Final Implementation Report

V. 1.0

30 June 2026

Emergency Life Saving through Multi-Modal Mobility (ELSa-M3)
Southern Alleghenies Planning & Development Commission
USDOT SMART Contract 69A3552441031
Fiscal Year 2023 Stage 1 Award
Fiscal Year 2024 Performance
Period of Performance: July 1, 2024 – January 31, 2026

Report Prepared by: SAP&DC, Aerium, Inc., and ATA Aviation

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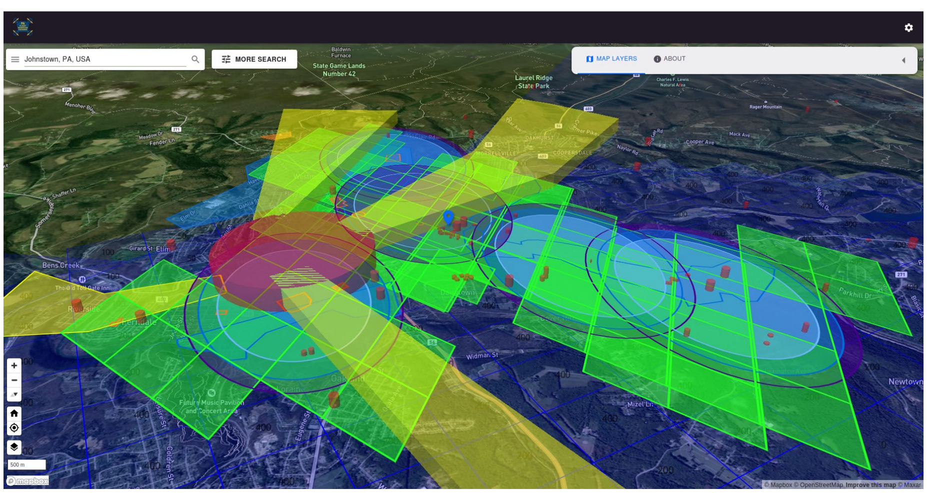
1 Executive Summary

Deployment of the Stage 1 system was fully successful, with a fully functional system that supports direct dispatch of emergency medical delivery via drone. We were able to conduct over 100 shakedown and test flights, including 52 test delivery flights for data collection. 29 of these resulted in successful test delivery, an overall success rate of 56%. Combined with the rate of serviceable calls, we estimate that a regional emergency medical delivery program could reduce harm to over 2,000 individuals per year in the SAP&DC region.

ELSa-M3 used a contractor to provide initial UAS logistics services as a mechanism to accelerate entry into service of the Stage 1 capability, including regulatory authorities. The contractor operated UAS was able to provide initial delivery times that are competitive with an EMS ambulance, and would arrive ahead of the ambulance 25% of the time in its current configuration. However, the UAS and software used in ELSa-M3 were sub-optimal in terms of speed of vehicle and time required to physically dispatch the unit – new commercial units have already been identified that will likely increase the UAS to arriving in advance of the ambulance 40-6 0% of the time.

The ELSa-M3 capability is supported by the Pennsylvania Flight Information Exchange, which provides shared airspace awareness across project participants and other airspace participants through groundspace configuration data and navigation aids; a shared public airspace sensing



network; and direct integrations with the 911 dispatch system and flight control software across a system that enjoys 99.9%+ uptime, sub-second latency for airspace awareness, and automated drone tasking in 5-8 seconds. Characterization of the airspace sensing network indicates a 25 square mile coverage area where, by analyzing co-occurrence of tracks, we can detect the tracks of conventional aircraft to support procedural deconfliction with the UAS, maintaining safety. The network natively supports integration with

UAS Traffic Management services for strategic deconfliction, consistent with pending Federal Aviation Administration (FAA) Part 108 rules.

The ELSa-M3 project successfully used Stage 1 to identify efficiencies, reducing deployment times form weeks to hours during the course of the project, and identifying significant operational efficiencies that allow the system to be deployed going forward for significantly less cost than Stage 1 because of these lessons learned. Conservative go-forward cost estimates for Stage 2 deployment will cost approximately $38,750 per square mile and $24 per covered life and operating costs will be $22,440 per square mile and $14 per covered life. As a public digital services system, it is critical to keep driving down the costs of these shared services. ELSa-M3 developed a highly templatized process that can be repeated for communities around the country.

This highly cost-effective model, combined with effective intervention times and an understanding of affected cost structures has the potential to yield $16MM in annual benefit across the region in dispatch, emergency medical costs, chronic medical costs, and related new commercial services. The industry and commercial interest in the project is substantial, and has already attracted two now companies (ATA Aviation and Horizon Aerobotics) to the region. The combination of hard-dollar savings analysis and cost-effective deployment in our Stage 2 public-system deployment model can be transitioned to a revenue-neutral system in 3-5 years with an estimated internal rate of return on investment of 27%.

Key lessons learned from the ELSa-M3 project include: i) the contractor model is not a cost-effective model for staffing emergency systems in lower-volume rural areas; ii) contractor cost limitations and regulatory limitations from re-using commercial regulatory approvals resulted in a constrained service area that limited our ability to service actual calls; iii) future projects should focus on optimizing commercially available equipment for the mission rather than re-purposing existing specialty equipment. The combination of these three factors limited the effective services areas and times and, while perfectly adequate for collecting test and performance data, were not effective at supporting live public safety operations. The system performed well technically, however the staffing model and dispatch model for the particular UAS used were poorly suited to the actual operating environment.

Next steps for the ELSa-M3 project include developing more appropriate regulatory approvals with the FAA and securing transition funding that will allow the project team to bring operation of the system in-house, staffing the UAS operations with existing public safety personnel. This transition lowers the operating cost of the system and accelerates the path to revenue-neutrality and return on investment. The ELSa-M3 anticipates that the next operational phase of the system – Drone814 – will go live in the first quarter of 2027.

2 Introduction and Project Overview

2.1 Project Title and Administrative Information

Project Title: Emergency Life Saving through Multi-Modal Mobility (ELSa-M3)
Recipient: Southern Alleghenies Planning & Development Commission (SAP&DC)
Fiscal Year of Award: 2023 Stage 1 Class
Period of Performance: July 1, 2024 – January 31, 2026
Organizations preparing the report: SAP&DC, Aerium, Inc., ATA Aviation, DroneUp
Submission date: 31 July 2026

2.2 Project Description and Overview

The SAP&DC region has a high concentration of overburdened, underserved communities that struggle with nutrition and drug addiction: hence our focus on the real and immediate problems of Opioid overdose, cardiac arrest, and anaphylactic shock. These problems are compounded by economic constraints (limited tax base to extend emergency services and surface transport), workforce and recruiting challenges (chronically understaffed and short-staffed emergency services), and geography (a mountainous region that limits straight-line surface response). To improve lives and reduce harm through transit in the SAP&DC region, we have to find creative ways to respond to medical emergencies both faster and cheaper.

The Emergency Life Saving through Multi-Modal Mobility (ELSa-M3) project is an innovative use of uncrewed aircraft systems (UAS, or drones) to enhance emergency services logistics in the region through a public ground-based sensor network integrated with airspace management. ELSa-M3 will utilize UAS to improve emergency response time and resiliency by responding to emergency calls with drones delivering NARCAN (Opioid overdose), EpiPen (allergic shock), Tourniquet (bleeding), and AEDs (cardiac arrest). The prototype system developed during the first stage of our SMART grant addresses real world issues in this region and can improve access to healthcare services and the quality of life for the underserved communities within the project area and the broader Stage 2 area.

Stage 1 of the ELSa-M3 project was located in a historically income, health, housing, pollution and transportation disadvantaged community straddling the border of Cambria and Somerset Counties, centered on Johnstown, PA, and nearby communities. The project location encompassed 12 transportation disadvantaged census tracts from the United States Department of Transportation Climate & Economic Justice Screening Tool including income, health, housing, pollution, transportation, and workforce burdens; 8 Low Food Access areas as described in the United States Department of Agriculture's Economic Research Service Food Access Research Atlas; and 3 Medically Underserved Areas as defined by Health Resources and Services Administration.

A potential Stage 2 regional rollout at-scale will comprise the major and rural population centers in the six counties of the SAP&DC planning region: Cambria, Somerset, Blair, Bedford, Huntington, Fulton. The total population of the six counties is approximately 484,000 people in 131 localities, with a mean size of locality of 3,781 and a median size of 2,045. Smaller localities are interspersed with a handful of larger localities: Johnstown City (18,411), Richland Township (12,233), Somerset Township (11,378), Salisbury Township (13,529), Altoona (42,048), Logan Township (12,083), Hopewell Township (13,230), Bedford Township (5,022), and Huntington (6,956).

To deliver this capability, ELSa-M3 is focused on the UAS operations necessary to support emergency services and the infrastructure necessary to support the safe integration of those UAS operations into the airspace. Therefore, the Stage 1 project and the Stage 2 at-scale rollout have two main thrusts of effort: UAS operations and UAS infrastructure.

UAS operations in Stage 1 consisted of developing the Standard Operating Procedures (SOPs) for the emergency dispatch of medical articles, and the related UAS vehicles, procedures, and training necessary to implement this on a broad scale. The developed SOPs included rules and procedures required for safe and effective operation. Some of the defined procedures included the simultaneous dispatch of drones in addition to surface ambulances, the handling and control of medical articles included in the drone's payload, and how the UAS will be flown safely to and from the incident location and integrated with the airspace. These SOPs were developed and implemented in our Stage 1 field trials, held in July and August 2025 by DroneUp, a nationally experienced UAS operator, using two identified delivery vehicles with experienced crews using standard, established flight planning and safety procedures. The Emergency Integration and Dispatch Protocols are attached to this report as Appendix A.

Supporting UAS operations evaluations in Stage 1 were accredited equipment and trained personnel provided to Cambria County Emergency Services by DroneUp as a contracted service provider. Part of the equipment provided by DroneUp included accredited, proven UAS aircraft specifically designed to support these types of deliveries:

Short Range UAS: (used for commercial and medical operations)
Type - Octocopter (Traditional)
Range - 5 mile round trip, or 10 mile one way
Delivery Method - Winch
Payload Capacity - 10lbs
Parachute - Yes
Speed - 33 mph
Weather Limits - Wind 22 mph, Light Rain (.1in/hr), 32°F - 90°F

Mid Range UAS: (used for commercial and medical operations)
Type - Quadcopter (Thrust Vectoring)

Range - 7 mile round trip, or 15 mile one way (range can be expanded to 35 miles via R&D)
Delivery Method - Winch
Payload Capacity - 10lbs
Parachute - Yes
Speed - 39 mph
Weather Limits - Wind 28 mph, Light Rain (.1in/hr), 14°F - 100°F (rain and wind limits can be increased via R&D)

Supporting the safety of UAS operations across the region, ELSa-M3 deployed public digital infrastructure in Stage 1 to support safe integration of UAS operations within a 24-square mile area, including the City of Johnstown, western suburbs of Johnstown, and select locations in Cambria County. The specifications of this infrastructure as well as operational deployment locations are covered in more detail in Appendix B of this report. The Stage 1 infrastructure deployment included supplemental navigation data that allowed the drone to use its flight planning capabilities to avoid hazardous areas, supplemental weather observations to support identification of safe flying conditions, supplemental airspace surveillance sensors to avoid collisions and near misses, and integrated UAS flight planning capabilities available to the broad community to maximize situational awareness and safety.

The team conducted both an operational risk assessment and a service area risk assessment, developed a safety plan, and risk mitigation plan. These activities were supported through the use of specific standard operating procedures (SOPs). These procedures, developed collaboratively with team member organizations DroneUp and ACUASI, were informed by the types of UTM and Supplemental Data integrations which have been previously conducted in Virginia, Ohio, and California to support safe flight planning that avoids hazards. The resulting SOPs support safe and effective payload delivery, comply with regulation, and also “deconflict” ELSa-M3 drone flights from other drone and aviation flights in the ELSa-M3 service area. These risk assessments and the resulting System Design Document for infrastructure rollout were used as the roadmap for the Stage 1 deployments. The System Design Document (SDD) is attached to this report as Appendix B.

ELSa-M3 leverages inexpensive Commercial-off-the-Shelf (COTS) solutions and sensors integrated into a public network by SAP&DC and made available to public safety, the public, and industry in the project location by ATAA using an established, successful program model from Virginia, the Virginia Flight Information Exchange (VA-FIX). The ELSa-M3 “Aerium EASSE” (Figure 1) integrates local sensors, dispatch systems, and flight planning and management systems to demonstrate the benefits of an integrated drone safety system with a public sensor network at the core. Public sensors include fixed sensors installed in our identified project location census tracts including RemoteID sensors, ADS-B sensors, optical sensors, radar, and microweather sensors. By layering multiple sensors over each other in the service area, the aggregate detection accuracy of the network is greater than any one sensor, allowing us to leverage inexpensive sensors for a comprehensive cost-effective network.

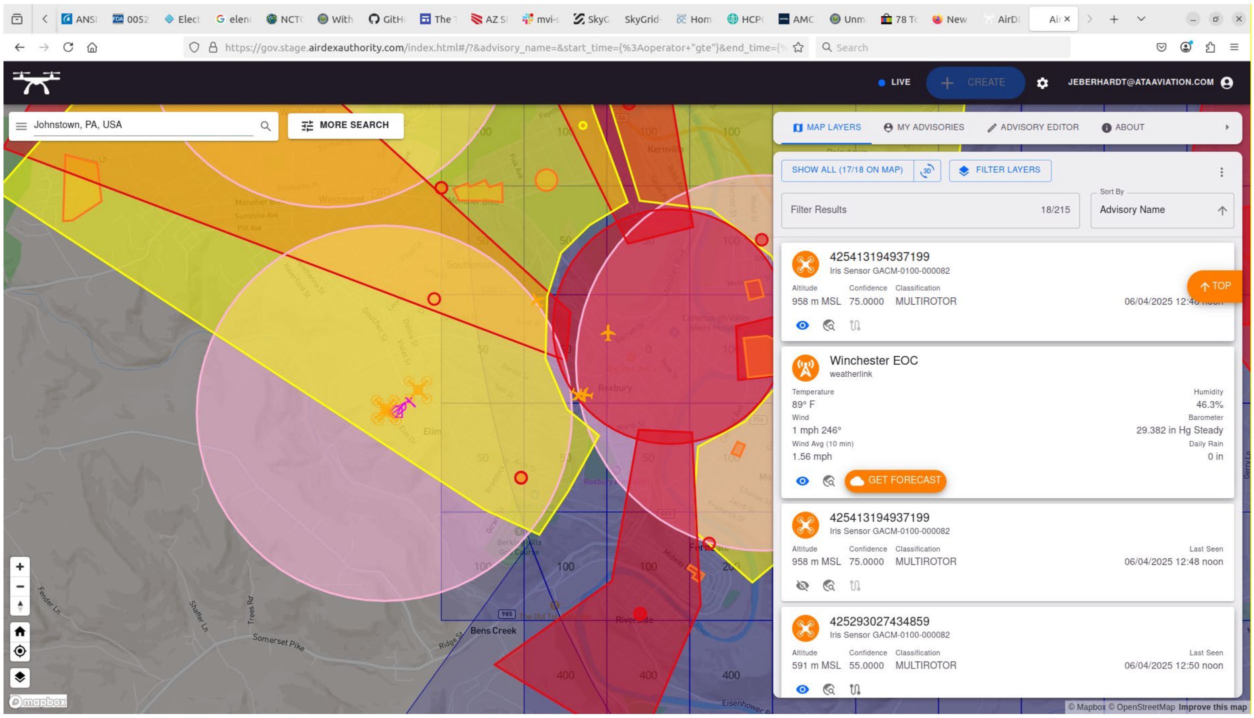


Figure 1: ELSa-M3 Aerium EASSE functioning during test and shakedown week showing drone and aircraft positions, navigational aids, and groundspace configuration

This model is based upon the Federal Aviation Administration's (FAA's) UAS Traffic Management (UTM) Concept of Operations (ConOps) V2 and traditional air traffic management with procedural and operational deconfliction together with awareness and conformance services to create a performance based, shared safety system. The ELSa-M3 UAS infrastructure support a layered approach to safety consisting of four principal layers, as described in Figure 2 below:

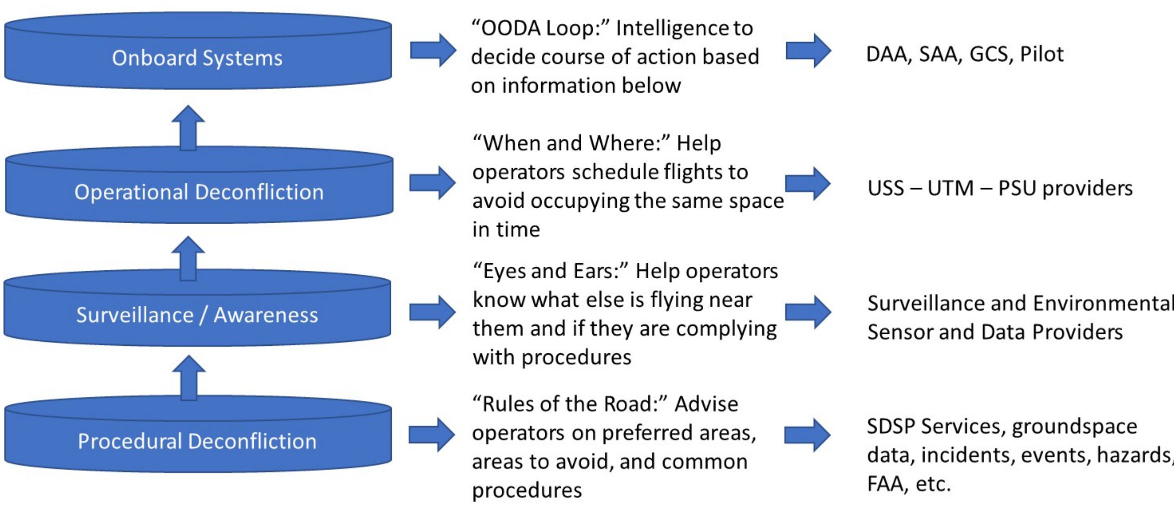


Figure 2 Layered Risk Mitigation Model – Conceptual Diagram

The ELSa-M3 infrastructure provides navigational and surveillance data to DroneUp and other UAS operators in the project area. Further, with team members Aloft and OneSky, we have integrated the sharing of flight plans across both participating (DroneUp, CCES) and non-participating (hobbyists, surveyors, videographers) UAS pilots in the project area. This maximizes the safety of ELSa-M3 while also enhancing the overall aviation safety of the region. Based on initial analysis and planning, a notional service coverage area (Figure 3) was developed and refined prior to the final development of the SDD and sensor installation planning.

