responses between the two groups surveyed could not be determined.

Q1: How familiar are you with the concept of using drones for delivering medicine and health supplies?

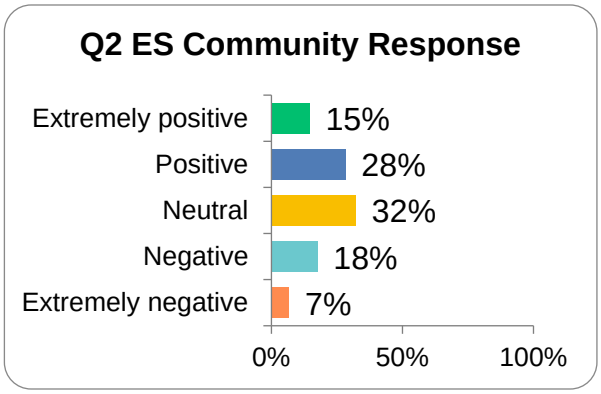


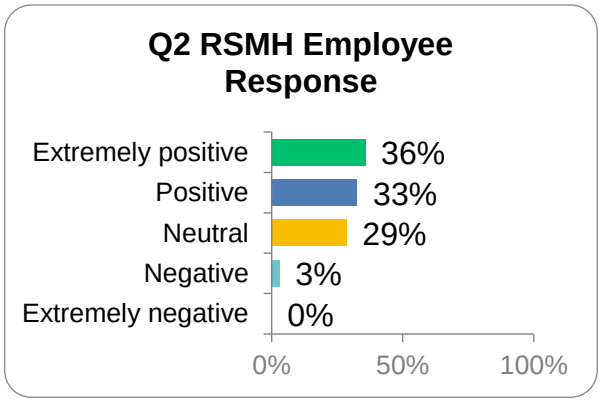


Q1. Eastern Shore Community Survey Results: Answered: 102 Skipped: 0

Q1. RSMH Employee Survey Results: Answered: 98 Skipped: 0

Q2: What is your initial reaction to the idea of using drones for delivering medicine and health supplies

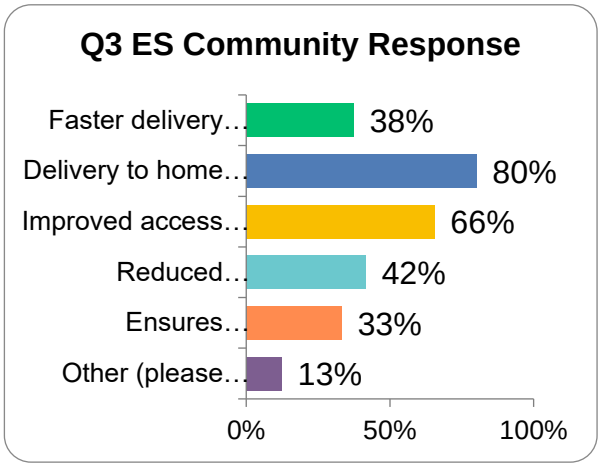


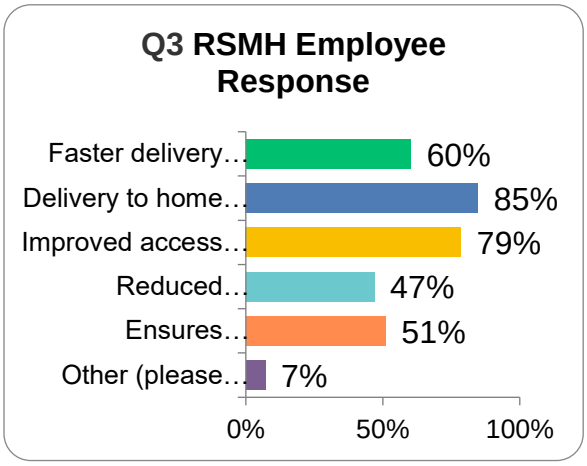


Q2. Eastern Shore Community Survey Results: Answered: 102 Skipped: 0

Q2. RSMH Employee Survey Results: Answered: 98 Skipped: 0

Q3: What potential benefits do you see in using drones for delivering medicine and health supplies? (Select all that apply)

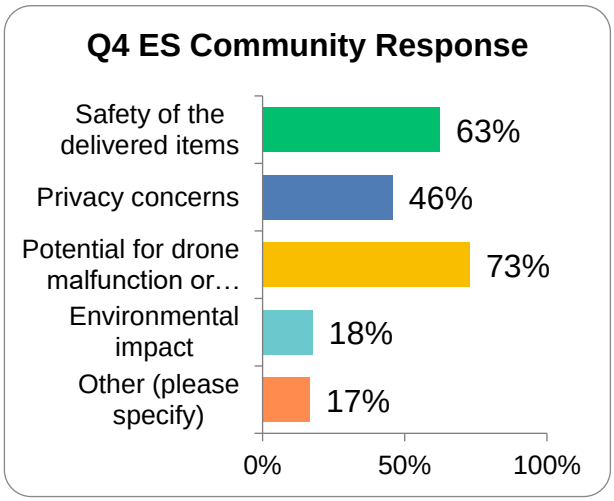


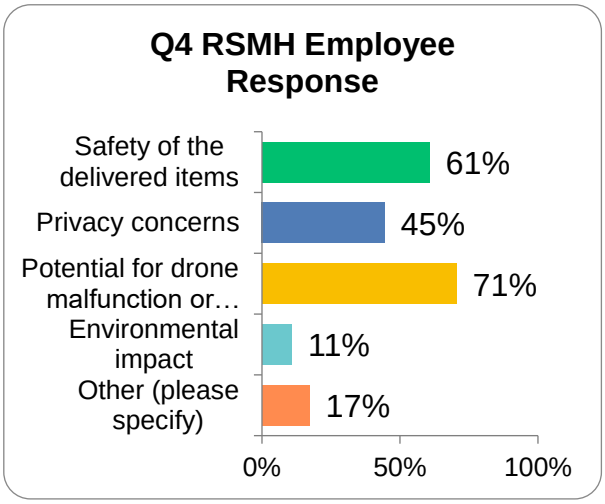


Q3. Eastern Shore Community Survey Results: Answered: 96 Skipped: 6

Q3. RSMH Employee Survey Results: Answered: 98 Skipped: 0

Q4: What concerns do you have, if any, regarding the use of drones for delivering medicine and health supplies? (Select all that apply)

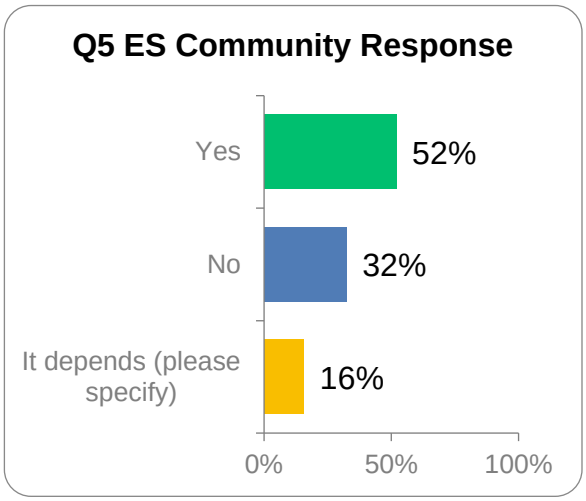


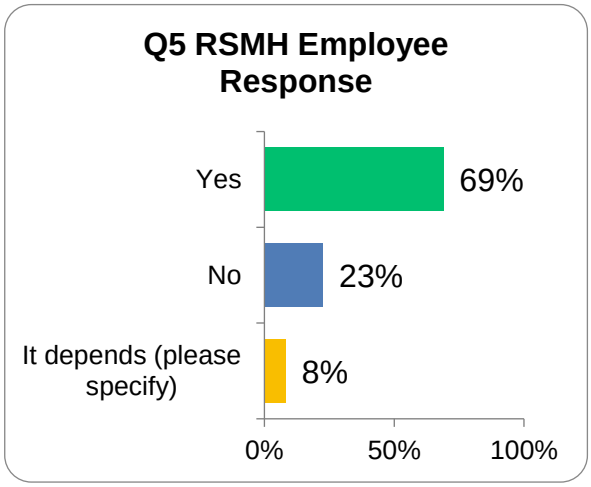


Q4. Eastern Shore Community Survey Results: Answered: 96 Skipped: 6

Q4. RSMH Employee Survey Results: Answered: 92 Skipped: 6

Q5: Would you be comfortable receiving medicine or health supplies delivered by a drone?