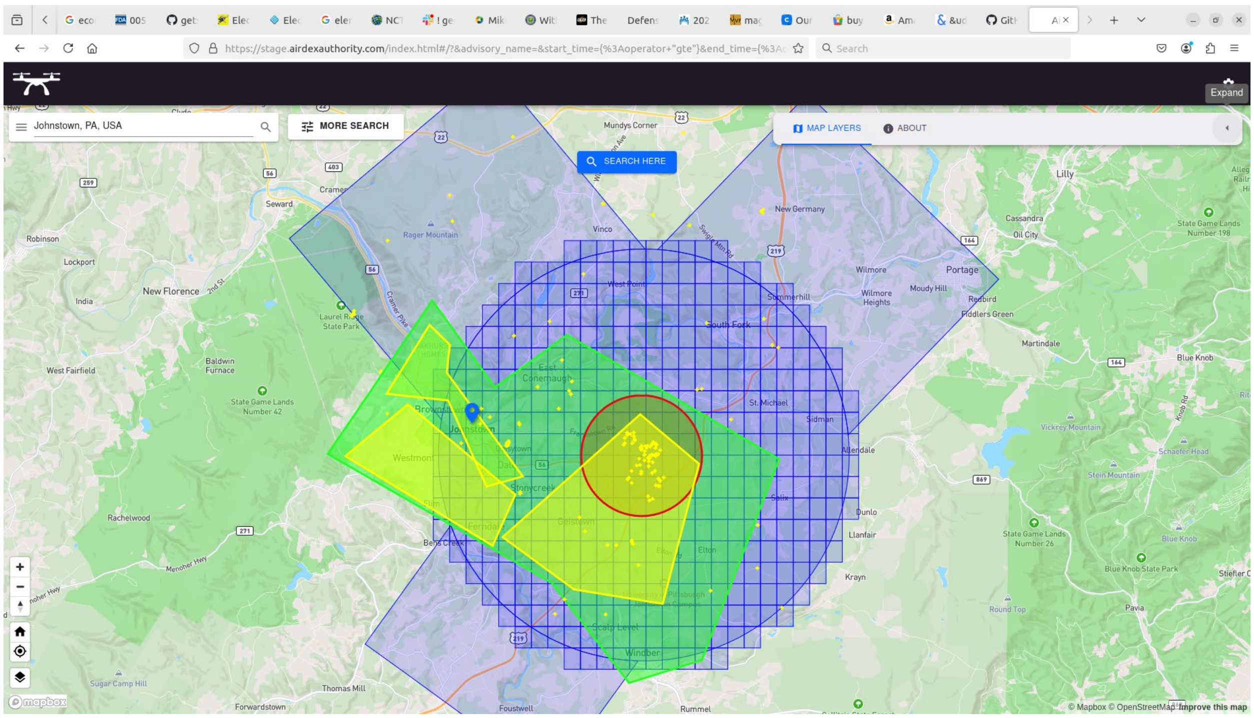


Figure 3: Initial Planned Infrastructure Coverage Area

Upon completion of the initial SDD, SAP&DC then conducted a public procurement for sensors through its subcontractor, Aerium. This procurement received responses from 10 vendors, including multiple vendors for ADS-B and RemoteID receivers, optical detection sensors, weather providers, and radars. Procured equipment includes ADS-B and RemoteID receivers (receiving transponder codes from conventional aircraft and drones), Cameras with detection algorithms (to complement transponders and detect non-transponding aircraft), radars (to detect non-transponding aircraft in high risk areas and complement the other sensors), and additional modes we may identify that enhance the overall detection. Further, based upon the SDD, project staff conducted detailed surveys on the ground to refine potential drone operating areas based upon topography, potential local hazards and obstructions, effective drone operating bases, potential sensor installation locations with sufficient field of view and accessible services and local approvals. Further, the project team engaged with the Medevac provider for the local hospital and the control tower at John Murtha Johnstown-Cambria County Airport to ensure ground and airspace configurations that deconflicted ELSa-M3 operations from conventional air traffic. The updated service area is described in Figure 4.

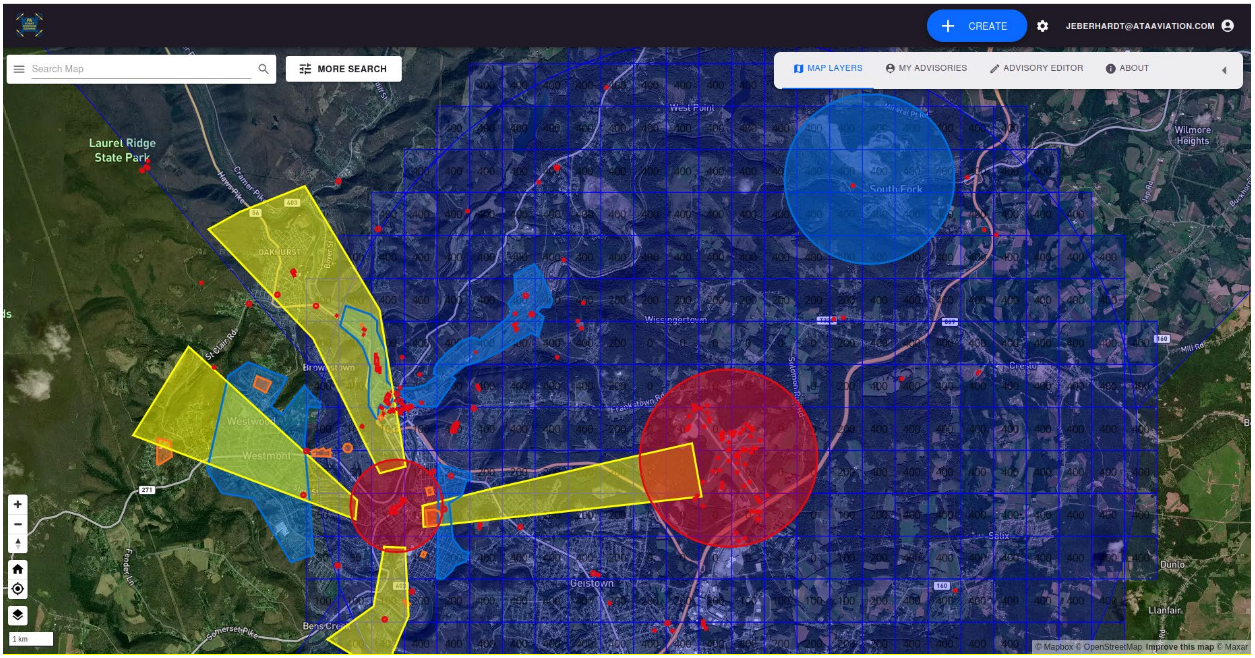


Figure 4: Final ELSa-M3 Configured AERIUM EASSE Operating Service Area

The final Stage 1 UAS infrastructure deployment is based on an updated comprehensive SDD (Appendix B) that supports the risk mitigation strategy and overall concept of operations, as well as provide the mechanism for collection of study data to support the Data Management Plan and Study and Evaluation Plan. This includes ASTM UTM integrations with Aloft, DroneUp, and OneSky to support flight intent deconfliction and also includes sensor coverage that supports: i) characterization and awareness of the airspace for aviation safety in civil aviation and AAM; ii) support for Beyond Visual Line of Sight (BVLOS) operations of small UAS (sUAS) under emerging FAA rules; and iii) supporting the “detect” portion of a counter-UAS mitigation strategy. This SDD will be updated on final time subsequent to any remaining adjustments made during the flight trials in July and August 2025.

As mentioned above, the ELSa-M3 team utilized COTS technologies to fulfill the mission, both in terms of UAS vehicle and ground-based infrastructure. The actual technologies deployed, and how they map to SMART program technology areas, are described in Table 1 below.

Technology Area	Technologies Deployed
Coordinated automation	Integration of UAS technology (Mid-Range UAS) with UAS Service Supplier (USS) tools (Aloft, OneSky) through a common real-time data messaging platform (AirDex) to share flight plans and syndicate sensor data.
Intelligent sensor-based infrastructure	Deployed a mixed-mode airspace sensing network consisting of ADS-B (Airport Monitoring Solutions, Sunhillo), RemoteID (AirSentinel), Optical detection (uAvionix, Lighthouse), and phased-array radar (MatrixSpace) syndicated through our real-time messaging platform (AirDex).
Systems integration	Integrated the 911 Emergency Operations Center Computer Aided Dispatch (CAD) software (Motorola) with our real-time messaging platform (AirDex) and then syndicates this data to the UAS flight planning and control software, while also syndicating relevant data to the USS tools, (Aloft, OneSky) exchange of flight plans between USS tools to support deconfliction of flight intents, and syndication of ground-based airspace sensing data to all tools to support a common airspace picture.
Commerce delivery and logistics	Use of innovative UAS technology, combined with USS tools and real-time data syndication, to support Emergency Medical Delivery integrated with 911 dispatch and occurring within minutes: this same integrated technology stack also supports commercial UAS delivery and drone-as-a-first-responder for Public Safety.
Innovative aviation technology	The entire ELSa-M3 program is centered on enabled UAS-driven logistics as both an alternative, and an augmentation, to surface-driven options for emergency medical delivery, commercial medical delivery, and public safety response.

Table 1: Technologies Deployed and Mapping to SMART Program Technology Areas

In Stage 1, the integrated UAS operations and infrastructure support 2 current UAS operations and 2 future UAS Operating sites supporting 3-10 square miles of coverage each within a total coverage are of approximately 25 square miles. The ELSa-M3 team conducted final test and evaluation flights to characterize the formal service area. Ultimately, the combination of drone operations and a ground sensor network results in safe, shared airspace that can support not just emergency response but also commercial UAS and commercial UAS logistics activities. The network deployed in ELSa-M3 provides a highly complete, common operating picture with views of ground configuration data, shared information on flight intents, knowledge of expected conventional aviation traffic, real-time integration into the CAD systems, and real-time common airspace awareness data to identify cooperative and uncooperative air traffic to ensure that emergency response UAS flights reach their destination quickly and safely.

SAP&DC's proposed six-county regional at-scale rollout would deploy the ELSa-M3 network to 26 UAS operating sites supported by 108 sensor sites supporting 53 Service Volumes covering 240 square miles of area. This planned Service Area would cover approximately 6% of the six-county area's landmass with direct sensor coverage, but would also cover over 50% of the six-county population with direct UAS service under the current regulatory authorities under the Stage 1 grant. The ELSa-M3 team, through interactions with ACUASI and the FAA, believes that the next stage of regulatory approvals would allow SAP&DC to expand ELSa-M3 services into adjacent, low density service areas using the planned Stage 2 coverage and achieve coverage of 75% of the population of the six-county area through FAA regulatory authorization based upon the safety record and performance data of the ELSa-M3 system. Figure 5 below shows the planned six-county system rollout in Stage 2.

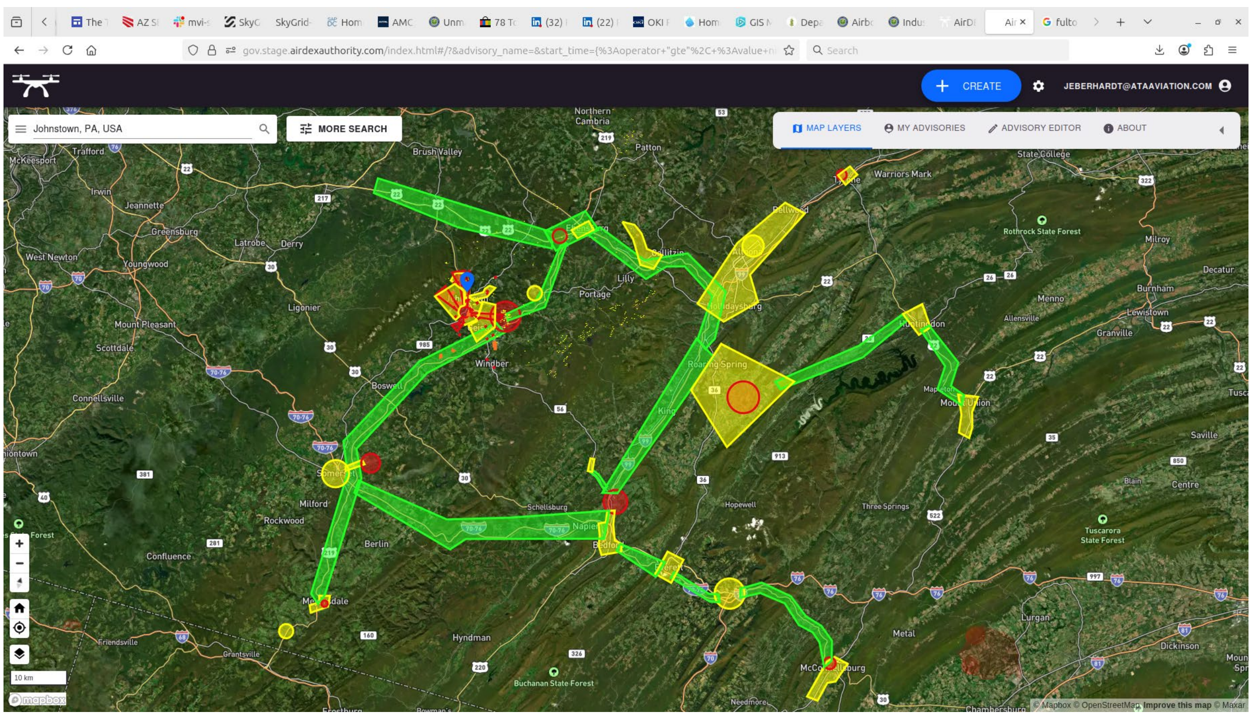


Figure 5: Planned six-county Stage 2 at-scale rollout

The outcome of the ELSa-M3 integrated network is a community-centered approach to provide access to emergent medical treatment, reduce response time, reduce cost and harm, save lives, and establish additional commercial services by developing a six-county wide implementation in Stage 2 of the project. ELSa-M3 demonstrates the requirements to deliver these outcomes through the initial use of emergency drone delivery to underserved communities using a cost-effective and affordable public network, including safety, equipment, and operational considerations. <u>The principal project goal was to identify and quantify the feasibility of the system and identify the requirements for a region-wide six-county emergency delivery UAS network to augment emergency services, reduce time to service, improve patient outcomes, and</u>

reduce costs while creating a baseline for commercial UAS services. This was reflected in four specific project objectives:

1. Demonstrate the ability to safely respond to services calls in the project location via drone and integrate this into the airspace;
2. Reduce first on site response time vs. conventional methods, resulting in reductions in ambulance and medical cost, medical harm, mortality, and patient hospitalization time;
3. Demonstrate a cost-effective deployment model and fiscally sustainable plan for the Stage 2 expansion of ELSa-M3 based on the performance, benefit, and cost data collected; and;
4. Develop a specific repeatable regional deployment plan for public network infrastructure, including proposed service areas, estimation of benefits, and detailed cost estimates based on Stage 1 performance data.

SAP&DC evaluated these Project Objectives using the Performance Metrics developed in the Performance Evaluation Plan, and assessed collected data through the Evaluation Methods discussed below. Our results are published to the National Transportation Library's ROSA-P data repository according to our Data Management Plan (DMP). Table 2 below details how SAP&DC's ELSa-M3 Project Objectives map to the SMART program's statutory requirements under Public Law 117-58 Sec 25005 D(3)(ii).

Statutory Requirement	Related Project Objective
(I) reduce congestion and delays for commerce and the traveling public;	Project Objectives 1 and 2 reduce the future number of emergency services vehicles on the road, reducing congestion and hazards.
(II) improve the safety and integration of transportation facilities and systems for pedestrians, bicyclists, and the broader traveling public;	Project Objectives 1 and 2 support integrated data that allows for next-generation UAS services to be integrated into our regional logistics network, improving options for residents.
(III) improve access to jobs, education, and essential services, including health care;	Project Objectives 1, 2, 3, and 4 create a sustainable system that not only supports Emergency Services, but also creates new commercial opportunities in UAS and related demand for pilots, technicians, and other logistics personnel.
(IV) connect or expand access for underserved or disadvantaged populations and reduce transportation costs;	Project Objectives 1, 3, and 4 specifically focus on the ability to service hard-to-reach or hard-to-serve populations using automation and innovative aerial technologies while maintaining a sustainable, cost-effective profile.

Statutory Requirement	Related Project Objective
(V) contribute to medium- and long-term economic competitiveness;	Project Objectives 3 and 4 create cost-effective shared infrastructure that is an enabler for new pilot and technician jobs developing and supporting new UAS services.
(VI) improve the reliability of existing transportation facilities and systems;	Project Objectives 1, 3, and 4 specifically focus on the ability to rapidly switch logistics between ground and air.
(VII) promote connectivity between and among connected vehicles, roadway infrastructure, pedestrians, bicyclists, the public, and transportation systems	Project Objectives 1, 3, and 4 focus on integration of the ELSa-M3 system with other regional systems, focusing initially on the Public Safety CAD system.
(VIII) incentivize private sector investments or partnerships, including by working with mobile and fixed telecommunication service providers, to the extent practicable;	Project Objectives 3 and 4 create cost-effective shared infrastructure that is an enabler for developing and deploying new aviation product and services, and support engagement with the aviation business community.
(IX) improve energy efficiency or reduce pollution;	Project Objectives 3 and 4 create cost-effective shared infrastructure that allows for the selection of the optimal mode for logistics and transport throughout the region.
(X) increase the resiliency of the transportation system; and	Project Objectives 1, 3, and 4 specifically focus on the ability to rapidly switch logistics between ground and air, especially in emergency situations.
(XI) improve emergency response.	Project Objectives 1 and 2 are focused on improving the reach, and speed, of emergency response in the Stage 1 project are and Stage 2 regional deployment.

Table 2: ELSa-M3 Project Goals Support Statutory Impact

2.3 Community Involvement and Expected Community Impact

An important aspect of our project was to ensure that residents in the project area were aware of the tests, not surprised by the drone interventions, and had an opportunity to provide feedback into the system design and deployment. SAP&DC, Aerium, and St. Francis University conducted a series of community engagement and education forums to educate the residents about the project and services, and to collect resident feedback into ways that we can improve our prototype.

These forums included both open forums and targeted outreach to the individual localities and emergency services involved. Open forums have included a 2-day Community Open House at the Pasquerilla Conference Center in Johnstown May 13-14, 2025 and a community demonstration of the UAS delivery system itself at Greater Johnstown High School on May 30,

2025. Individual outreach has occurred through meetings, briefings, and question and answer sessions with:

- Johnstown City Council
- Dale Borough Council
- Franklin Borough Council
- Ferndale School District
- Greater Johnstown School District
- West Hills School District
- Upper Yoder Township
- Lower Yoder Township
- Conemaugh Memorial Hospital
- Seventh Ward EMS
- Riverside Fire / EMS
- West End EMS
- Conemaugh Valley EMS Regional
- Hilltop EMS
- Upper Yoder EMS

Of particular note, the ELSa-M3 team has developed a public, project specific website (www.drone814.com) and conducted a Community Open House on May 13-14 2025 to help educate the community about the project, collect feedback, and identify partnerships. One result of this open house was to deepen partnerships with the local medical community, where we identified potential need in Portage, PA (Cambria County) where the local critical care hospital and EMS service have closed – ELSa-M3, if deployed there, would literally be a lifeline to that community. In addition to identifying new medical partners in the region, the Johnstown Chamber of Commerce and Johnstown Area Regional Industries (JARI) expressed strong interest in partnering with SAP&DC and the ELSa-M3 team to work with existing and potential regional businesses to leverage the ELSa-M3 infrastructure to grow local jobs. Figure 6 below shows community engagement at the ELSa-M3 / drone814 open house.

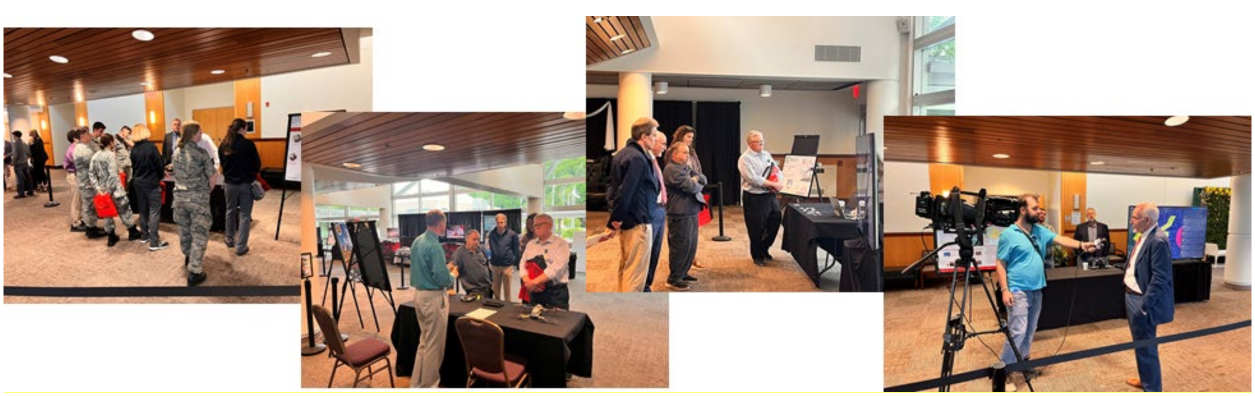


Figure 6: ELSa-M3/drone814 Open House May 13-14, 2025

In addition to successful engagement, specific potential community impacts of ELSa-M3 are: i) improve the reliability and resiliency of emergency services for underserved communities in the region, especially emergency medical delivery of NARCAN, AEDs, Tourniquets, and Epi pens; ii) directly reduce harm and save lives by using drones to deliver self-administered life-saving treatments while personnel are en-route; and iii) establish a cost-effective public network with a sustainability model to ensure continued access, local financial sustainability, and regional economic development. Analysis of historical dispatch data identified over 700 relevant emergency medical calls per year in the project area that could benefit from a reduction in total response time. For example, medical literature shows that for each minute of response time save in cardiac arrest, there is a 20% reduction in mortality. Figure 7 below summarizes overall Cambria County dispatch data which was used to identify the proposed service area (area of highest need). One meta-analysis indicated that cardiac arrest survival could be increased from under 10% to over 50%. Further, the American Heart Association recognizes that early interventions reduce the long-term morbidity associated with Cardiac Arrest. The National Institute on Drug Abuse references studies that show that better NARCAN access could reduce overall mortality by 11%-21%.

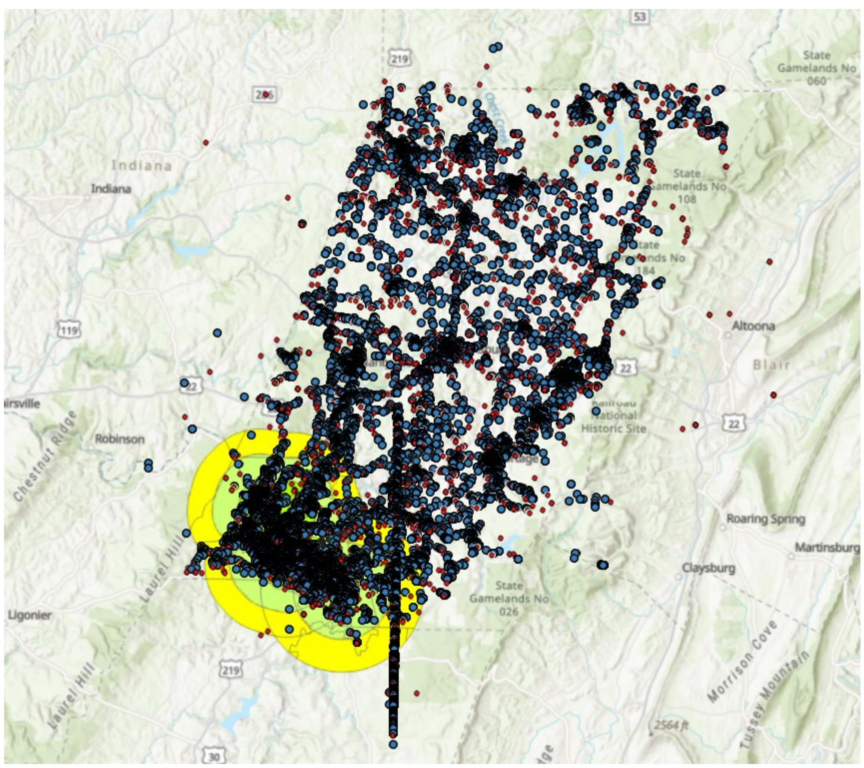


Figure 7: Distribution of Dispatch Data in Stage 1 Prototype Deployment Area

An easily replicated, cost-effective solution allows this approach to be easily adapted across disadvantaged communities across the region and the country and create significant benefits in reduced mortality, reduced morbidity, and improved emergency services at reduced service cost. The following benefits in the project location are directly measured:

- Safety and Reliability: Uptime and safety performance of drone delivery and calculation of relative performance to surface emergency vehicles and benefits in overall response;
- Resiliency: Demonstration of revenue-neutral cost sustainment model ensure system can be maintained and operated locally, and accessible to underserved communities;
- Equity and Access: Direct reduction in harm for underserved communities in our region through fast, cost-effective drone emergency medical response and demonstration of cost-benefit profiles to support Stage 2 service expansion;
- Climate: Demonstration of service to areas at high risk of flooding as an alternative, resilient means of emergency logistics and demonstrated reduction in response time;
- Partnerships: Convening of both public and private organizations committed to delivering services to the community including the Johnstown Chamber of Commerce, Conemaugh Memorial Medical Center, and JARI;
- Integration: Integration with public safety, educational institutions, and aviation at John Murtha Johnstown-Cambria County Regional Airport and the Cambria County Emergency Operations Center; and
- Technology Innovation: Identify additional areas that the ELSa-M3 infrastructure can support, such as Drone-as-a-First-Responder, infrastructure inspection, emergency operations, and commercial medical and retail delivery to create a more efficient and scalable model in Phase 2.

Community impact is realized in three principal ways: harm reduction, cost savings, and economic development. Harm reduction and cost savings are closely related: to the degree a UAS intervention with treatment articles while ambulance is en-route is successful (UAS arrives prior to ambulance and victim period of unconsciousness and hypoxia is reduced) the harm for the victim, and resulting medical delivery costs savings, are substantial. Economic develop results from the development and deployment of infrastructure that fully cost-amortized on the Emergency Medical Case, allowing for infrastructure to support additional services at negligible infrastructure cost, solving a major hurdle for the deployment of UAS technologies into our communities.

To evaluate the potential benefit of ELSa-M3, we focused on the two of the five medical emergencies we service that are the most straightforward to cost model: cardiac arrest and opioid overdose. The rule of thumb in emergency medical services literature indicates that for each minute sooner that a cardiac arrest patient is resuscitated, mortality and morbidity are reduced by 20%. One study indicates that access to a defibrillator prior to EMS arrival reduces morbidity and mortality by 53%[1]. The literature indicates that administration of NARCAN immediately after overdose reduces mortality and morbidity by 61.1%[2]. Assuming UAS intervention is successful on 20% of calls (which assumption we will definitively validate in the July and August 2025 flight trials), given the population of the Stage 2 six-county rollout area and 2022 911 dispatch call volume reported by Pennsylvania Department of Emergency Management[3], ELSa-M3 could potentially reduce harm to approximately 2,500 individuals annually in these two categories alone. Assuming only a 20% success rate for UAS deliveries and a 5% rate of mortality avoidance, a Stage 2 roll-out of ELSa-M3 could save 250 lives annually in the six-county rollout.

Assuming a 20% rate of successful UAS mission, the savings in the Stage 2 rollout area on downgraded ambulance charges from ALS2 to BLS2 would equal $1.2MM annually across the six-county Stage 2 rollout area. Referencing the literature related to expected length of stay for out of hospital cardiac arrest or opioid overdose post admission from emergency medical response, a successful intervention could potentially reduce an inpatient stay for cardiac arrest from 10 to 8 days[4], and for opioid overdose from 5.8 to 3.8[5] days for a successful UAS intervention. KFF Health Policy Research indicates and average daily charge of $3,081[6] for Southwestern Pennsylvania, while the National Center for Health Statistics suggests a daily charge rate of $2,989[7]. Assuming an average 2-day reduction in overall length of stay and an average $3,000 daily charge, this indicates a potential savings $3,000 per harm reduced individual. Given an estimated 2,500 individuals per year, the inpatient and ambulance charge savings could potentially **save the SAP&DC region $3.5MM in medical costs each year.**

Further, as noted above, given the frequency of Emergency Medical calls at 2-4 per day, per site, the infrastructure and equipment will be available for other uses approximately 22 hours per day. This remaining time can be used to sustain other public safety services and commercial, non-emergency medical and retail delivery services while keeping a second vehicle available. This allows for the development of additional services, and the realization of additional cost savings, at effectively no marginal cost expect for battery charging consumption of electricity. In the cases on delivering medication to diabetics and those with heart disease, a simple estimate of cost

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[1] The Effects of Public Access Defibrillation on Survival After Out-of-Hospital Cardiac Arrest: A Systematic Review of Observational Studies; Baekgaard, Josefine S, et. al., Circulation, Volume 136, Number 10, https://doi.org/10.1161/CIRCULATIONAHA.117.029067

[2] Effects of naloxone distribution to likely bystanders: Results of an agent-based model; Keane, Christopher, et. al.; International Journal of Drug Policy, Volume 55, May 2018, Pages 61-69; https://doi.org/10.1016/j.drugpo.2018.02.008

[3] https://www.pa.gov/content/dam/copapwp-pagov/en/pema/documents/911/documents/annual-reports/2022.pdf

[4] Receiving Hospital Characteristics Associated with Survival after Out-of-Hospital Cardiac Arrest; Calloway, Clifton, et. al., Resuscitation. 2010 Jan 13;81(5):524–529. doi: 10.1016/j.resuscitation.2009.12.006

[5] Geographic variation in hospital costs, payments, and length of stay for opioid-related hospital visits in the USA; Mallow, Peter J. et. al.; J Pain Res. 2018 Dec 4;11:3079–3088. doi: 10.2147/JPR.S184724

[6] https://www.kff.org/health-costs/state-indicator/expenses-per-inpatient-day/?currentTimeframe=0&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D

[7] https://nchstats.com/average-cost-of-hospital-stays-in-us/

savings can be derived. Using National Center for Health Statistics data, we assume a population of 36,795 diabetics (regional prevalence of 7.6%) and a population of 35,350 with chronic heart disease (regional prevalence of 7.3%).

Using amortized infrastructure to support regular commercial medical delivery of insulin and heart medication to this population could reduce emergency room visits for medication non-compliance. By way of example, assuming 20% of the diabetic and chronic heart disease populations took advantage of this service, and we reduced medication non-compliance rates of approximately 25%[8],[9] by 25%, then assuming avoidance of a literature derived annual emergency room cost of $1,863[10], **potential savings in the Stage 2 six-county rollout region could total a further $7.5MM in emergency room visits each year**.

Further, using data from the Chula Vista Drone as a First Responder dashboard[11], we estimate that the same infrastructure, applied to Drone as a First Responder capabilities, would reduce unnecessary dispatch by 20%, **resulting in approximately 15,000 fewer police and fire trips annually in the Stage 2 six-county area**.

Basic initial modeling estimates the creation of 42 technician and 20 pilot jobs within three years as ELSa-M3 is deployed regionally. Additionally, the ELSa-M3 investment in regional infrastructure for Advanced Air Mobility has already attracted the interest of multiple commercial UAS and aviation companies interested in leveraging this infrastructure and helping develop the regional ecosystem. Companies that have express an interest in conducting operations, and hiring, in the Johnstown region include Horizon Aerobotics, Electra, Beta, and ATA Aviation.

Table 3 below details how the Community Impact of the ELSa-M3 Stage 1 and Stage 2 projects map to the statutory objectives of the SMART program.

Statutory Requirement	Statutory Impact at the Community Level
(I) reduce congestion and delays for commerce and the traveling public;	Transition medical services to UAS logistics; support Drone-as-a-First-Responder and remove 15,000 police and fire trips annually.

[8] Trends of self-reported non-adherence among type 2 diabetes medication users in the United States across three years using the self-reported Medication Adherence Reasons Scale, Unni, Elizabeth J. at. al.; Nutrition, Metabolism and Cardiovascular Diseases; Volume 32, Issue 1, January 2022, Pages 151-159; https://doi.org/10.1016/j.numecd.2021.09.018

[9] Medication adherence in adults after hospitalization for heart failure: A cross-sectional study; Huber, Manuela, et. al.; International Journal of Cardiology Cardiovascular Risk and Prevention, Volume 20, March 2024, 200234; https://doi.org/10.1016/j.ijcrp.2023.200234

[10] Economic impact of medication non-adherence by disease groups: a systematic review; Cutler, Rachelle Louise et. al.; BMJ Open. 2018 Jan 21;8(1):e016982. doi: 10.1136/bmjopen-2017-016982

[11] https://www.chulavistaca.gov/departments/police-department/programs/uas-drone-program

Statutory Requirement	Statutory Impact at the Community Level
(II) improve the safety and integration of transportation facilities and systems for pedestrians, bicyclists, and the broader traveling public;	Fully integrated system with UAS Emergency Medical en-route through automated CAD dispatch.
(III) improve access to jobs, education, and essential services, including health care;	The ELSa-M3 infrastructure has already attracted commercial interest and commitments from Horizon Aerobotics, ATA Aviation, Electra, and Beta.
(IV) connect or expand access for underserved or disadvantaged populations and reduce transportation costs;	ELSa-M3 covered 25 square miles of urban and suburban environment with 2 UAS operating sites.
(V) contribute to medium- and long-term economic competitiveness;	The ELSa-M3 infrastructure has already attracted commercial interest and commitments from Horizon Aerobotics, ATA Aviation, Electra, and Beta.
(VI) improve the reliability of existing transportation facilities and systems;	Demonstrated integration with 911 CAD system shows ability to “hot swap” logistics methods as needed and appropriate.
(VII) promote connectivity between and among connected vehicles, roadway infrastructure, pedestrians, bicyclists, the public, and transportation systems	Demonstrated integration between UAS ground control software, USS software, airspace awareness sensor network, and 911 CAD system demonstrates a fully integrated system with a common operating picture that is applicable beyond UAS.
(VIII) incentivize private sector investments or partnerships, including by working with mobile and fixed telecommunication service providers, to the extent practicable;	ELSa-M3 is leveraging existing public assets and has identified a partnership with a local mobile data provider, Blade Broadband.
(IX) improve energy efficiency or reduce pollution;	Transition medical services to UAS logistics; support Drone-as-a-First-Responder and remove 15,000 police and fire trips annually.
(X) increase the resiliency of the transportation system; and	Demonstrated integration with 911 CAD system shows ability to “hot swap” logistics methods as needed and appropriate.
(XI) improve emergency response.	Fully integrated system with UAS Emergency Medical en-route in approximately 60 seconds and supports future Drone-as-a-First-Responder capabilities natively.

Table 3: ELSa-M3 Project Goals Support Statutory Impact at the Community Level

2.4 Stage 1 and Stage 2 Deployment Scaling

The current ELSa-M3 Stage 1 deployment is a small-to-medium scale deployment, consisting of 27 sensors across 12 public sites covering 7 service volumes over approximately 24 square miles, as described above in Figure 4. The ELSa-M3 deployment is also integrated with the Cambria County 911 CAD system, the UAS ground control and planning software, and 2 USS providers, all connected via a real-time data messaging backbone. This gives SAP&DC almost total visibility into all participating and non-participating air operations in the deployment area, as illustrated in Figure 1.

While this is a medium-scale deployment, ELSa-M3's service area actually covers 45.5% of the population of Cambria County and, using the benefits model, has the potential to generate $3.9MM in annual medical savings in the Stage 1 deployment area alone. The actual deployment time for the ELSa-M3 Stage 1 prototype is approximately four months, once the longest lead time item was resolved, which was contracting: the contracts between USDOT and SAP&DC; the contracts between SAP&DC and commercial partners; and the competitive procurement of the sensors. Once all contracting items were resolved the planning, design, deployment, and integration work ran apace and SAP&DC will be completing full integration, deployment, and testing of the system in July 2025 to support field trials in July and August 2025.

Table 4 below describes the sequential deployment steps, time in motion for each step, and improvements made throughout the Stage 1 deployment that support the ability to scalably deploy the six-county system in Stage 2. An example of the planning process is provided in Appendix B: Aerium EASSE System Design Document.

Step	Time in Motion	Process and Improvements
1. Describe enabled UAS Services	1-2 days	UAS services are described using function, control mechanism, regulatory pathway, and risks.
2. Describe proposed service areas	1-2 days	Desired Service Areas are identified based upon community need and ability to service that need efficiently and safely.
3. Risk analysis of UAS Services and Service Volumes	1-2 days	UAs services are risk analyzed using a Failure Modes Effect Criticality Analysis and overlaid on a qualitative analysis of structure, topography, and density risk by service volume, resulting in through risk-based performance tiers for Service Volumes: Tier 1 (lower risk), Tier 2 (intermediate risk, and Tier 3 (highest risk).

Step	Time in Motion	Process and Improvements
4. Draft System Design Document	2-4 days	UAS operations, service volumes, and risk analysis are used to describe notional Service Volumes within the service area and identify preliminary siting.
5. Draft deployment plan	1 day per service volume	A detailed draft sensor an operating site per Service Volume described in the SDD.
6. Service Volume Research and Site Identification	1 day per service volume	Using the Draft Deployment Plan, physical survey of the Service Volume to determine if proposed sites are appropriate, identify potential alternate sites, commence site hosting and approval process (public sites).
7. Site survey and final selection	2 sites per day	A detailed final site roster is provided in the SDD.
8. Draft installation guide	2 sites per day	A draft installation guide is developed for site owner approval so that requirements, equipment, and install burden are clear and agreed in advance.
9. Site approvals	2 sites per day	Support local approval process for installation of equipment at public sites using the draft installation guide.
10. Installation	1 day per site	Final site deployment using a standardized deployment template developed in ELSa-M3 Stage 1.
11. Integration, testing, and final documentation	1 day per site	Post deployment, integration sensor feeds into the AirDex real-time data syndication network and validate downstream connectivity; final step is to fly UAS and General Aviation aircraft against the sensor to validate the coverage envelope and performance.

Table 4: Deployment Process Time in Motion

Cost of Stage 1 deployment are approximately as follows:

- Program Management: $633,944
- Airspace Awareness – Hardware: $288,908
- Airspace Awareness – Deployment: $94,049
- Data Integration and Syndication: $276,900
- UAS Logistics Equipment: $87,685
- UAS Flight Planning and Control Software: $96,200
- Pilots and Equipment Operations: $270,345
- System Deployment and Integration: $177,225

- Total Cost: $1.92MM

As part of process improvement in the Stage 1 deployment, to improve efficiency, we rapidly developed and refined a standard install package and mount that dropped initial installation time from 3-4 days to 1 day. Figure 8 below shows equipment testing, the standard mount and equipment being deployed in the field at Greater Johnstown Elementary School. The combination of process streamlining during Stage 1, simplification of installation, and expected costs benefits of volume discounts in any potential Stage 2 means that the ELSa-M3 team expects the time and cost per site and service volume to decline in future extensions of the program, supporting greater scaling as part of the six-county regional rollout. If funded for additional work. the ELSa-M3 team would draft an SDD to plan and execute deployment for each of the five remaining counties: Somerset, Blair, Bedford, Huntingdon, and Fulton.