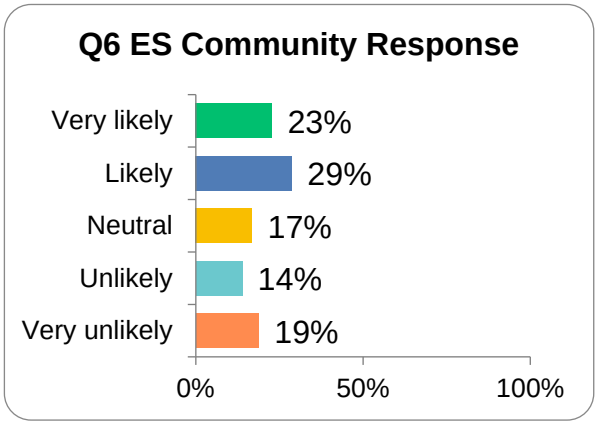


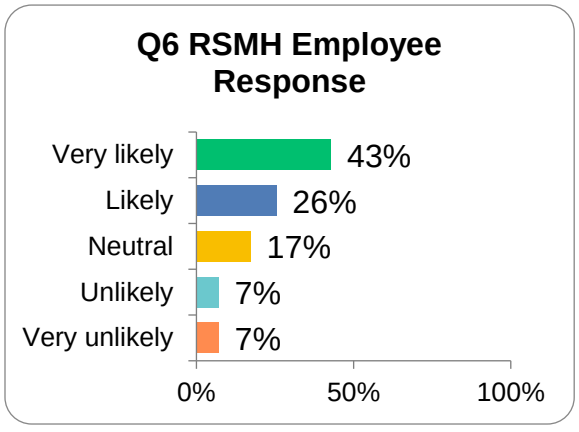


Q5. Eastern Shore Community Survey Results: Answered: 102 Skipped: 0

Q5. RSMH Employee Survey Results: Answered: 97 Skipped: 1

Q6: How likely would you be to use a service that offers drone delivery of medicine and health supplies, assuming all safety and privacy measures are ensured?





Q6. Eastern Shore Community Survey Results: Answered: 101 Skipped: 1

Q6. RSMH Employee Survey Results: Answered: 98 Skipped: 0

APPENDIX D. DRONE DELIVERY PROGRAM EXIT SURVEY RESPONSES

Three of the five patients enrolled in the drone-delivered medication trial program provided feedback at the conclusion of the program in January 2025.

1. How would you rate the overall reliability of the drone delivery service? (Options: Very Reliable, Reliable, Neutral, Unreliable, Very Unreliable)

- Patient 1: Very Reliable
- Patient 2: Very Reliable
- Patient 3: Reliable

2. Do you feel this service improved your access to necessary medications? (Options: Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree)

- Patient 1: Strongly Agree
- Patient 2: Strongly Agree
- Patient 3: Strongly Agree

3. What was the most convenient aspect of using the drone delivery service?

- Patient 1: I loved seeing the package on the front stoop and the whole concept. My neighbors were impressed.
- Patient 2: That I don't have to go and pick it up.
- Patient 3: Arrives at your door.

4. Did you experience any issues with enrollment or delivery during the program? If so, were these issues resolved to your satisfaction once Riverside was made aware of them?

- Patient 1: No issues.
- Patient 2: No issues.
- Patient 3: There were 1 or 2 hiccups in the beginning but not in a while and yes they were resolved to my satisfaction.

5. Did your prescription(s) arrive damaged?

- Patient 1: Everything was intact. No damage even in the rainy/snowy weather.
- Patient 2: No damage.
- Patient 3: Arrived intact

6. Did you feel the level of communication from the program was appropriate? (Options: Too Much, Just Right, Too Little)

- Patient 1: Just right
- Patient 2: Just right
- Patient 3: Just right

7. If this service were offered permanently, would you be interested in signing up? Why or why not?

- Patient 1: Yes because it was efficient.
- Patient 2: Yes. Very convenient.
- Patient 3: Yes probably.

8. If there were a fee for this service, what is the maximum amount you would feel comfortable paying per delivery?

- Patient 1: Not sure. I'm able to travel to a local CVS.
- Patient 2: $15-$20
- Patient 3: Not a lot because I can drive.

9. What suggestions do you have for improving the drone delivery program in the future?

- Patient 1: I think the program is great! There are areas on the Eastern Shore that are more isolated and more elderly patients that are shut in so they should be the next target.
- Patient 2: No improvement needed. It was cool because you don't see that every day.
- Patient 3: Don't have any.