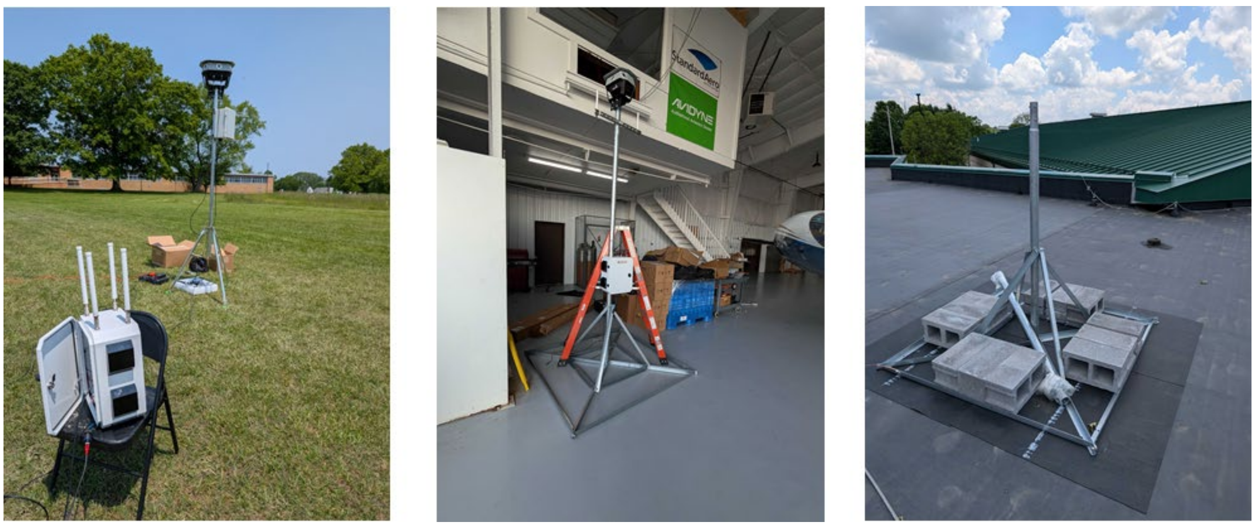

Figure 8: Field Equipment Testing, Standard Installation and Mounting, Deployment in Process

In order to transition from the State 1 prototype to an at-scale six-county deployment, the questions surrounding four key requirements would need to be addressed in order to ensure a credible, scalable, financially viable Stage 2 regional rollout:

1. Safe Integration of Scalable UAS Operations: what can we apply from national efforts, FAA regulatory guidance, and lessons learned in Stage 1 to ensure the safe, scalable integration of UAS into the NAS in the SAP&DC region? What other services can be enabled in the SAP&DC region?
    - Stage 1 Identified Stage 2 Requirement: Leverage existing county and private Certificate of Agreement and Operator Part 135 approvals with the FAA for deployment now while preparing for the FAA Part 108 Beyond Visual Line of Site rule, together with our integrated sensor and USS network, to ensure safe, FAA-compliant operations.

2. Cost of Infrastructure, Time to Deployment, and Operational model: What are the actual costs and time required to both deploy and operate the infrastructure necessary to ensure safe integration of UAS into the NAS? How do we keep costs as low as possible while still maintaining safety? What are the security and performance requirements? Who will provide this service, can it be a 3rd party contract or technology implementation that is ultimately administered by public service agencies?
    - Stage 1 Identified Stage 2 Requirement: Leverage Stage 1 templated risk assessment, planning, and deployment model to ensure clear understanding of deployment and operating costs and keep cost variances low.
3. Demonstration of Cost-Benefit and Sustainment: What are the actual patient outcomes and medical cost benefits of faster intervention through UAS, and how do these relate to medical reimbursement to produce sufficient economic benefit and cost sustainment of UAS operations and UAS infrastructure? What other UAS and drone operations can be supported through the ELSa-M3 infrastructure?
    - Stage 1 Identified Stage 2 Requirement: Continue to partner with regional medical providers and continue the focus on reimbursable services through direct engagement with the Pennsylvania Department of Human Services.
    - Stage 1 Identified Stage 2 Requirement: Transition system to local ownership and operation and identify vehicles with appropriate performance characteristics to maximize benefit.
4. Economic Benefit to the Community: Do the lessons learned and data collected provide a clear path to sustainable UAS operations in the community, and what are the knock-on economic benefits to education and creation of high-quality technician jobs? What institutions need to collaborate? What are the workforce development requirements to take advantage of these benefits?
    - Stage 1 Identified Stage 2 Requirement: Continue to partner and engage with local training, educational, and economic development partners (St Francis University, University of Pittsburgh, Aerium, JARI, Johnstown Chamber of Commerce, Carnegie Mellon University).

2.5 Stage 1 Project Activities

After receiving our finalized grant agreement from USDOT on September 24th, 2024, SAP&DC published an RFP in early October of 2024 to procure a contracting team for the Elsa-M3 project. On January 13th, 2025, a consortium of the following organizations was selected and contracted for this purpose as described in Table 5 below.

Partner	Role
Cambria County Emergency Services	Local provider of emergency services to oversee and operate UAS emergency medical deliveries.
Alaska Center for UAS Integration (ACUASI)	FAA UAS Test Site to provide safety case, COA, and regulatory.
St. Francis University	Local university with experience in community engagement and aviation workforce development in underserved communities.
Aerium	Local non-profit supporting community outreach for aviation, aviation training, and workforce development.
DroneUp	Leading Part 107 national operator of UAS logistics, supporting emergency services deliveries.
Aloft	Leading national provider of USS services with over 500,000 users; FAA onboarded LAANC USS.
OneSky	Leading global provider of USS services in over 10 countries.
ATAA	Provider of supplemental data software & integration services for Public Digital Services in airspace & ground awareness with over 75 agencies in three states & over 35,000 published advisories

Table 5: ELSa-M3 Contractual Team

Once under contract, team members were subdivided into seven work areas focusing on various aspects of ELSa-M3 according to their expertise. These areas and their membership are detailed in Table 6 below.

Working Group	Members
Project Administration	SAP&DC, Aerium, ATAA, DroneUp
Research, Design, and Data Collection	ATAA, ACUASI, Cambria County EMS, DroneUp
Emergency Medical Services Planning	CCES, Aerium, ACUASI, ATAA, DroneUp
Communications and Community Outreach	Aerium, Saint Francis University, CCES, SAP&DC

Working Group	Members
Flight Safety and Operations	DroneUp, ACUASI, ATAA, CCES
System Design, Implementation, and Integration	DroneUp, ATAA, ACUASI, Aloft, CCES, OneSky
Certification of Authorization and FAA Waivers	Aerium, ACUASI, DroneUp, CCES

Table 6: Project Work Areas and Membership

Table 7 below summarizes major activities undertaken and milestones delivered by the ELSa-M3 project team and its working groups. While this list is comprehensive of project milestones completed, it is not exhaustive of all work conducted under the grant agreement. Additional activities were conducted in between these specific milestones to ensure effective system deployment and integration into the community, as reflect in monthly status reports.

Date	Project Milestone	Working Groups
12/15/2024	Finalized and Submitted Data Management Plan to USDOT	Project Administration; R&D and Data Collection
	Finalized and Submitted Evaluation Plan to USDOT	Project Administration; R&D and Data Collection
1/13/2025	Contractor and Sub-Contractor Procurement Completed	Project Administration
2/28/2025	Technical and Safety Requirements Finalized	Flight Safety and Operations
3/15/2025	ELSa-M3 System Design Document Completed	System Design, Implementation, and Integration
	Identified Service Areas for Stage 1 Operations	EMS Planning
3/31/2025	Identified specific CCES support units for testing and operations	EMS Planning
	Identified, documented, and finalized regulatory requirements for FAA certificate of authorization or waiver (COA).	FAA COA and Waivers

Date	Project Milestone	Working Groups
	Submission to FAA for COA	FAA COA and Waivers
4/9/2025	Finalized non-competitive, single-source procurement contracts for Cambria and Somerset Counties regarding equipment placement and operation	Project Administration
	Drone814 project website launched	Communications and Community Outreach
4/15/2025	Resident Outreach Strategy and Plan finalized and outreach to identified service areas begins. Non-participant input collection from community outreach efforts begins	Project Administration; Communications and Community Outreach
	Flight Conditions of Operation (ConOps) finalized	Flight Safety and Operations
	ELSa-M3 System Quality Assurance and Testing Plan completed	System Design, Implementation, and Integration
4/30/2025	ELSa-M3 Safety and Risk Mitigation Plan completed including sections for ConOps, Safety Analysis, and Regional Airspace Management.	Flight Safety and Operations; FAA COA and Waivers
	HIPAA Confidentiality and Data Collection Consent Requirements finalized.	R&D and Data Collection
	Emergency Services Requirements finalized	EMS Planning
	Sensors Procured	System Design, Implementation, and Integration
5/14/2025	Public kickoff and open house event in Johnstown	Project Administration; Communications and Community Outreach
5/15/2025	**Operational Testing Begins, Data Collection Begins**	Flight Safety and Operations; R&D and Data Collection
5/30/2025	Flight Test Schedules, Locations, and Goals finalized	Project Administration; Flight Safety and Operations

Date	Project Milestone	Working Groups
	VIP Demonstration and Test Flight	Flight Safety and Operations
	UAS Traffic Management (UTM) Deployment and Integration Plan completed	System Design, Implementation and Integration
5/30 – 6/6	Shakedown Flight 1, including Community Demonstration Flights	Flight Safety and Operations
6/30 – 7/2	Shakedown Flight 2	Flight Safety and Operations
7/15 – 7/25	Final Shakedown and Test	Flight Safety and Operations
8/11 – 8/27	Field Testing and Data Collection Flights	Flight Safety and Operations
10/12 – 10/25	Production Operations Test Window	Flight Safety and Operations

Table 7: Project Milestones and Work Progress Over Time

A shakedown flight and an additional public demonstration of drone operations were scheduled for the second week of July 2025. Final field demonstration and operational data collection occurred in August and October 2025. These flights and their associated data collection provide test cases for Stage 1 of ELSa-M3 for evaluation as discussed later in this report.

2.6 Project Media and UAS Community Impact

As a result of the ELSa-M3 community outreach approach, the ELSa-M3 project (also termed the drone814 project for community marketing purposes) has garnered significant local and national media attention. The ELSa-M3 project team was invited to present (and presented) our project and our findings at three separate regional transit and medical conferences, and have identified additional partners throughout the region as a result:

- Transportation Engineering and Safety Conference, December 11-13, 2024, Penn State University
- Keystone Trauma, Emergency and Neurology Summit, May 7-8, Seven Springs, PA
- Conducted a Session at the Pennsylvania Chamber of Business & Industry Healthcare Summit, May 27, 2025
- Presenting at the Medical Autonomous Care State of the Science Meeting (MAC-SOS) September 16-17, 2025, University of Pittsburgh

Our drone814 website (www.drone814.com) and our community outreach events, in addition to educating the public and soliciting significant community feedback, has also resulted in substantial news and media coverage for the ELSa-M3 project locally, regionally, and nationally. Some examples of ELSa-M3 / drone814 media coverage:

- Medical Drone Trials to Test Supply Drops for Emergencies (https://www.govtech.com/em/preparedness/medical-drone-trials-to-test-supply-drops-for-emergencies)
- Test flights to begin for Johnstown emergency drone program (https://www.altoonamirror.com/news/local-news/2025/04/test-flights-to-begin-for-johnstown-emergency-drone-program/)
- Nonprofit partners with Drone814 to save lives in Central PA (https://www.wtaj.com/news/local-news/nonprofit-partners-with-drone814-to-save-lives-in-central-pa/) (also picked up on Yahoo News)
- Medical drone initiative trials set for summer in Johnstown area (https://www.tribdem.com/news/medical-drone-initiative-trials-set-for-summer-in-johnstown-area/article_939fc8fc-c39e-469c-a741-5ec72829dc62.html)
- EMS Drone Initiative Trials Set for Summer in PA (https://www.jems.com/ems-operations/ems-equipment-gear/medical-drone-initiative-trials-set-for-summer-in-pa/)
- dailyamerican.com/story/news/local/2025/04/16/drones-delivering-medical-supplies-before-paramedics-arrive-somerset-county-test-program/83011079007
- Medical drone trials set for summer in Pa. community (https://www.ems1.com/ems-drones/medical-drone-trials-set-for-summer-in-pa-community)
- Medical drone initiative trials set for summer in Johnstown area (https://www.tribdem.com/news/medical-drone-initiative-trials-set-for-summer-in-johnstown-area/article_939fc8fc-c39e-469c-a741-5ec72829dc62.html)
- Medical drones to deliver life-saving supplies (https://www.wtaj.com/news/local-news/medical-drones-to-deliver-life-saving-supplies/)
- Medical care by drone delivery in the works for Cambria and Somerset counties (https://wjactv.com/news/local/medical-care-by-drone-delivery-in-the-works-for-cambria-and-somerset-counties)
- Drone technology demo in Cambria County showcases future of lifesaving medical deliveries (https://wjactv.com/news/local/drone-technology-demo-in-cambria-county-showcases-future-of-lifesaving-medical-deliveries)
- Johnstown students preview drone emergency service program (https://www.wtaj.com/news/local-news/johnstown-students-preview-drone-emergency-service-program/) (picked up by Yahoo News)
- Drone814 partners: Johnstown test run “just the beginning” (https://www.tribdem.com/news/drone814-partners-johnstown-test-run-just-the-beginning/article_644a11c0-be68-44d0-9ab8-58622d5de80b.html)

- The Zone with Referee Rich (WWCP Altoona) – Picked up local news about ELSa-M3

According to Critical Mention, a media tracking service, ELSa-M3 news content has reached a local audience of 121,154 and a national audience of 28,460,535. Figure 9 below provides images and resulting news coverage from our May 30 technology demonstration at Greater Johnstown High School.

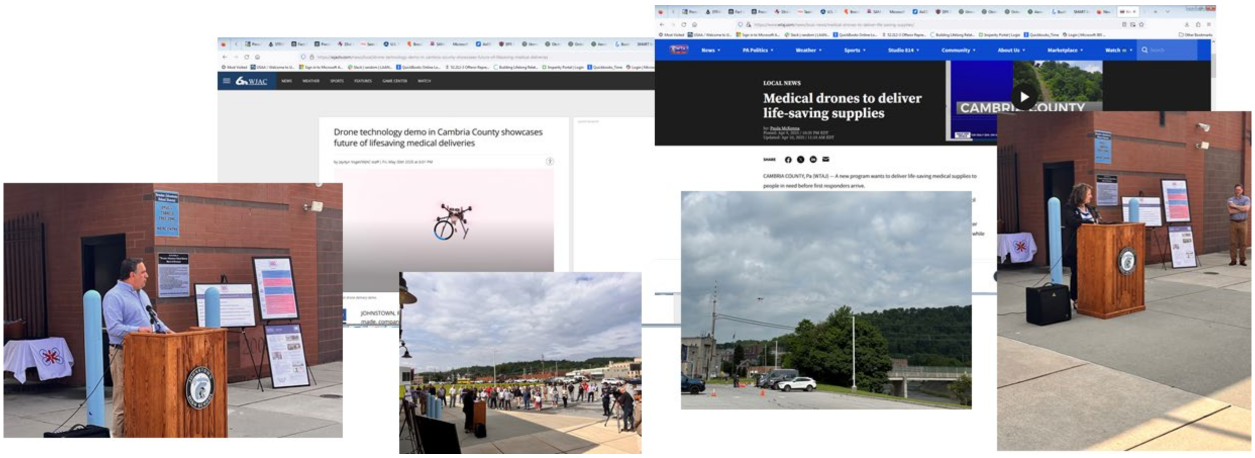

Figure 9: Technology Demonstration at Greater Johnstown High School May 30, 2025

2.7 Deviations

The original budget tasked Cambria County with procuring the necessary equipment (sensors, radios, etc.) and supplies for the project. The budget was amended to shift the procurement of equipment to the drone contracting team. The decision to amend the original budget was made solely to speed up the procurement process. The industry knowledge of the drone contracting team allowed them to process and finalize equipment bids in a timely manner enabling the project to continue progressing. The original budget and scope of work also included certain sensors that ended up not being used for the project. In particular, ground-based GPS GNSS-RTK navigation sensors and Radio Frequency (RF) triangulation sensors ended up not being replaced with comparable hardware. These technologies were not mature enough to be used effectively in this project. The use of different technologies resulted in a surplus budget. As we conducted operations, and noted above, we added additional sites such as South Fork, removed sites that we not feasible such as West End, and added a mobile unit to support UAS deployment at sites such as the West Suburban Little League fields.

The most significant deviation from plan was the inability to collect direct medical benefit data – live field data collection was limited by two specific structural limitations: i) limited funding, combined with an expensive and labor intensive contractor model, resulted in limited service hours (approximately six hours per day) that severely limited the ability to respond to 911 calls that are normatively distributed throughout the day; and ii) the Certificate of Authorization (COA) used by DroneUp for the testing was originally designed to support commercial package delivery in areas with relatively flat topography, and therefore resulted in disjointed service areas. The result was that the 911 calls either occurred outside of service hours for the day, or outside of the COA areas for operation on any given day. Therefore, system performance and benefit are estimated using a paired case-control method, comparing UAS performance data to EMS/Ambulance performance data.

3 Proof of Concept and Prototype Evaluation Findings

3.1 Stage 1 Evaluation Metrics and Criteria

The ELSa-M3 Stage 1 project evaluated the safety, performance, and scalability (both technological and financial) of drone-based emergency medical delivery supporting public emergency services by exercising a set of operational use cases through testing and live flights; this includes data collection for comparative assessment of the benefit to the patient of the drone delivery, assessment of the potential medical and cost benefits of the approach, and assessment of the UAS infrastructure's effectiveness in facilitating safe, cost-effective integration of UAS operations into the national airspace (NAS).

The goal of ELSa-M3 Stage 1 is to support the Project Objectives and future Stage 2 planning requirements by measuring the cost-benefits of ELSa-M3 including: i) drone response times to that of the peered ambulance traveling by surface; ii) potential estimated differences in resident medical status at arrival of ambulance, post-event hospitalization requirement, and overall morbidity in drone-serviced cases versus those not serviced by drone; iii) ability to service a given call and the reasons why a call could not be serviced; iv) cost of the UAS required equipment, operations and infrastructure and per-call cost of service of the program vs. conventional alternatives; v) per-call cost benefits of reduced medical transport, reduced hospital stay, and improved quality of life; and (vii) new workforce and job creation impact to ultimately operate a long-term program. These performance measures will be used to evaluate the Stage 1 prototype and develop the revenue-neutral sustainment plan for a Stage 2 capital investment rollout to the SAP&DC region.

These data collection and evaluation activities included four sets of data collection activities: i) collecting medical and cost benefit data from conducting paired drone-ambulance interventions; ii) collecting medical and cost benefit data from paired ambulance-only interventions; iii) collecting design and cost data for the supporting UAS infrastructure; and iv) collecting general statistics about the SAP&DC region, the region's geography, the region's service needs, and the region's cost structure to support economic sustainability modeling.

SAP&DC is explicitly measuring the cost-benefits of ELSa-M3 Stage 1 prototype by comparing: i) drone response times to that of the peered ambulance traveling by surface; ii) differences in resident medical status at arrival of ambulance, and overall morbidity; iii) ability to service a given call and the reasons why a call could not be serviced; iv) per-call cost of service of the program; v) per-call cost benefits of reduced medical transport, reduced hospital stay, and improved quality of life; and vi) cost of operations of the supporting infrastructure. These quantitative performance statistics are being used to develop the revenue-neutral sustainment plan for a Stage 2 rollout to the SAP&DC region.

Table 8 describes each measure, the Stage 1 objective it measures, the Stage 2 requirement it supports, and how the relevant metrics are being calculated. Our focus in these metrics is to assess the performance of the prototype specifically, try to control for externalities and confounding factors (such as weather) and avoid collecting direct patient medical information. Table 8 below describes the evaluation measures; the Evaluation Methodology discusses the relevant statistical methods for determining the validity of each metric.

Measure	Stage 1 Objective	Stage 2 Requirement	Description	Metric
Availability	1, 2	1	Total System uptime and availability (excluding externalities such as severe weather)	Total system uptime and latency during active flight periods
Response Time	2	3, 4	Comparative time before response is in motion between drone and ambulance	Comparison of drone time to flight vs. ambulance time to response (from dispatch)
Intervention Time	2	3, 4	Overall speed to delivery of intervention (e.g., ability to treat the patient)	Comparison of drone time of delivery vs. ambulance time of arrival (from response to time on scene)
Total Travel Distance	2	3, 4	Comparison of total distance traveled by each responding vehicle	Comparison of drone distance traveled vs. ambulance distance traveled
Ambulance Cost	3	3, 4	Ambulance charges for service	Comparison of unit cost of ambulance charges for response to drone; comparison between ambulance charges for drone-supported vs non-supported
Intervention Benefit	3	3, 4	Drone intervention improvement of patient condition prior to ambulance arrival	Comparison of patient status at ambulance arrival for drone supported vs non-supported
Morbidity and Hospital Cost	3	3, 4	Reduction in hospitalization time due to drone intervention	Comparison of hospital length of stay for drone supported vs non-supported

Measure	Stage 1 Objective	Stage 2 Requirement	Description	Metric
Flight Plan Performance	1, 3, 4	1, 3, 4	Measure compliance with safety plan and risk mitigation	Flight plan conformance and any reason for divergence (e.g., weather, malfunction, inappropriate landing site, etc.)
Air Safety	1	1	Separation between aircraft as a proxy measure for air risk and safety; ability to identify and detect non-participating aircraft	Compare separation of drone from other aircraft and separation between non-participating aircraft in the service area; analyze sensor performance
Adverse Events	1, 3	1, 3	Identify adverse event rate to determine relative overall safety	Adverse event counts (e.g., safety issues, patient issues, incidents) compared to ambulance alone
Infrastructure Cost Measurement	3	3, 4	Evaluate cost of ownership relative to other infrastructure / service options	Compare cost per square mile of service coverage to established metrics for road and aviation infrastructure development

Table 8: ELSa-M3 Stage 1 Prototype Evaluation Measures

3.2 Preliminary Proof of Concept Scaling Findings

During Stage 1, SAP&DC identified that the ELSa-M3 system was deployable, integratable, testable, would support safe and compliant UAS operations, would provide a time-competitive means of servicing emergency medical calls if the right equipment is used, and that data and UAS operations would scale within the service area. The ELSa-M3 team conducted a one-week test and shakedown activity June 4-8, 2025, conducted two additional shakedown weeks July 15-25, 2025, and then conducted live-field flight testing August 11-27 (during which comparative service time data were collected) and conducted live production testing October 12-25, 2025. The ELSa-M3 team identified that the system relayed all necessary data with 99.9&+ uptime and availability and with second- and sub-second latency.

One of the key findings in Stage 1 was the streamlining of the process for deployment of UAS operations sites and sensor sites. During the Stage 1 deployment, we identified standard templates and processes that allowed us to reduce sensor deployment times from multiple days to less than one day. These templates include:

- Standard draft deployment plan that identified potential sites in advance;

- Standard site survey template that allows site survey and assessment to be completed quickly in a standardized way;
- Standard draft installation guide to support consistent, compliant installations;
- Standard deployment equipment list, mounting approach, and mounting to ensure rapid, consistent, compliant installation; and
- Standard deployment documentation to support site approvals, tracking, operations, and maintenance.

In addition to the scalable network design and deployment templates and processes, the ELSa-M3 team has also identified key activities and approaches to meet the Stage 2 scalable deployment requirements. SAP&DC's Stage 1 ELSa-M3 prototype project supports Stage 2 goals of deploying drone-enhanced emergency services and cost-effective, sustainable infrastructure by identifying methods that address key risk and requirements for successful Stage 2 planning and rollout within the four Stage 2 requirements discussed above (and identifies the relevant team member), as described in in Table 9 below.

Requirement	Scaling Solution
1. Safe Integration of Scalable UAS Operations by leveraging existing county and private Certificate of Agreement and Operator Part 135 approvals with the FAA for deployment now while preparing for the FAA Part 108 Beyond Visual Line of Site rule, together with our integrated sensor and USS network, to ensure safe, FAA-compliant operations.	- Characterization of the regional airspace and potential for adverse events (including non-compliant aircraft) for safety (ACUASI, DroneUp, and ATAA) - Register of region-specific state, local, and federal (Federal Aviation Administration (FAA) and Health and Human Services (HHS)) requirements for operations at scale (Aerium ACUASI, DroneUp, ATAA) - Characterize and measure weather downtime to devise potential Stage 2 mitigations and inform overall cost-benefit (DroneUp, ATAA) - Identification of specific communications methods between CAD and UAS, between USSes, and UAS operations protocols and procedures to support safe operations at scale (DroneUp and ATAA);
2. Cost of Infrastructure, Time to Deployment, and Operational Model leveraging Stage 1 templated risk assessment, planning, and deployment model to ensure clear understanding of deployment and operating costs and keep cost variances low.	- Development of templated planning and deployment process for rapid site identification, characterization, approval, and installation - Collection of Total Cost of Ownership for UAS Infrastructure including sensor acquisition and operation costs, sensor installation costs, and software costs; (ATAA and DroneUp) - Total Service Uptime for UAS services, inclusive of system uptime and external factors such as weather, maintenance, and unforeseen events (DroneUp, ATAA, CCES) - Loading and prep time (for drone) vs Dispatch/Response gap (ambulance) to identify ways

Requirement	Scaling Solution
	to improve overall system performance in Stage 2 (DroneUp, CCES) - Infrastructure performance including coverage area and detection performance, availability and uptime of infrastructure, and latency of data relay (ATAA);
3. Demonstration of Cost-Benefit and Sustainment by continuing to partner with regional medical providers and continue the focus on reimbursable services through direct engagement with the Pennsylvania Department of Human Services.	- Collection of relevant medical cost data including ambulance reimbursement rates in Cambria County and throughout the region to support detailed commercial medical cost-benefit analysis (CCES, SFU, and Aerium) - Collection of Hospital stay costs throughout the region to support detailed commercial medical cost-benefit analysis (CCES, SFU, and Aerium) - Use of ambulance response and length of stay to asses downstream improvement in patient outcomes and value of clinical benefit (CCES, SFU, and Aerium) - Usability of medical articles by the caller/recipient to identify potential blockers to use and improve patient outcomes in Stage 2 (CCES, Aerium, and SFU) - Continue to work with Conemaugh Memorial Hospital and regional medical centers to identify service areas, reimbursement models, and additional uses (Aerium, ATAA)
4. Economic Benefit to the Community by continuing to partner and engage with local training, educational, and economic development partners.	- Continue to engage with regional partners (St Francis University, University of Pittsburgh, Aerium, JARI, Johnstown Chamber of Commerce, Carnegie Mellon University) (Aerium and SAP&DC) - Identification of specific additional regional service areas through geospatial information systems (GIS) analysis of service calls (CCES) - Specific identification of additional external organizations participating in the project and collection of feedback as well as potential future partners and beneficiaries, commercial and public (Aerium and SFU) - Measurement of community acceptance of drone services (Aerium and SFU) - Identification, measurement, and estimation of new workforce and job creation impact to ultimately operate a long-term program (Aerium and SFU)

Table 9: ELSa-M3 Stage 1 Scaling Findings Support Stage 2

3.3 Preliminary Proof of Concept Performance Findings

3.3.1 Performance Evaluation Metrics

SAP&DC focused on the Stage 1 prototype deployment, assuring a safe and effective program, managing regulatory requirements, and deploying equipment. The ELSa-M3 team conducted a one-week test and shakedown activity June 4-8, 2025, conducted two additional shakedown weeks July 15-25, 2025, and then conducted live-field flight testing August 11-27 (during which comparative service time data were collected) and conducted live production testing October 12-25, 2025. Based on initial testing, we can report the following quantitative outcomes of performance in the formal field trials, described in Table 10 below.

Measure	Stage 1 Objective	Stage 2 Requirement	Description	Initial Findings
Availability	1, 2	1	Total System uptime and availability (excluding externalities such as severe weather)	During the Stage 1 project, system services exceeded 99.9% uptime, with sub second latency for airspace awareness data syndication, and 5-8 second latency for UAS dispatch tasking. (Appendix E)
Response Time	2	3, 4	Comparative time before response is in motion between drone and ambulance	While UAS response times were similar to EMS Ambulances, the UAS was approximately 90 seconds slower to dispatch, with a median of 257.0 seconds vs 170.5 seconds (p<.01). However, 60-90 seconds of dispatch time were attributable to DroneUp elements that will be discarded in future work. (Appendix F)
Intervention Time	2	3, 4	Overall speed to delivery of intervention (e.g., ability to treat the patient)	Overall UAS response times were comparable to EMS Ambulance times, with no statistically significant distance in time in the raw data. Analysis identified that, on a head-to-head basis, the UAS would beat the ambulance 25%, but an optimization analysis based on modest performance improvements from different equipment identified that rate would likely be 40-60% in a full deployment. (Appendix F)

Measure	Stage 1 Objective	Stage 2 Requirement	Description	Initial Findings
Total Travel Distance	2	3, 4	Comparison of total distance traveled by each responding vehicle	Travel distances between the UAS and EMS Ambulances were similar, with median distances slightly longer for the UAS (3.3. vs 2.0 miles), but the differences are not statistically significant. (Appendix F)
Ambulance Cost	3	3, 4	Ambulance charges for service	The ELSa-M3 team was unable to obtain this data from local EMS brigades.
Intervention Benefit	3	3, 4	Drone intervention improvement of patient condition prior to ambulance arrival	A meta-analysis of the literature and review of likely overall effective rate of 20-30% indicates potential harm reduction to over 3,000 individuals per year in the SAP&DC region.
Morbidity and Hospital Cost	3	3, 4	Reduction in hospitalization time due to drone intervention	A meta-analysis of the literature indicated costs savings of $200 - $3,000 per intervention, depending on severity.
Flight Plan Performance	1, 3, 4	1, 3, 4	Measure compliance with safety plan and risk mitigation	Findings during test and shakedown indicated effective conformance and maintenance of well-clear. (Appendix G)
Air Safety	1	1	Separation between aircraft as a proxy measure for air risk and safety; ability to identify and detect non-participating aircraft	Leveraging a 3-7x oversampling rate, the non-participating detection network was able to detect conventional aircraft tracks in 55 of 94 grids, with specific point sensitivity of 33% and a false positive rate of 78%. While this is not sufficient for real-time track separation management, 55 of the grids have are able to detect all ADS-B tracks, supporting a procedural deconfliction approach. (Appendix G)

Measure	Stage 1 Objective	Stage 2 Requirement	Description	Initial Findings
Adverse Events	1, 3	1, 3	Identify adverse event rate to determine relative overall safety	Only one adverse event occurred during Stage 1 – a delivery line became hung up on power lines. The delivery winch functioned correctly, disconnecting the line with no injuries or damage resulting. Adverse event rate below 1% of all flights. (Appendix G)
Infrastructure Cost Measurement	3	3, 4	Evaluate cost of ownership relative to other infrastructure / service options	Stage 1 deployment total actual cost was $77,000 per square mile and $48 per covered life of system coverage. A de novo analysis, taking advantage of lessons learned, produces a cost of $38,750 per square mile and $24 per covered life. Operating cost estimates are $22,400 per square mile and $14 per covered life, assuming no amortization of program costs across jurisdictions. (Appendix H)

Table 10: ELSa-M3 Stage 1 Prototype Evaluation Measures

3.3.2 Method for Statistical Data Analysis for Stage 1 Prototype Evaluation

Table 11 below maps the elements collected in the data sets described in Section 4.4.2 to the measures described for the evaluation of the Stage 1 prototype in Section 3, and describes the specific statistical and analytical methods that will be used to evaluate and publish each metric in the final evaluation report.

Measure	Description	Metric	Data Elements Used	Analytical and Statistical Methods
Availability	Total System uptime and availability (excluding externalities such as severe weather)	Total uptime and response time during active flight periods	Sensor accuracy and error, sensor uptime and availability characterization, system and network latency, system uptime and availability,	Descriptive statistics of system technical performance (Appendix E)
Response Time	Comparative time before response is in motion between drone and ambulance	Comparison of drone time to flight vs. ambulance time to response (from dispatch)	Time to dispatch, time to response	Mean comparison between cohorts using Welch's t-test for unequal variance (Appendix F)
Intervention Time	Overall speed to delivery of intervention (e.g., ability to treat the patient)	Comparison of drone time of delivery vs. ambulance time of arrival (from response to time on scene)	Time on scene	Mean comparison between cohorts using Welch's t-test for unequal variance (Appendix F)
Total Travel Distance	Comparison of total distance traveled by each responding vehicle	Comparison of drone distance traveled vs. ambulance distance traveled	Distance traveled	Mean comparison between cohorts using Welch's t-test for unequal variance (Appendix F)
Flight Plan Performance	Measure compliance with safety plan and risk mitigation	Flight plan conformance and any reason for divergence (e.g., weather, malfunction, inappropriate landing site, etc.)	Flight tracks, diversions	Descriptive statistics, qualitative discussion (Appendix G)
Air Safety	Separation between aircraft as a proxy measure for air risk and safety	Compare separation of drone from other aircraft and separation between non-participating aircraft in the service area	Flight tracks, diversions	Analysis of Variance of separation and geospatial analysis of correlation as well as estimated positional uncertainty (Appendix G)

Measure	Description	Metric	Data Elements Used	Analytical and Statistical Methods
Adverse Events	Identify adverse event rate to determine relative overall safety	Counts of adverse events (e.g., safety issues, patient issues, incidents) compared to established metrics for ambulance alone	Adverse events	Qualitative discussion
Infrastructure Cost Measurement	Evaluate cost of ownership relative to other infrastructure / service options	Compare cost per square mile of service coverage to established metrics for road and aviation infrastructure development	Site, sensor, materials, and deployment costs, sensor detection characterization, characterized service volume	Descriptive statistics, qualitative discussion (Appendix H)

Table 11: Statistical Analysis Methods

3.4 Preliminary Proof of Concept / Prototype Alignment to Proposal

The principal project goal for ELSa-M3 Stage 1 was to identify requirements for a region-wide six-county emergency delivery UAS network to augment emergency services, reduce time to service, improve patient outcomes, and reduce costs while creating a baseline for commercial UAS services. This was reflected in four specific proposed project objectives. Table 12 below describe below how Stage 1 ELSa-M3 project activities align to the original objectives.

Objective	Aligned Activities
1. Demonstrate the ability to safely respond to services calls in the project location via drone and integrate this into the airspace.	The ELSa-M3 Stage 1 prototype developed a process for integrating UAS response into emergency services workflows, completed automation integration with Cambria County 911 CAD, and deployed an integrated USS and airspace sensing network to support safe, compliant UAS flight.

Objective	Aligned Activities
2. Reduce first on site response time vs. conventional methods, resulting in reductions in ambulance and medical cost, medical harm, mortality, and patient hospitalization time.	The ELSa-M3 Stage 1 prototype integrates directly into the Cambria County Emergency Services system, test and shakedown is complete, and SAP&DC and the ELSa-M3 team conducted formal field trials in July, August, October 2025 to collect this data by delivering NARCAN, AED, Epi Pens, Tourniquets, and Oral Glucose. Initial data show that the UAS delivery is competitive with ambulance On Scene times – however, the UAS and control software used in this project were not optimal. Transitioning to a platform that has better characteristics for speed and rapid response will make the drone platform fully competitive with ambulance on-scene times and can result in UAS deliveries ahead of EMS on scene in 40-60% of cases.
3. Demonstrate a cost-effective deployment model and fiscally sustainable plan for the Stage 2 expansion of ELSa-M3 based on the performance, benefit, and cost data collected.	The ELSa-M3 team has identified a highly efficient, cost-effective, and scalable deployment model that will deploy the network supporting services at less than $40,000 per square mile, and order of magnitude cost reduction. Further, the ELSa-M3 team has identified substantial medical benefits that will fully fund the long-term operations of the system and has begun long-term medical reimbursement discussions with the Pennsylvania Department of Human Services.
4. Develop a specific repeatable regional deployment plan for public network infrastructure, including proposed service areas, estimation of benefits, and detailed cost estimates based on Stage 1 performance data.	The ELSa-M3 has developed a highly standardized, templated process that uses COTS equipment and has developed standard cost and benefits models that can be used by other regions and localities.

Table 12: ELSa-M3 Prototype Alignment to Proposal

3.5 Proof of Concept / Prototype Statutory Areas of Improvement

Table 13 below describes the alignment of ELSa-M3 Stage 1 activities and findings to the statutory objectives of the SMART program.

Statutory Requirement	Statutory Area of Improvement
(I) reduce congestion and delays for commerce and the traveling public;	Initial ELSa-M3 prototype deployment suggests the ability to support DFR capabilities that will reduce police and fire dispatch.
(II) improve the safety and integration of transportation facilities and systems for	Initial ELSa-M3 prototype deployment demonstrates integration with the county 911 CAD system, demonstrating

Statutory Requirement	Statutory Area of Improvement
pedestrians, bicyclists, and the broader traveling public;	the ability to integrate with other dispatch and transit systems, supporting multi-modality.
(III) improve access to jobs, education, and essential services, including health care;	Initial ELSa-M3 prototype deployment testing data suggests a dramatic expansion in access to time-sensitive, lifesaving care in the Stage 1 pilot region.
(IV) connect or expand access for underserved or disadvantaged populations and reduce transportation costs;	Initial ELSa-M3 prototype deployment testing data suggests a dramatic expansion in access to time-sensitive, life-saving care in the Stage 1 pilot region in an economically depressed region with a challenging road network.
(V) contribute to medium- and long-term economic competitiveness;	Initial ELSa-M3 prototype development has already attracted interest in commercial entities leveraging the network, including Horizon Aerobotics, Electra, Beta, and ATAA.
(VI) improve the reliability of existing transportation facilities and systems;	Initial ELSa-M3 prototype development provides an alternate logistics option (UAS) to existing surface options.
(VII) promote connectivity between and among connected vehicles, roadway infrastructure, pedestrians, bicyclists, the public, and transportation systems	Initial ELSa-M3 prototype deployment demonstrates integration with the county 911 CAD system, demonstrating the ability to integrate with other dispatch and transit systems, supporting multi-modality.
(VIII) incentivize private sector investments or partnerships, including by working with mobile and fixed telecommunication service providers, to the extent practicable;	Initial ELSa-M3 prototype development has already attracted interest in commercial entities leveraging the network, including Horizon Aerobotics, Electra, Beta, and ATAA. The network provides these entities with cost-effective shared public infrastructure, lowering the cost of operations and making the region an economically attractive location to develop products and services.
(IX) improve energy efficiency or reduce pollution;	Initial modeling suggest DFR capabilities would substantially reduce public safety vehicle trips.
(X) increase the resiliency of the transportation system; and	The integrated ELSa-M3 system supports UAS logistics, providing a cost-effective alternate logistics option (UAS) when existing surface options are not available.
(XI) improve emergency response.	Initial ELSa-M3 findings suggest that UAS Emergency Medical Delivery will meaningfully improve access to care, outcomes, and costs.