10. Would you recommend this service to others in your community? Why or why not?

- Patient 1: Yes definitely. It was very contemporary way of delivery.
- Patient 2: Yes. Very convenient.
- Patient 3: Yes

11. Did the service meet your expectations for delivery speed and timing? If not, what could have been improved?

- Patient 1: Yes it met my expectations.
- Patient 2: Yes it did.
- Patient 3: Yes

APPENDIX E. WORKFORCE DEVELOPMENT

DOT SMART Grant (200390-010) WF Workforce Development Plan with Subcontract Task to ESCC

To better target a potential workforce within the service area, an expanded curriculum was developed with ESCC through a Stage 1 subcontract task as outlined below. This increased the robustness of the current drone training program (FAA Part 107) typically offered twice a year. It also developed a "blueprint" for an expanded program covering multiple aspects of drone operations (e.g., operations, maintenance, and repair) that could lead to a certificate program.

Stage 1 Subcontractor Tasks/Deliverables:

- Purchased additional drones, and other equipment as needed, to support an expanded, more comprehensive development program.
- Conducted a focused effort to expand the current student pool for the existing and potentially expanded program through:
  - A focused recruitment effort with Tangier Island residents.
  - Community engagement/demo days at the college, as well as the schools in Northampton and Accomack counties, and local private schools.
  - Internship opportunities with the local/regional industry, coordinating/leveraging Virginia Space Grant Consortium programs where appropriate.
- Developed the “blueprint” for an expanded program, to include specific course content, required budget, faculty, and number of students for a certificate program.

Budget*:*
The final budget for this task was $15,625 split between course development ($8,438) and supplies ($7,187)

Proposed curriculum:
Program Name: Information Technology Certificate (Unmanned Aerial Systems)

	Class	Description	Credit Hours
First Term			
	SDV 100/101	Orientation	1
	UMS 107	FAA Licensing	2
		(FastForward Class – Credit for Prior Learning)	

UMS 111	Small Unmanned Aircraft Systems	3
	Subtotal:	6

Second Term

ITN 101	Network Concepts	3
UMS 177	Drone Components & Maintenance	3
IND 137	Team Concepts & Problem Solving	3
	Subtotal:	9

Third Term

ENG 115	Technical Writing	3
GIS 200	Introduction to GIS	3
UMS 120	Drone Imaging	3
	Subtotal:	9

Fourth Term

ETR 167	Logic Circuits	3
UMS 190	Mapping & Surveying	3
UMS 211	Mission Planning & Operations	3
	Subtotal:	9
	Total Credit Hours	33

APPENDIX F. STAGE 2 SUMMARY BUDGET NARRATIVE

Budget Narrative for At-Scale Implementation: the funding necessary for an at-scale implementation of this project in Stage 2 is as follows:

Budget Breakdown by Critical Team Members

A-NPDC: $2,754,975

- $1,466,905 Personnel (grant administration, project management, coordination, public outreach, safety and risk management, workforce and education)
- $385,649 Fringe Rate 26.29%
- $20,000 Travel (USDOT conferences and local events and meetings)
- $3,000 Supplies
- $3,000 Equipment (Computer for project staff)
- $60,000 Other (Training, Title VI, Contingency)
- $816,421 Indirect Cost Rate 44.07%

Riverside Health Systems: $2,387,171

- $1,283,292 Labor (operational development, IT integration, logistics)
- $333,656 Fringe
- $72,773 Travel (public outreach, conferences)
- $321,680 Supplies (community engagement, program publications)
- $64,400 Equipment
- $311,370 Indirect costs (15%)
- $2,387,171 Total

Old Dominion University: $879,798

- Labor: $434,076
- Fringe: $177,922
- Travel: $26,000
- Supplies: $15,000
- Equipment: $30,000
- Contract Services: $25,000
- Indirect (30.3%): $171,800
- Total: $879,798

DroneUp: $ $8,962,919

- $2,518,752 Labor
- $793,407 Fringe
- $1,101,683 Supplies
- $3,795,000 Equipment
- $80,000 Travel across all three years
- $674,076 Indirect (15%)
- $8,962,919 Total

Total Project Funding Request:

- Total: 14,984,863 over a 3-year period
- Summary of How Funds Will Be Spent
- Personnel: Accounts for a significant portion of the budget across all partners.
- Fringe Benefits: Range from 26-32% among the four partners.
- Travel: Includes travel to USDOT meetings, and frequent travel across the Chesapeake Bay Bridge Tunnel during project implementation.
- Equipment: Primarily covers drone and related equipment.
- Supplies: Budgeted for drone parts, consumables, mobile infrastructure, pharmacy supplies, and packaging.
- Contractual: Includes $8,962,919 for DroneUp's equipment procurement and engineering labor, $2,387,171 for Riverside's personnel and operational costs, and $879,798 for ODU's project management and data analysis.
- Other: Public outreach, including hearings, demonstrations, and training sessions, with Title VI training by A-NPDC.
- Indirect Charges: Negotiated rates with federal departments, with Riverside and DroneUp applying a 15% minimum rate excluding equipment.