Table 13: ELSa-M3 Project Goals Support Statutory Impact

4 Anticipated Costs and Benefits of At Scale Implementation

4.1 Calculated estimates of At-Scale Implementation Benefits

SAP&DC and the ELSa-M3 team developed a direct benefit model based on Emergency Medical Delivery, Commercial Medical Delivery, and Drone-as-a-First-Responder services for the six-county area. This model is discussed in detail in Section 2.3, Community Impact. Analyzing the regional population, 911 dispatch calls, prevalence of disease and known costs in the six-county region, modest estimates of success (a 20% rate of successful delivery with 50% harm reduction, which assumptions will be adjusted post-field trials in July and August 2025), deploying ELSa-M3 scalably throughout the region yields the following annual benefits:

- 15,000 dispatches (vehicle trips) avoided annually;
- Harm reduced for 2,500 individuals annually;
- 250+ lives saved annually;
- $0.5MM in annual Emergency Medical Services savings;
- $3.0MM in annual Inpatient Cost savings;
- $1.5MM in annual dispatch avoidance savings: and
- $7.6MM in annual Emergency Room savings.

It is because of these clinical outcomes benefits and potential cost savings that the Pennsylvania Department of Human Services has been willing to engage with the ELSa-M3 team to discuss what an initial reimbursement pilot might entail. Further benefits accrue from the system as it also supports commercial UAS operations, including BVLOS operations, that would also benefit from and pay into the system. These benefits can be mapped to the statutory goals of the SMART program as described in Public Law 117-58 Sec 25005 D(3)(ii) in Table 14 below.

Statutory Requirement	Statutory Area of Benefit
(I) reduce congestion and delays for commerce and the traveling public;	Initial ELSa-M3 prototype deployment suggests the ability to support DFR capabilities that will reduce police and fire dispatch by 15,000 vehicle trips per year, and also diver logistics traffic to UAS from surface vehicles.
(II) improve the safety and integration of transportation facilities and systems for pedestrians, bicyclists, and the broader traveling public;	Initial ELSa-M3 prototype deployment suggests the ability to support DFR capabilities that will reduce police and fire dispatch by 15,000 vehicle trips per year, and also diver logistics traffic to UAS from surface vehicles.

Statutory Requirement	Statutory Area of Benefit
(III) improve access to jobs, education, and essential services, including health care;	Initial ELSa-M3 prototype deployment testing data suggests a dramatic expansion in access to time-sensitive, lifesaving care in the Stage 1 pilot region with the potential to reduce harm to over 2,500 individuals annually.
(IV) connect or expand access for underserved or disadvantaged populations and reduce transportation costs;	Initial ELSa-M3 prototype deployment testing and regional modeling suggests a dramatic expansion in access to time-sensitive, life-saving care in the Stage 1 pilot region, and economically depressed region with a challenging road network, potentially servicing over 100,000 calls annually.
(V) contribute to medium- and long-term economic competitiveness;	Initial ELSa-M3 prototype development has already attracted interest in commercial entities leveraging the network, including Horizon Aerobotics, Electra, Beta, and ATAA.
(VI) improve the reliability of existing transportation facilities and systems;	Initial ELSa-M3 prototype development provides an alternate logistics option (UAS) to existing surface options.
(VII) promote connectivity between and among connected vehicles, roadway infrastructure, pedestrians, bicyclists, the public, and transportation systems	Initial ELSa-M3 prototype deployment demonstrates integration with the county 911 CAD system, demonstrating the ability to integrate with other dispatch and transit systems, supporting multi-modality.
(VIII) incentivize private sector investments or partnerships, including by working with mobile and fixed telecommunication service providers, to the extent practicable;	Initial ELSa-M3 prototype development has already attracted interest in commercial entities leveraging the network, including Horizon Aerobotics, Electra, Beta, and ATAA. The modeling of the clinical outcomes benefits, with a potential for $16MM in annual savings, creates an opportunity for development of a commercial service provider network leveraging the ELSa-M3 network in exchange for user fees.
(IX) improve energy efficiency or reduce pollution;	Initial modeling suggest DFR capabilities would substantially reduce public safety vehicle trips.
(X) increase the resiliency of the transportation system; and	The integrated ELSa-M3 system supports UAS logistics, providing a cost-effective alternate logistics option (UAS) when existing surface options are not available.
(XI) improve emergency response.	Initial ELSa-M3 findings suggest that UAS Emergency Medical Delivery will meaningfully improve access to care, outcomes, and costs. Estimated cost savings of $25MM create room to reinvest in medical and emergency services.

Table 14: Impact of At-Scale Benefits on Statutory Requirements

4.2 Cost Model for Scalable Implementation

The cost model for the Stage 2 six-county at scale deployment starts by modeling the population centers and performing a preliminary risk analysis, as described in Section 2.2 above. This modeling exercise identified 108 sites in 53 service volumes, as describe in Figure 5. Excluding the existing deployed Stage 1 sites and volumes results in the need to deploy an additional 96 sites in 46 service volumes during the Stage 2 at scale six-county rollout.

The first component of the cost model is program management, which would be executed by the same core team at SAP&DC, albeit with additional time requirements. SAP&DC would oversee the ELSa-M3 team in conducting the first phase of the rollout, which would leverage the design, planning, and deployment process describe in Section 2.4. As such, the Stage 2 cost model for planning, design, and testing is based on actual time-in-motion level of effort and personnel costs per Service Area, Service Volume, and Site.

The second component of the cost model is the acquisition and deployment, including site selection and planning, installation, and maintenance of the sensor network. This component of the cost model leverages the known sensor costs from our open, competitive procurement and assumes no volume discounts at this stage. It assumes the known costs for mounting and installation hardware, personnel time, and personnel costs.

The third component of the cost model is the acquisition of UAS equipment. There is an argument to be made that this is an external cost, to be borne by the UAS operator, however, as the success of the program and realization of the benefit requires the existence of the technical capability, we are treating this as required equipment. Costs in the cost model are based on actual vehicle and equipment costs, not assuming volume discounts.

The result is a five-year cost model with a three-year program management, equipment rollout, and operations costs of $13.2MM, describe in Figure 10.

Program Costs - ELSa-M3 Network	Year 1	Year 2	Year 3	Year 4	Year 5
Cost to Deploy Integrated Airspace Awareness Network					
Program Management	$250,000	$250,000	$250,000	$250,000	$250,000
Planning, Design, Integration and Validation	$585,600				
Cost to Acquire, Deploy, and Integrate Sensors	$4,042,527				
Operations & Maintenance		$1,497,909	$1,497,909	$1,497,909	$1,497,909
Cost to Acquire UAS and UAS Site Equipment	$4,030,000	$403,000	$403,000	$403,000	$403,000
Total	$8,908,127	$2,150,909	$2,150,909	$2,150,909	$2,150,909
Total Program Cost - Equipment (3 Years)	$13,209,945				

Figure 10: System Deployment and Operations Costs – Five Years

However, to deliver services, there is a fourth cost component, consisting of the pilot and the personnel required to operate the equipment. SAP&DC's Concept of Operations for Stage 2 is that operations would be conducted by a third-party commercial UAS vendor, however, in considering total costs of service delivery, and overall Return on Investment, these costs must also be factored in. The intent is to ensure that the medical costs savings produce a positive return on all components of the regional service. Figure 11 below describes five-year personnel costs, with a three-year total cost of $7.4MM.

Program Costs - UAS Operations		Year 1	Year 2	Year 3	Year 4	Year 5
Operations Personnel						
Technicians and Maintenance		$884,000	$1,768,000	$1,768,000	$1,768,000	$1,768,000
Pilots		$594,066	$1,188,132	$1,188,132	$1,188,132	$1,188,132
Total Pilot\ Costs		$1,478,066	$2,956,132	$2,956,132	$2,956,132	$2,956,132
Total Personnel Costs - UAS Operations (3 years)		$7,390,330				

Figure 11: System Deployment and Operations Costs – Five Years

How these costs interact with benefits to deliver return in investment is a function of whether we consider total system return, or specific return in investment for the ELSa-M3 network.

4.3 Positive ROI for At-Scale Implementation: Benefits Exceed Costs

Figure 12 below shows the calculation of Return on Investment for the At-Scale Implementation in two ways:

- Total benefit to the region and return on investment, hard dollar excluding economic development benefits
- Program specific net surplus and hard dollar return on investment assuming a commercial operator fulfills UAS operations and pays user fees into the system

Benefits to the region are calculated based on several key metrics:

- Assumption that 15% of calls are applicable to a Drone-as-a-First-Responder program, and that 20% of these avoid dispatch (consistent with reported program data);
- Given the observed service success rate of 56% and a calculated 40% - 50% of missions arrive ahead of the ambulance, a 20% harm reduction rate is applied to 2% of 911 calls, consistent with the observed incident rate on the Stage 1 Cambria County data; and
- 20% of the population use a commercial medical or commercial drone delivery service at least four times per year, consistent with observed experience in the Dallas / Ft. Worth region.

The total benefit does not assume any "value loss" to either medical reimbursement or profit margins of commercial providers. It provides a total return to the region, inclusive of any costs savings inuring to the benefit if health insurers or providers, profits to commercial service providers, and other benefits to the community. This model shows the system clearing break-even in Year 2 and estimates a five-year Internal Rate of Return of 27%.

The Program-Specific Net Surplus, or commercial approach, examines hard dollar return on investment at the ELSa-M3 network program level. It assumes 50% of the medical benefits and cost savings are consumed by health insurers, and that UAS operations are provided by a commercial service provide that pays approximately 50% of revenue into the system as a user fee. Under this model, the commercial UAS operator breaks even in Year 3, the ELSa-M3 program breaks even in Year 2, and the estimated hard dollar internal rate of return of 5%.

Calculation of Net Benefit and Returns		Year 1	Year 2	Year 3	Year 4	Year 5
Medical and Public Safety Cost Savings		$0	$4,000,000	$8,000,000	$16,000,000	$16,000,000
Flights			115,645	231,290	462,579	462,579
Value per Flight			$34.59	$34.59	$34.59	$34.59
Total System Benefit						
Medical and Public Safety Cost Savings		$0	$4,000,000	$8,000,000	$16,000,000	$16,000,000
Network Cost		($8,908,127)	($2,150,909)	($2,150,909)	($2,150,909)	($2,150,909)
UAS Operations Cost		($1,478,066)	($2,956,132)	($2,956,132)	($2,956,132)	($2,956,132)
Net Benefit		($10,386,193)	($1,107,041)	$2,892,959	$10,892,959	$10,892,959
Five Year Internal Rate of Return		27%				
Commercial Sustainment Model						
Total Flights		0	115,645	231,290	462,579	462,579
Value Share (Charge) per Flight / Reimbursement	50%	$0.00	$17.29	$17.29	$17.29	$17.29
Total Commercial Revenues		$0	$2,000,000	$4,000,000	$8,000,000	$8,000,000
UAS Operations Costs		($1,478,066)	($2,956,132)	($2,956,132)	($2,956,132)	($2,956,132)
User Fees paid into ELSa-M3 System, per Flight	$15	$0	($1,734,673)	($3,469,346)	($6,938,691)	($6,938,691)
Commercial Profit		($1,478,066)	($2,690,805)	($2,425,478)	($1,894,824)	($1,894,824)
ELSa-M3 User Fee Sustainment Revenue		$0	$1,734,673	$3,469,346	$6,938,691	$6,938,691
ELSa-M3 Network Operations Costs		($8,908,127)	($2,150,909)	($2,150,909)	($2,150,909)	($2,150,909)
SAP&DC Net Surplus Operating ELSa-M3		($8,908,127)	($416,236)	$1,318,437	$4,787,782	$4,787,782
Five Year Internal Rate of Return		5%				

Figure 12: ELSa-M3 Return on Investment – Five Years

4.4 Baseline Data

Baseline data used to develop the Stage 2 at-scale six-county rollout cost and benefit model includes the following baseline data included in this report and in Stage 1 prototype deployment data:

- Time in motion data for System Design, Planning, Sensor Installation and Integration, as described in Section 2.4;
- Actual sensor costs as described across 15 vendor products in an open competitive procurement as described in Appendix H;
- Actual related UAS equipment costs from Stage 1 costs as described in Appendix H;
- System Performance data as described in Appendix E
- Overall response time and comparative response time data as described in Appendix F
- Medical benefit determined based on literature review, known 911 dispatch calls, and known disease prevalence in the region
- Sensor performance data and analysis as described in Appendix G

5 Challenges Addressed and Lessons Learned

5.1 Administrative Challenges

The most significant administrative challenge of the project was the initial contracting phase with USDOT. SAP&DC had to retool the budget and budget justification before the master agreement with USDOT was authorized, causing a several month delay. The delay in the master agreement additionally caused a delay in SAP&DC contracting with the project partners. Despite the initial delays, the project has been able to proceed smoothly, and the entire scope of work will be completed within the period of performance.

An additional challenge was receiving local approval from our public partners. Despite local support for the project before and during the application process, certain processes needed to be followed to garner official approval. SAP&DC and our private partners held multiple meetings with the county partners to explain the expected roles of the counties and gain official approval.

The team addressed these challenges by developing templates and standardizing equipment and processes in order to accelerate the pace of roll-out and be able to leverage consistent approaches and resources wherever they reside within the ELSa-M3 team.

5.2 Process and Technology Integration Challenges

The ELSa-M3 team faced two integration challenges: 1) doing a first-of-its-kind drone dispatch integration with the Cambria County 911 CAD system and 2) integrating airspace surveillance data, USSes, and UAS ground control software as complete many-to-many integration, which has not been done before.

CAD integration challenges included how to integrate the UAS into a CAD system not designed for it, and how to add an additional response mechanism while not disrupting dispatcher workflow or providing confusing instructions to the caller. The ELSa-M3 team overcame this challenge by working closely with the dispatchers and the EOC team in Cambria County to identify where to add the UAS as apparatus (resulting in a standard dispatch), identifying key nature codes for which the UAS intervention is meaningful, and developing a focused dispatcher workflow and script to insure information is communicated effectively to the caller while maintaining clarity and efficiency in the EOC.

The medical articles were pre-packaged into a single, color coded “intervention” box which will weigh less than 10 pounds to streamline loading and dispatch of the drone conducted by DroneUp, and simplify delivery to, and use by, the caller. The dispatch of the drone with the intervention box was made by the CCES dispatch center, and the dispatcher will be responsible for following protocols developed by the CCES dispatch director which were used to direct DroneUp to dispatch the drone, using the roles described in Table 15 below. Once the box reaches the intervention site, the dispatcher walks the caller through the use of the medical articles using existing protocols. Further, the Cambria County medical director determined appropriate state medical protocols and individual protocols at the service level as required, and CCES and SFU supported briefing the individual ambulance service medical directors. Table 3 below describes the roles of the actors in the emergency medical dispatch and treatment scenario. Appendix A includes the detailed Emergency Services Protocols.

Actor	Role
Caller	Calls dispatch to request assistance, administers articles when drone arrives under the guidance of the dispatcher
Dispatcher	Follows protocols to determine if drone dispatch is appropriate, directs DroneUp to dispatch, guides caller through use of medical articles
Remote Pilot	Follows dispatch direction and delivers articles in accordance with Flight Plan and protocols
Responder	Responds to incident dispatch, treats patient upon arrival and transports patient to hospital, collects field data
Medical Director	Will draft protocols that comply with state and federal requirements and ensure compliance with dispatch and use protocols

Table 15: Dispatch and Treatment Roles

The technology integration challenges were more straightforward, as individual integrations have been conducted and ASTM standards for UAS Traffic Management (F3548-21) and Supplemental Data Service Providers (F3623-23) already existed and provided technical guideposts. The ATA Aviation team led the integration and testing effort and supported this complex challenge by created and test and quality assurance plan to guide integrations, managed and oversaw both tabletop and field-testing exercises, and managed a joint project plan that detailed the specific integrations required between the different systems (CAD-SDSP, SDSP-USS, USS-USS, USS-UAS, SDSP-UAS).

In conjunction with the UAS Concept of Operations, the System Quality Assurance and Testing Plan, and the System Design Document, SAP&DC, CCES, DroneUp, ATAA, Aloft, and OneSky will conduct dedicated testing sessions to ensure that the various digital systems (navigation, sensors, UTM systems, ground control software) are properly integrated with correct functionality and meet availability, uptime, and latency targets. These discrete systems testing sessions used existing open-source testing tools and evaluate system integration and performance against the referenced ASTM standards.

In addition to simulation and tabletop systems testing, the ELSa-M3 team also conducted live-flight shakedown testing where we will conduct 40 hours of flights over 5 days, simulating dispatch, flight, and integration to test performance of the SOPs and protocols, system integration performance, flight control and safety of UAS, and ability to effectively deliver the medical articles.

5.3 Regulatory and Policy Challenges

In Stage 1, delivery of medical articles occurred via drones operated by DroneUp in a mixture of FAA Class C (controlled) and Class G (uncontrolled) airspace. LAANC grids are deployed in the region, but not enabled. As such, operations were conducted under three existing regulatory authorities: i) the existing Cambria County public COA and Emergency Services waivers with RemoteID equipped aircraft; ii) the DroneUp delivery operations 49 U.S.C. §44807 Special Authority; and iii) the DroneUp 14 CFR Part 135 authorization for UAS-based delivery services. All of these FAA regulatory paths require detailed risk analysis and minimizing flight over uncovered people. Therefore, the ELSa-M3 Aerium EASSE SDD conducts a careful analysis of Service Volume risk and UAS operations and sensor siting accounts for these risk factors. These existing regulatory authorities plus the Aerium SDD provide the regulatory approvals to service the initial Service Area from 2 UAS operating sites.

One of the challenges with the DroneUp regulatory authorities is that they were developed for commercial package delivery operations in areas with a relatively flat topography. Combined with the LAANC UASFM grids not being enable, the result was a highly constrained set of operating areas (representing less than 50% of the total service area and potential COA operating areas). This was a necessary trade-off, but highlighted the need to engage directly with the FAA to develop specific approvals for the ELSa-M3 program that supported broader operations and the ability to service the entire operating area from 1-2 fixed locations.

Ideally, we need to be able to operate drones to their full, 15-30-mile operating capacity. As such, the ELSa-M3 team has been developing a set of additional regulatory pathways to support long-distance BVLOS UAS operations. These include developing: i) a set of regional COAs and waivers that the ELSa-M3 team can submit using the performance data from the fully characterized ELSa-M3 Aerium EASSE collected during the July, August, and October 2025 Field Trials; and ii) using the ELSa-M3 Aerium EASSE, partner integrations, and UAS operations data to submit a “Near Term Approval Process” (NTAP) package to the FAA for an FAA Letter of Authorization to operate a regional BVLOS system. Both of these solutions are currently in process with the FAA.

Further, the FAA landscape for UAS regulations continues to evolve. The Notice of Proposed Rulemaking for the FAA BVLOS was released in late 2025, and we expect the rule to take effect in the near future. Of note, the FAA has identified the ELSa-M3 project as a project of interest that can help the FAA learn about potential models for the implementation of the BVLOS rule.

Assisting in the ELSa-M3 teams FAA discussions, the UAS infrastructure developed for ELSa-M3 supports operational safety and risk mitigation by supporting procedural deconfliction and detect-and-avoid capabilities on other flight operations and flight plans in the project area on a real time basis. Data services and interfaces deployed as part of the UAS infrastructure were developed in accordance with industry standards, including ASTM F3548 – 21 (UAs Traffic Management (UTM) Standard), ASTM F3442/F3442M − 23 (Detect and Avoid Standard) and ASTM F3623-23 (Airspace Surveillance Supplemental Data Service Provider (SDSP)) to ensure data are useable going forward and we enable maximum data sharing.

5.4 Contractor Model, UAS Equipment and Software Challenges

One significant issue, as discussed in Appendices F and H, was the use of a contractor partner, DroneUp, to accelerate deployment and approval of the system. While there was no issue with DroneUp per se, and the DroneUp team acquitted themselves admirably, two issues were highlighted during the Stage 1 project. The first was the issue of the cost model – contractor personnel are expensive, and emergency operations tend to be “low frequency-high severity” meaning that personnel have to be ready to respond while enduring long periods of waiting. This model is not conducive to a contractor cost model that is designed to support high volume, high frequency operations. The result was that, combined with the COA restrictions, the actual ability to service the overall area was severely constrained. Another issue was the use of the DroneUp software and vehicle – selected because they allowed for rapid deployment and approval, which DroneUp provided. However, the vehicle and related software were designed and optimize for use in retail commercial delivery – where there was a requirement to support hundreds of delivery articles in an environment that was not as time critical. The result was a cumbersome dispatch process and a vehicle that did not have the optimal speed profile.

Both of these issues can be addressed in the Stage 2. The ELSa-M3 team has undertaken two specific activities to address them. The first is to bring the operations personnel (pilots, mechanics, support) in house, and this is actually consistent with the regulatory direction being pursued by the ELSa-M3 team with the FAA. The result is that the Stage 2 system will be staffed using existing personnel, reducing cash cost of staffing to zero and resulting in an effective modest cost of allocated time. Additionally, the ELSa-M3 team is in the process of acquiring commercial off the shelf vehicles and software that: i) support faster flight speeds and delivery times; ii) have a simplified launch process that reduces dispatch time; and iii) allows the team to rely on cost-effective, commercially supported products.

5.5 Community Acceptance Challenges

The ELSa-M3 team expected a substantial amount of community pushback and negative feedback concerning the use of UAS in the community and issues related to privacy safety. However, as the team has engaged in community outreach, the reaction from the community has been almost completely positive. The only challenges we have met are: i) ensuring that every single person in the community is aware of the program and how to apply the medical articles being delivered; and ii) communities in Cambria County wanting to know why this service won't be available in their community or available sooner. During operations, the team received only one concerned phone call, and adjusted routing to address the constituent's concerns.

The ELSa-M3 team addressed the awareness and knowledge challenge through hosting community events, engagements with schools and civic organizations, local medical providers, and engagement with regional media such as the Johnstown Tribune-Democrat, the Altoona Mirror, and local television stations WTAJ and WJAC. The ELSa-M3 team addressed the concerns about service availability by encouraging local political subdivisions (e.g., Conemaugh Township, Richland Township, Lower Yoder Township, Dale Borough) to engage directly in the ELSa-M3 Stage 2 process.

6 Deployment Readiness

6.1 Status of Deployment

The ELSa-M3 Stage 1 prototype is complete, with field testing and shakedown complete.

6.2 Requirements for Regional At-Scale Deployment

In order to deploy at scale, SAP&DC and the ELSa-M3 team have identified four key requirements:

1. Demonstrate the ability to safely respond to services calls in the project location via drone and integrate this into the airspace.
2. Reduce first on site response time vs. conventional methods, resulting in reductions in ambulance and medical cost, medical harm, mortality, and patient hospitalization time.
3. Demonstrate a cost-effective deployment model and fiscally sustainable plan for the Stage 2 expansion of ELSa-M3 based on the performance, benefit, and cost data collected.
4. Develop a specific repeatable regional deployment plan for public network infrastructure, including proposed service areas, estimation of benefits, and detailed cost estimates based on Stage 1 performance data.

Having successfully procured, deployed, and integrated this equipment, the greatest barrier to scaling is the site identification, selection, planning, and approvals process. Given that our Stage 2 six-county roll out would support 96 sites in 46 service volumes, standardization and repeatability are of the essence. This is why, during ELSa-M3 Stage 1, the team developed a set of templates and repeatable process (described in Section 2.4) where we have already substantially reduced time and cost to install the sensor components of the network.

In addition to these programmatic requirements leveraging the standardized, repeatable deployment process developed in Stage 1 with known-cost items, the ELSa-M3 team has also considered the following key topics in Table 16 below as identified in the SMART program guidance.

Stage 2 Areas of Concern	Readiness and Potential Obstacles
Legal, Policy, and Regulatory Requirements	Expanding the area serviced by ELSa-M3 in stage 1 from a singular city to a six-county region will require additional regulatory and legal work to ensure the project maintains compliance with state and federal law while maintaining a high level of performance. The larger service area necessitates additional environment review to ensure Stage 2 work is compliance with NEPA. Additionally, all procurement to establish an integrated, region-wide UAS and sensor network will continue to abide by BABA requirements as it has in stage 1. FAA COAs and waivers which allow UAS operations in our stage 1 service area will also need to be revisited as they are currently insufficient for the long-range

Stage 2 Areas of Concern	Readiness and Potential Obstacles
	drone deployments planned for Stage 2. To this end, the ELSa-M3 team has been developing a set of additional regulatory pathways to support long-distance BVLOS UAS operations as discussed in Section 5.3 of this document. Also, of note, this project represents a novel regulatory case for BVLOS rulemaking to the point where the FAA has labeled ELSa-M3 a project of interest. We currently collaborate with FAA through information and data exchanges likely to continue in Phase 2.
Procurement and Budget	A large service area and higher volume of UAS flights will necessitate the expansion of budgetary requirements and procurement needs in a potential Stage 2 grant. Rising material costs, especially for the required sensors, could pose an obstacle to a region-wide rollout but have been anticipated in preparing cost projections for Stage 2. Conversely, SAP&DC may be able to drive product discounts on substantial orders of equipment.
Partnerships	Another potential obstacle could present itself is in delays related to local approval from municipal and county-level governments. In Stage 1, these delays occurred despite preexisting support from these groups in the application process. Lessons learned from these experiences have been applied to an updated, standardized, templated process for site identification, planning, approvals and installation. The ELSa-M3 team will prioritize Service Volume planning and site identification, planning, and approval early in the process.
Technology Suitability and Integration with Incumbent Systems	A Stage 2 rollout could encounter some potential obstacles in regard to both the technologies deployed and the integration of additional CAD systems into UAS operations. As previously discussed, the proposed Stage 2 service area could require long-range drone operations of 15-30 miles. While our platform is capable of flights of this distance without issue, additional standard operating procedures will have to be developed to address the challenges associated with long-distance deployments in a systematic manner. Additional issues may arise with sensor placement and operation due to the region's rugged topography and rural nature. Additionally, integration between the project's UAS and Cambria County's 911 CAD system proved to be challenging in Stage 1. Stage 2 promises integration with several other County 911 systems across the region of unknown nature and technical specifications. The nature of integration work will require detailed attention to be paid to each of these EMS organizations and their operations in order to allow UAS to interface properly and autonomously. The ELSa-M3 team will apply lessons learned from CAD integration, as discussed in Section 5.2 of this document. Finally, SAP&DC may use lease instead of buy for those airspace awareness sensors that have a rapid technology cycle, insulating from the financial impact of the need to perform early technology refresh due to the advancement of the state of the art.

Stage 2 Areas of Concern	Readiness and Potential Obstacles
Data Governance	Critical to data governance in a six-county rollout is for SAP&DC to lead a data governance work group for the regional ELSa-M3 system, ensuring that data meets requirements as described in the ASTM standards and FAA regulations, while also protecting privacy.
Workforce Capacity	The long-term viability of a Stage 2 deployment will require a higher level of regional workforce development in both drone operations and support roles. Regional EMS services are generally understaffed and under-resourced – especially in this regard. Stage 2 of ELSa-M3 will explore strategies to expand regional workforce capacity in the necessary sectors.
Internal Project Coordination	Internal project coordination between the various working groups of the ELSa-M3 project has been broadly effective and has enabled the team to accomplish a significant amount of work despite a shortened period of performance. Stage 2 expansion would require a similar level of effectiveness to ensure multiple competing priorities can be seen to completion despite a much larger service area geography. Our current organizational makeup is likely flexible enough to accommodate additional staff and working priorities, but a thorough review of Stage 1 work processes will be conducted at the conclusion of our period of performance in order to optimize them prior to Stage 2.
Community Impact	Additional work is needed to characterize the operational impact of a potential Stage 2 on the regional airspace. However, it is likely such impacts will be similar in nature to those already shown in the stage 1 service area. Additional inquiries will need to be conducted to ensure that UAS operations in a potential stage 2 deployment are unobtrusive but still capable. Infrastructurally, sensor siting work will become a larger component of a Stage 2 deployment. We will need to work closely with local partners to ensure proper installation and sensor coverage of a more rural and remote landscape than that of Stage 1. In terms of health impacts in an expanded Stage 2 service area, the ELSa-M3 team has already modeled the potential benefits of the six-county regional rollout in terms of improved health outcomes and costs savings in immediate known areas of improvement. However, we will need to continue to partner with regional health systems and health partners to identify additional, potentially beneficial, areas such as whole blood delivery that may require changes to plan or additional specialized equipment or infrastructure.
Public Acceptance	We expect that many residents of proposed Stage 2 serviced areas may hold an initially skeptical attitude towards the project. To counter this, a potential Stage 2 rollout will require a coordinated outreach campaign involving local community organizations, news media, schools, civic organizations, medical providers, and other local stakeholders based on the successful Stage 1 campaign.

Stage 2 Areas of Concern	Readiness and Potential Obstacles
Cybersecurity	Cybersecurity challenges in a potential Stage 2 deployment would be similar to those in Stage 1 but on a much larger scale. Our software solutions are secure and scalable, but a large project presence with a greater number of missions will increase the visibility of our systems to threats and malicious actors. Additional auditing work may need to be completed to ensure our information systems remain secure. For baseline security, ELSa-M3 relies on AICPA SOC II Type 2 hosting environments configured to a NIST 800-53 FIPS 200 Moderate level. As we add additional capacity, we will also have to evaluate how scaling of data volumes impacts performance and security under these two standards.
Change to Better Suited UAS Equipment	As identified in the Lessons Learned, Results, and Appendices, the equipment used by DroneUp was not optimal for the ELSa-M3 mission. While sufficient to deliver the initial system, prove out the concept, and validate baseline performance, it is not sufficiently robust or fast to support the required level of ROI. The ELSa-M3 team has already identified existing COTS equipment and is in the process of acquisition to shift to this COTS equipment.
Change of Staffing Model	The contractor staffing model created meaningful financial and structural constraints the both reduced the ability to provide full coverage but also rendered the long-term financial model of the program tenuous, as the cost of contractor personnel is prohibitive and an order of magnitude higher than allocated public safety personnel time. The ELSa-M3 team is already assembling a regional public safety team to support an FAA application for a regional program staffed directly by public personnel.

Table 16: Readiness of ELSa-M3 Stage 1 for Stage 2 Deployment

As described above, SAP&DC and the ELSa-M2 team have spent a substantial amount of time in the Stage 1 prototype deployment identifying templatized, standard methods for planning, development, deployment and integration. These processes are taken into account in our Stage 2 rollout plan and budget, and our Stage 2 budget reflects actual known cost and time.

Further, the project partners are in place, familiar with the work and systems, and have the ability to simply roll forward, adding Service Volumes and sites to the ELSa-M3 network.

6.3 Supporting Maintenance and Operations

As described in Section 2.4, the ELSa-M3 team has developed a highly standardized, templated site survey and installation process. As such, the team has real world data on time in motion and costs associated with installing, operating, and maintaining these sites that act as a good guidepost for estimation in Stage 2. Section 4.4 describes baseline cost and performance data collected in Stage 1, including an open, competitive procurement that allowed the team to see refresh and update costs across 15 different products, providing a fairly wide view of costs. The ELSa-M3 team baked all of these known factors into our roll-out budget and estimates for Stage 2.

6.4 At-Scale Rollout Supports Economic Development

Basic initial modeling estimates the creation of 42 technician and 20 pilot jobs within three years as ELSa-M3 is deployed regionally. Further, as noted above, the ELSa-M3 has already attracted the interest of multiple commercial UAS and aviation companies interested in leveraging this infrastructure and helping develop the regional ecosystem.

7 Summary Wrap Up

Summary lessons from the ELSa-M3 Stage 1 prototype deployment include:

- Deployment of the Stage 1 system was successful, with a fully functional system that enjoys 99.9%+ uptime, sub-second latency for airspace awareness, and automated drone tasking in 5-8 seconds;
- The airspace awareness network is functional, providing 25 square miles of initially validated coverage to detect both participating and non-participating aircraft, and further improvements are forthcoming
- The network has the ability to support integration with UAS Traffic Management services for strategic deconfliction
- The cost profile of the system, at $24 per covered life to deploy and $14 per covered life to operate, continues to be costs competitive – and these numbers are based on conservative assumptions
- The UAS was able to service 56% of simulated calls
- The UAS was able to provide initial delivery times that are competitive with an EMS ambulance, and is estimated to beat the ambulance 25% of the time in its current configuration
- The UAS and software used in ELSa-M3 were identified as sub-optimal in terms of speed of vehicle and time required to physically dispatch the unit – new commercial units have been identified that will likely increase the proportion of arriving in advance of the ambulance to 40-60% of the time
- The contractor staffing model, as evaluated, was identified as the wrong model for going-forward projects – staffing the system with public safety personnel results in a more cost-effective staffing model that is also consistent with FAA regulatory pathways
- The ELSa-M3 team has already initiated the FAA regulatory discussions to support the Stage 2 project
- The initial project plan as proposed identified all of the key areas for work in Stage 1 and most of the goals, with the exception of specific clinical data collection, were met
- A well-validated process for deployment and strong understanding of costs was developed and is available for future projects
- The deployment of hardware largely occurred on schedule and within budget constraints, once contracting was concluded
- Commercial and job-creation knock on benefits are exceeding expectations, the desire for this type of infrastructure from the aerospace industry is strong
- The project and its expected benefits were effectively conveyed to the community through various engagement methods, including media spots, public meetings, project demonstrations, and open houses, which were well received by the community

- Community engagement and excitement with the project exceeds expectations, the desire for this type of service is substantial
- Even with an approvals process, use of only public sites results in substantial savings of deployment cost, operating cost, and deployment time
- We believe a Stage 2 deployment can be transitioned to a revenue-neutral system within 3-5 years
- The developed process is highly templatized and can be repeated for communities around the country
- The project established a process of coordination between public and private entities to smoothly deliver a project over the period of performance that can be replicated in other communities
- Other than delays with the initial contracting process with USDOT, no significant delays or adverse effects were encountered

8 APPENDIX A: Emergency Services Protocols

Cambria County Emergency Services

Drone Integration Requirements / Protocols

Version 2.0

6 June 2025

Contents

8.1 Flight Operations

Dispatcher Training [identify 1 or 2 dates before end of May]

Provide a detailed briefing to dispatchers, get feedback on protocols, conduct elementary training and plan testing during testing and shakedown week.

Testing and Shakedown Week: 6/2-6/8

We can collect operational performance and safety data during this week.

Interventional Test Week 1: 7/14-7/25 (Service Volume 4 – Westmont/Southmont)

We will collect intervention-specific data this week. This will be specifically for a Service Volume 4.

Non-Intervention Control Data Service Volume 4: 7/28-8/8

We will collect the same ambulance-only performance data for Service Volume 4.

Interventional Test Week 2: 8/11-8/22 (Service Volumes 1, 2, 3 – Johnstown/Conemaugh)

We will collect intervention-specific data this week. This will be specifically for a Service Volumes 1, 2, 3.

Non-Intervention Control Data: 8/25 – 9/5

We will collect the same ambulance-only performance data specifically for a Service Volumes 1, 2, 3.

8.2 Pre-Deployment Planning

8.2.1 Framing Notes

Many/Majority of the time, the dispatcher doesn't know it's an overdose until the ambulance crews tell them; they know if it's a cardiac arrest but don't necessarily know why. Therefore, it is important to ensure that drone dispatch is only used when:

- The coding allows us to know that the incident would specifically benefit from the products being delivered by the drone; AND
- The dispatch would occur before / coincident with the ambulance dispatch (after is useless).

We will identify the applicable nature codes in advance and these define where the apparatus is added for dispatch. We have already added the apparatus to these nature codes, and have identified the drone operations sites, airspace sensor sites, and delivery area boundaries based on the drone and sensor sites in advance. Further, we will analyze population density, structures, suitability for delivery and other factors in advance to pre-determine potential risk and assist the pilot in determining if a given dispatch delivery site is to risk to service at dispatch time for emergency drone delivery using background risk and environmental factors at time of dispatch request. This determination will be made by the DroneUp flight team and used to accept or reject the dispatch.

We designed these dispatch protocols with three overarching factors in mind, which are related and have some natural tension between them:

- Minimize workload and new procedures on the dispatcher – push as much data from CAD out to the drone team so that dispatcher has to do little to no communication and resulting response decision is transferred to the drone team so that the dispatcher does not have to actively track the drone dispatch;
- Minimize workload/new procedures for the dispatched ambulance crew; and
- Minimize the degree to which the 911 caller is surprised by the Emergency Drone delivery.

8.2.2 Relevant Nature Codes

Based on discussion and of the appropriate / relevant medical events and articles, we have identified that the drone apparatus should be specifically added to the following nature codes. We have identified the following codes, described in Table 1 below, that we believe are appropriate based on the type and severity of the event.

Incident Category	Nature Code (s)	Box Item(s)
Diabetic Problems	13-D (Level D – Unconscious)	Oral Glucose, AED
Traumatic Injuries	30-D (Level D – Unconscious, Arrest)	Tourniquet, AED, Bandages
Overdose/Poisoning	23-E (Narcotic/Opioid Arrest) 23-D (Arrest, Unconscious, Changing Color)	NARCAN, AED
Hemhorrage/Lacerations	21-D (Dangerous Hemorrhage)	Tourniquet
Cardiac or Respiratory Arrest	9-E (Workable Arrest) 9-D (Ineffective Breathing?)	AED

Incident Category	Nature Code (s)	Box Item(s)
Allergies/Envonomations	2-E (Ineffective Breathing) 2-D (Not alert)	Epi Pen
Stab/Gunshot/Penetrating Trauma	27-D (Wounds, Unconscious	Tourniquet

Table 1: Relevant Nature Codes

8.2.3 Scripts

Dispatchers use scripts provided by ProQA that are embedded within the Infor system, and these scripts cannot be easily modified. Nor do they need to be, because apart from the notification to the caller that a drone has been dispatched and some specific instructions for retrieval and use of the medical articles box, no additional script is needed.

Additional script lines and ProQA script references are described in the Dispatch Card in this document, to be used in accordance with the Dispatch Integration Sequence described below.

8.2.4 Items to be Completed Prior to Deployment

The five following items must be completed prior to field testing and deployment of the system for data collection Flight Testing:

- Match dispatch codes - complete
- Feedback from the Dispatchers on design and workflow / workload
- Feedback from the ambulance crews on design and workflow / workload
- Add “apparatus” or “unit” to the dispatch sets for each of these identified codes
    - Add the DroneUp Unit/Apparatus to those codes in the CAD so they are automatically dispatched for matching codes / severity via an alarm card/response card
    - Code the apparatus as “DRONE1” as DroneUp will operate one drone at a time for the pilot and geocode to relevant Emergency Service Zones
- DroneUp has received a MobileCAD account and training
- Acquire relevant articles:
- Tabletop testing / training exercise – scheduled June 2

8.3 Draft Deployment Protocol

8.3.1 Overall Dispatch Integration Sequence

The following outline described the proposed dispatch sequence.