APPENDIX G. REFERENCES

A comprehensive list of data sources used for the modeling and simulation are outlined in the Data Management Plan located on https://dmptool.org/, https://doi.org/10.48321/D1F723D6D2

The data generated from this project is available in the project data repository: https://dataverse.harvard.edu/dataverse/DroneDOTSMART, https://doi.org/10.7910/DVN/GETYAP

Works Cited:

Amanda Nguyen, Ph.D, Jeroen van Meijgaard, Ph.D, Sara Kim, MS, and Tori Marsh, MPH, "Mapping Healthcare Deserts", The GoodRx Research Team, Sep. 2021, https://assets.ctfassets.net/4f3rgqwzdznj/6iU4VnrKD1eIDthc7i1hcl/2d42cfeb3e24e897f281eebfc7708eab/Healthcare_Deserts_Sept_2021.pdf

ATA, Hampton Roads Advanced Air Mobility (AAM) Service Enablement Assessment, 30, June 2023, John S. Eberhardt and Scott Drew, https://visaatodu.org/projects/hampton-roads-aam-service-enablement-assessment/

Board of Pharmacy, Alternative Delivery of Prescriptions in Virginia, Guidance Document: 110-3, September 16, 2021. https://townhall.virginia.gov/l/GetFile.cfm?File=C:\TownHall\docroot\GuidanceDocs\223\GDoc_DHP_1333_v6.pdf

Chen, Y.-H., El-Adle, A. M., O'Brien, K. J., Wentworth, T., & Richter, H. G. (2025). Drone-Based Medication Delivery for Flood-Prone Coastal Communities. Manuscript submitted for publication.

Clark, Christine. "Launching a Hospital Pharmacy Drone Delivery Service for Underserved Communities - Medical Update Online." Medical Update Online, 17 Feb. 2025, medicalupdateonline.com/2025/02/launching-a-hospital-pharmacy-drone-delivery-service-for-underserved-communities/. Accessed 15 Mar. 2025.

Clark, Christine. "Launching a Hospital Pharmacy Drone Delivery Service for Underserved Communities – Pharmacy Update Online." Pharmacy update.online, 2024, www.pharmacyupdate.online/launching-a-hospital-pharmacy-drone-delivery-service-for-underserved-communities/. Accessed 15 Mar. 2025.

Cornell, A., Riedel, R., Liu, C., Brown, R., & Ramos, T. (2024, October 1). Consumer views of drone delivery: How soon can you get here? McKinsey & Company. https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/future-air-mobility-blog/consumer-views-of-drone-delivery-how-soon-can-you-get-here

2022 Community Health Needs Assessment and Implementation Plan Executive Summary, Riverside Health System, https://www.riversideonline.com/-/media/about/community/comm-health-needs-assessments-docs/rsmhchnaexecsummaryfinal122122.ashx

2023 CHNA Exec summary and implementation plan https://www.riversideonline.com/-/media/about/community/comm-health-needs-assessments-docs/rsmhchnaexecsummaryfinal122122.ashx

Eastern Shore Health District Community Health Assessment 2023 – 2024 Accomack County Northampton County, Eastern Shore Health District, Virginia Department of Health, https://www.vdh.virginia.gov/content/uploads/sites/78/2024/04/ESHD-CHA-2023-2024.pdf

Eastern Shore Health District. (2024). Community health assessment 2023–2024: Accomack County, Northampton County. Virginia Department of Health. https://www.vdh.virginia.gov/content/uploads/sites/78/2024/04/ESHD-CHA-2023-2024.pdf

Federal Aviation Administration. (2023). *FAA Order 8040.4C: Safety risk management policy*. U.S. Department of Transportation. Retrieved from https://www.faa.gov/documentLibrary/media/Order/FAA_Order_8040.4C.pdf

Health Resources & Services Administration. “MUA Find.” Hrsa.gov, 2019, data.hrsa.gov/tools/shortage-area/mua-find.

Hildebrand, Walter. “VB Company Demonstrates Drone Delivery.” WAVY.com, 27 Mar. 2024, www.wavy.com/news/business/vb-company-demonstrates-drone-delivery/. Accessed 15 Mar. 2025.

High Need Mapping Tool, Health Resources and Services Administration, https://data.hrsa.gov/maps/high-need-mapping-tool/

Kaplan, David. “New Program Tests Delivering Medications via Drone in Rural Virginia.” FOX 5 DC, 26 Feb. 2024, www.fox5dc.com/news/new-program-tests-delivering-medications-via-drone-in-rural-virginia.

Kidd, Beverly. “Testing Prescription Med Delivery by Drone on the Eastern Shore.” News 3 WTKR Norfolk, 28 Feb. 2024, www.wtkr.com/PositivelyHR/service-that-delivers-prescription-meds-by-drone-tested-on-the-eastern-shore. Accessed 15 Mar. 2025.

Kleinsinger, Fred. “The Unmet Challenge of Medication Nonadherence.” The Permanente Journal, vol. 22, no. 18-033, 5 July 2018, www.ncbi.nlm.nih.gov/pmc/articles/PMC6045499/, https://doi.org/10.7812/tpp/18-033.

Legislative Information System, Virginia Administrative Code, 18VAC110-20-275. Delivery of Dispensed Prescriptions, June 2025. https://law.lis.virginia.gov/admincode/title18/agency110/chapter20/section275/

Look, K. A., & Stone, J. A. (2018). Medication management activities performed by informal caregivers of older adults. Research in social & administrative pharmacy : RSAP, 14(5), 418–426. https://doi.org/10.1016/j.sapharm.2017.05.005

PLACES: Local Data for Better Health, County Data 2024 release, Centers for Disease Control and Prevention, https://data.cdc.gov/500-Cities-Places/PLACES-Local-Data-for-Better-Health-County-Data-20/swc5-untb/data_preview

Chronic Disease Prevalence in Virginia, Virginia Department of Health, https://www.vdh.virginia.gov/data/chronic-disease-in-virginia/prevalence/

Riverside Shore Memorial Hospital 2019 Community Health Needs Assessment, Riverside Health System, https://www.riversideonline.com/-/media/about/documents/rsmh-2019-chna-final-sept-2019.ashx

URSA, Hampton Roads Virginia Airspace Analysis, October 22,2023, Ryan Wallace and David Kovar, https://vipcorg.app.box.com/s/3kbzf30vhjgy8ea4qyman9o57pafs8d8

U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, Transporting Infectious Substances Safely, https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/2024-04/Transporting-Infectious-Substances-Safely-PHH50-0186-0622.pdf

U.S. Postal Service Office of Inspector General. (2016). Public perception of drone delivery in the United States (Report No. RARC-WP-17-001). U.S. Postal Service. https://www.uspsoig.gov/sites/default/files/reports/2023-01/RARC_WP-17-001.pdf

Valliant, S. N., Burbage, S. C., Pathak, S., & Urick, B. Y. (2022). Pharmacists as accessible health care providers: Quantifying the opportunity. Journal of Managed Care & Specialty Pharmacy, 28(1), 85–90. https://doi.org/10.18553/jmcp.2022.28.1.85

Virginia Department of Health. (2023). Chronic disease prevalence in Virginia. Virginia Department of Health. Retrieved March 15, 2025, from https://www.vdh.virginia.gov/data/chronic-disease-in-virginia/prevalence/

“Virginia Adult Health Survey - BRFSS.” BRFSS, 21 June 2024, www.vdh.virginia.gov/brfss/.

Virginia Geographic Information Network, Virginia Department of Emergency Management, https://vgin.vdem.virginia.gov/

“WBOC News at 6 - February 26, 2024.” WBOC TV, 26 Feb. 2024, www.wboc.com/news/latest-newscasts/wboc-news-at-6---february-26-2024/video_ab88d19a-4e8f-52ca-9fd6-dabea6428a57.html. Accessed 15 Mar. 2025.

Laraia BA. Food insecurity and chronic disease. Adv Nutr. 2013 Mar 1;4(2):203-12. doi: 10.3945/an.112.003277. PMID: 23493536; PMCID: PMC3649100. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3649100/