1) DroneUp notifies dispatch (via phone call) when DRONE1 apparatus is in/out of service
    a. When DroneUp arrives and verifies DRONE1 is "flight ready" – notify dispatch that DRONE1 is in service - **EMS Line: 814-472-2576**
    b. If at any time during shift, drone is non-flyable for any reason, call dispatch and notify that DRONE1 is out of service – when drone flyable again, notify dispatch that DRONE1 is in service - **EMS Line: 814-472-2576**
    c. When DroneUp finishes for the day, notify dispatch (via phone call) that DRONE1 is out of service - **EMS Line: 814-472-2576**
2) Caller calls in with emergency, if nature code matches relevant nature code and severity, drone apparatus is added automatically in alarm/response card and "DRONE1" dispatched concurrent with ambulance dispatch
    a. Relies on alarm / response card and apparatus mapping described in pre-deployment activities
    b. Ambulance dispatched as normal course – no changes
    c. Automatically generates dispatch call to drone team / DroneUp through DroneUp MobileCAD account – does not require dispatcher to perform additional work
3) DroneUp/DRONE1 receives dispatch notification via MobileCAD
    a. DroneUp accepts call notification by clicking "OK"
    b. Question: We can pass the address from MobileCAD to ATAA to DroneUp / MobileCAD to DroneUp or DroneUp can just key the address directly? (see questions re: DroneUp MobileCAD account and APIs)
4) DroneUp software determines if the address can be safely serviced at the time based on address, pre-calculated GIS data, and other factors
    a. DroneUp will finalize status within 60 seconds as this allows the dispatcher to know there is no drone coming if they need to provide an updated
        i. Change Status to "En Route"
    b. If DroneUp can service, dispatch drone
        i. Once off the ground, Drone Up adds "INFLIGHT" in notes
    c. If DroneUp cannot service due to terrain, weather, equipment
        i. Drone Up adds "NOSERVICE – [REASON]" in notes
        ii. no further dispatcher requirement beyond what they normally do in dispatching the ambulance
        iii. When DroneUp can't service, DroneUp records reason why in MobileCAD and in their own log, using one of the following reasons:
            1. Technical
            2. No Pilot
            3. Weather
            4. Not Serviceable Area
            5. Other
    d. Dispatcher doesn't know anything about drone UNLESS DroneUp accepts – if DroneUp rejects, no new or additional workflow for dispatcher

5) The EMS Dispatcher notifies the Fire/Call Take Dispatcher that drone is en-route and primary dispatcher informs caller
    a. MobileCAD/Infor notifies equipment dispatcher that DRONE1 has accepted the call
    b. Equipment Dispatcher notifies responding ambulance crew that drone is en-route (no surprises)
    c. Dispatcher notifies caller that drone and ambulance are en-route; this may be a single notification or separate based on sequence of acceptance
        i. Do we notify as acceptance comes in or together? If DRONE1 accepts first, do we wait for ambulance to accept?
        ii. Dispatcher notifies caller that Drone is en-route using DRONE1 Dispatch Card and Script
    d. Dispatcher provides information to caller that drone is en route and on how to use articles in box from DRONE1 Dispatch Card and Script
6) When DroneUp arrives at the scene, change status to **"On Scene"**
7) Note: if Drone is en-route and can't complete delivery in a timely manner for any reason,
    a. DroneUp types "INCOMPLETE" in the notes
    b. **DroneUp MUST CALL DISPATCH AND NOTIFY THEM - EMS Line: 814-472-2576**
8) When DroneUp completes delivery, type "DELIVERED" in the notes
9) When DRONE01 is back on scene and ready to go, change status to "Available"
10) Normal dispatch workflow after notification that DRONE1 is en route – no new/further action for dispatcher related to the drone
11) After treatment, we need to retrieve AED / Box
    a. Ambulance crew collects
    b. If not, Conemaugh Memorial Hospital Paramedic Unit is second line of collection
    c. If not, then the drone team needs to collect
    d. The ambulance crew may be able to retrieve. Need to train ambulance crew; they can hand in the articles at the ED and we can do final retrieval from ED
    e. Backup plan- put a tracker in the box as a backup plan
12) After-event CCES data collection (may be done by an intern or staff member)
    a. CAD Data
        i. Call time
        ii. Dispatch time
        iii. On Scene Time for Ambulance
    b. Follow up data with ambulance crew (CCES)
        i. Patient status at arrival (Enumerated)
            1. Conscious and Breathing
            2. Unconscious and Breathing
            3. Unconscious and Not Breathing
        ii. Ambulance charges for that call (Dollar)
        iii. Length of stay in hospital (Days)
    c. Control Data for the same codes during the off weeks

i. Patient status at arrival (Enumerated)
   1. Conscious and Breathing
   2. Unconscious and Breathing
   3. Unconscious and Not Breathing
ii. Ambulance charges for that call (Dollar)
iii. Length of stay in hospital (Days)

8.3.2 ECC/CAD Dispatcher Side of Dispatch

This sequence only represents what the DISPATCH side sees.

1) Caller calls ECC
2) Primary Dispatcher follows usual dispatch protocols
3) Primary/Equipment Dispatcher sees that DRONE1 has accepted call on MobileCAD
4) Equipment Dispatcher notifies Primary Dispatcher that DRONE1 is en route
5) Primary Dispatcher notifies caller that drone is on the way in addition to the ambulance, and provides information from DRONE1 Dispatch Card and Script
6) Additional notes may become available from DroneUp team

8.3.3 DroneUp Side of Dispatch

This sequence only represents what DroneUp / DRONE1 sees.

1) DroneUp start shift
   a) Set up drone for ready mode
      i) Equipment layout
      ii) Install battery (or do we do this at dispatch to save energy?)
      iii) Preflight check
      iv) Mount preloaded labeled / colored compartmented box –sealed and locked up when not in “ready mode”
      v) Notify dispatch DRONE1 “in service” - **EMS Line: 814-472-2576**
   b) Out of Service – if while in ready mode, the vehicle, pilot, weather or other known conditions prohibit response within 60 seconds, notify dispatch that drone is “out of service” - **EMS Line: 814-472-2576**
      i) No-fly conditions
         (1) Malfunction in equipment
         (2) Pilots unavailable
         (3) Extreme heat or cold
         (4) Winds Aloft >23kts
         (5) Heavy precipitation
2) DroneUp receives dispatch notice from MobileCAD
   a) DroneUp accepts call notification by clicking “OK”
   b) Change Status to “En Route”

3) DroneUp determines if they can service within 60 seconds and notes status in MobileCAD
    a) Service determination based on condition of pilot and equipment and determination by flight planning if address is serviceable
    b) If DroneUp cannot service, Drone Up adds "NOSERVICE – [REASON]" in notes in MobileCAD call and DroneUp log:
        i) Technical
        ii) No Pilot
        iii) Weather
        iv) Not Serviceable Area
        v) Other
4) If DroneUp can service,
    a) Drone Up adds "INFLIGHT" in notes after DroneUp dispatches
    b) If delivery cannot be completed, call dispatch and notify that DRONE1 cannot complete delivery/service call
        i) DroneUp types "INCOMPLETE" in the notes
        ii) DroneUp calls the **EMS Line: 814-472-2576**
5) When DroneUp arrives at the scene, change status to **"On Scene"**
6) DroneUp delivers and Ambulance arrives (sequence to be learned)
    a) If ambulance arrives first and is on-site, DroneUp does not deliver. Collect the data for on-scene but not make delivery.
    b) Otherwise, DroneUp delivers – watch for person on the ground awaiting delivery
7) When DroneUp completes delivery, type "DELIVERED" in the notes
8) DroneUp DRONE1 returns to base and DroneUp makes any follow up / flight log notes and safety reports
    a) Record call time
    b) Record "in air" time
    c) Record delivery time
9) When DRONE01 is back on scene and ready to go, change status to "Available"
    a) Drone is "in service" in ready mode

8.3.4 Data Collection

For intervention benefit set, metrics are collected for ambulance side for both intervention and non-intervention periods, for the drone side on the intervention period.

8.4 Medical Articles Used

The table below lists the specific proposed medical articles for packaging in the pre-packaged box. It is proposed that DroneUp purchase these and be the "owner" of the goods for purposes of compliance with FAA waiver requirements.

Item	Unit/Make Model/SKU	Weight	Dimensions	Number	Cost
AED	Philips HeartStart FRx Model M5068A	3.3Lbs	2.8” x 7.4” x 8.3”	7	$1649.99
AED Pads	Philips HeartStart Replacement Pads – Adult M5071A	Included with AED (replacement)	Included with AED (replacement)	50	$89.00
Oral Glucose	Gluco-To-Go 15	<5 Oz (3 pack box)	< 5.59 in x 2.44 in x 2.09 in (3 pack box)	20	$14.99
NARCAN	NARCAN Nasal Spray 4Mg, in box	<2 Oz	2.98 x 2.39 x 5.61 inches	50	$44.97
Tourniquet	C-A-T Combat Application Tourniquet CAT1	2.7 Oz	6.5 x 2.4 x 6 inches	50	$30.86
Epinephrine	TBD	<5 Oz	1 1/2 in x 6 7/8 in x 3 15/16	50	~$100
Compression Bandages	RHINO RESCUE 6" Emergency Compression Bandage, 10 Count	< 5 Oz	7 x 4 x 0.5 inches	5	$55.90
Nitrile Gloves	Flash-Aid First Aid Gloves	< 2 Oz	6 in. x 4 in. x 0.5 in.	5	$19.50

Item	Unit/Make Model/SKU	Weight	Dimensions	Number	Cost
	Individually Wrapped – 20 Pack				

Table 2: Medical Articles to be Delivered

Estimated Budget: Goods ($25,468.23) + Tax and Shipping ($2,500.00) = $28,000

AED and Pads

https://www.heartsmart.com/Philips-HeartStart-OnSite-Home-AED--M5068A_p_906.html ($1649)

https://www.heartsmart.com/pdf/philips-heartstart-onsite-aed-brochure.pdf

https://www.heartsmart.com/philips-heartstart-hs1-adult-pad-m5071a-p

www.usa.philips.com/healthcare/product/HC861304/heartstart-frx-automated-external-defibrillator) ($1809)

Oral Glucose Gel

https://www.amazon.com/GLUCO-GO-15-Glucose-Flavored/dp/B0C5W283BY

NARCAN

https://www.amazon.com/NARCAN-Emergency-Treatment-Overdose-Single-Dose/dp/B0CDQMYP39

Tourniquet

https://www.amazon.com/CAT-Combat-Application-Tourniquet-Time-Stamp/dp/B01ITAKG6A/ref=sr_1_5?crid=CDX8TGNCVCV4&dib=eyJ2IjoiMSJ9.tYJ1mkB4NxyYZYP

PmdSHzbOJTsBioFghTyEb6xBCeTL2eUnuyr-LuvNPRdgNonq4_LuGeUqtr3QKtn7oj7PO7b6VwlGyumeq-EucUiGbHyOdIzrVtmGV7zBO-XgIn_YpKP1S_J64AmtmrjZFYNsIsIHoerPkjwfpFQhss6-n27OSTYK-60NvgQjWotGmc6Hd_GGCrH4iDd2xl3Xv6McmcxC2xCrTXkFaZGct1ohZd3PNWJBXXPzZm6yYsvqeN3RxUYt5OFJAx1O4lxrWarzOO_SM-fClNLzoyqcdkioRhjk.TPcgofB78ZadHfsCEbDsVIKpINgUByILyH7S0QL5tAA&dib_tag=se&keywords=tactical%2Btourniquet&qid=1744223446&sprefix=tactical%2Btourn%2Caps%2C88&sr=8-5&th=1

Nitrile Gloves

https://www.amazon.com/First-Aid-Gloves-Individually-Packaged/dp/B09XQ8XFTD/ref=sr_1_6?crid=Z0I9709PCP4G&dib=eyJ2IjoiMSJ9.SpCSsu7LsXgjyPhl9aNtw6ZQe93kOPkHljt-dqOgj9YqFddBZTQXVJoVEHWsl0QEwYL-j3ODPyj2gP2qr5yILl_bJgVFAPpzvfEftTHxO6uAZSetu4STPUyJGCISJBDpXIYINanqgqOi8zMir8j1DWNElfevdyidN2oG27e5lxwqs9H6xFjJiTOJaGzRo7H8-c_Qjs007Dx074veR3QsBQsUeKoKDZ8d02CCr8DGvi5ExLUx3KSWoisbPmJa4JkIl_86iaUeGqSZy1LCNgvWYgicpkx2a8YdCF_fEBFqgpk.6gYmq0MjNMmgc46J6pN_1Mr44ooJePnG7PjEmclOCw8&dib_tag=se&keywords=nitrile+gloves+individually+wrapped&qid=1744831536&sprefix=nitrile+gloves+individual%2Caps%2C96&sr=8-6

Compression Bandage

https://www.amazon.com/Emergency-Compression-Dressing-Tactical-Supplies/dp/B09PN9N4CT/ref=sr_1_3_sspa?crid=TBUUYRZAX98F&dib=eyJ2IjoiMSJ9.GVyLYZYP9qhWERuD0QzYebZePra-8dSAtXjG5PKYJvhGiWZHWPgMqKDgzmdpaPhN9eof3RQt1CoDLQQGIzWCxWi-gvvyEVKzFU2-SNkyyfTrwA2qEUvGPgg7P37zvNhSmFLmiruBfkVwGTPkZ0NhK4lAY32ete7mvRcBBhAMBxAmD2INN6Jm75FbL-TBmOsYez0e2QybGrY2JuLza5sLwYO1nilrFivmu2NcZt7I7R_kMq95UE_v8ZjHj4yVkPS-AOz1Mn6KTu-XR3eVVeO7ft2oYMdjUimAIlru_7A3Q18.43UOhrcjZJbM0qyOeIsvxt7PgEyWls6W-IXjE3SOvIk&dib_tag=se&keywords=bandages%2Bfor%2Bwounds&qid=1744831614&sprefix=bandages%2Caps%2C98&sr=8-3-spons&sp_csd=d2lkZ2V0TmFtZT1zcF9hdGY&th=1

8.5 Box Design

The box will be a white box the will:

- Compartmented into six (6) color coded, labeled compartments
- The box will be sealed prior to loading and delivery
- The box will have an EMT/ Paramedic Logo on the bottom
- The box will have contact information for CCES Dispatch, CCES Non-Emergency, and DroneUp on the box
- Ideally, the box would have some type of red flashing LED(s) to denote it is an Emergency package

The box compartment design is laid out in Table 3 below.

Item	Compartment Label	Compartment Color
AED/AED Pads	1/Heart Attack	ORANGE
Oral Glucose	2/Diabetic Shock	BLACK
NARCAN	3/Overdose	RED
Tourniquet	4/Bleeding	GREEN
Epinephrine	5/Allergic Shock	BLUE
Nitrile Gloves / Compression Bandages	6/Gloves/Bandages	WHITE/NO COLOR

Table 3: Delivery Box Layout

8.6 DRONE1 Dispatch Card and Script

"We are also dispatching a drone with treatment items. Is there someone who can go wait for the drone to retrieve the box?"

No: "Do not leave the victim"

Yes: "Send them to wait outside and look for the drone. **The drone will lower the box – don't touch the box until it is on the ground. The instructions will tell you which item to use.** If the ambulance arrives first, ignore the drone."

Incident Category	Nature Code (s)	Box Item(s)	Box Compartment
Diabetic Problems	13-D (Level D – Unconscious)	Oral Glucose	Black 2/Diabetic Shock
		Defibrillator/AED	Orange 1 / Heart Attack
Traumatic Injuries	30-D (Level D – Unconscious, Arrest)	Tourniquet	Green 4/Bleeding
		Defibrillator/AED	Orange 1 / Heart Attack
		Bandages	
Overdose/Poisoning	23-E (Narcotic/Opioid Arrest) 23-D (Arrest, Unconscious, Changing Color)	NARCAN	Red 3/Overdose
		Defibrillator/AED	Orange 1 / Heart Attack
Hemorrhage/Lacerations	21-D (Dangerous Hemorrhage)	Tourniquet	Green 4/Bleeding
Cardiac or Respiratory Arrest	9-E (Workable Arrest) 9-D (Ineffective Breathing?)	Defibrillator/AED	Orange 1 / Heart Attack
Allergies/Envenomation	2-E (Ineffective Breathing) 2-D (Not alert)	Epi Pen	Blue 5/Allergic Shock
Stab/Gunshot/Penetrating Trauma	27-D (Wounds, Unconscious)	Tourniquet	Green 4/Bleeding

Table 1: Relevant Nature Codes

9 APPENDIX B: System Design Document

Aerium District Enhanced Aviation Safety Service Enablement (Aerium EASSE)

Minimum Viable Infrastructure System Design Document

Prepared by ATA Aviation

Version 1.0

22 April 2026

Prepared for Aerium by:

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Contents

9.1 Overview and Executive Summary

The project focus is on deploying cost-effective solutions enabling near-term services and return on investment through "Flight Information Exchange" (FIX) and "Minimum Viable Infrastructure" (MVI). FIX-MVI creates Public Digital Services that support industry needs today and into the future. FIX is focused on cost-effective, secure mechanisms for data sharing to support Federal Aviation Administration (FAA) requirements for safe AAM integration as Public Digital Services. MVI is a risk-based approach to infrastructure resulting in cost-effective deployment of infrastructure enabling immediate next steps in AAM. The result is a return on investment and a path to financial sustainability within two-three years.

The *Emergency Life Saving through Multi-Modal Mobility* (ELSa-M3) project will demonstrate the of emergency drone delivery to underserved communities in the south western region of Pennsylvania, specifically Johnstown and environs. ELSa-M3 proposes, through the development of a cost-effective and affordable public network, to enable public emergency medical logistics via drone. The project involves nine partners including Southern Alleghenies Planning and Development Commission (SAP&DC), Cambria County Emergency Services, Somerset County Emergency Management, The Alaska Center for Uncrewed Aircraft Systems Integration, St. Francis University, Aerium, DroneUp, Aloft, OneSky, and ATA. The project lead, SAP&DC, serves six counties in southwestern Pennsylvania made up of urban, suburban, and rural communities in a mountainous region. This region experiences high vulnerability to climate risk and flooding, substantial low-income communities, and is historically medically underserved.

This document defines the Aerium District (Aerium) initial service area and the associated minimum viable infrastructure (MVI) system design document (SDD) supporting the Aerium/ELSa-M3 Enhanced Aviation Safety Service Enablement (EASSE) Area (AERIUM EASSE). It characterizes the types of operations that will be present, the risks associated with those operations, and the scale of MVI needed to safely execute those operations in the AERIUM EASSE. This document should be considered a foundation for the design and enablement of the AERIUM EASSE.

Successful implementation of MVI in the AERIUM EASSE will support the growth of the aviation industry, provide new goods and services for residents, and set the stage for advanced air mobility (AAM) by focusing on AAM capabilities that are ready now. MVI in the AERIUM EASSE will deliver functional Public Digital Services that support these and future capabilities—the concept is to realize benefits that are available now while paving the way for the future. An important and critical distinction is the role of the AERIUM EASSE in the Sense and Avoid / Detect and Avoid (DAA) problem – it is not the objective of the AERIUM EASSE to provide detect and avoid services, but rather to provide ground based data services that providers of DAA can integrate into their solutions and use to provide compliant DAA services.

The AERIUM EASSE pilot project is intended to be "multi-use" infrastructure: supporting Public Safety missions, commercial AAM services, and airspace integration and safety research. As such, the AERIUM EASSE is intended to be long-term, potentially even permanent, infrastructure and is intended to support six discrete research goals:

1. Characterize airspace in a real-world environment over a longer (>12 months) period of time;
2. Characterize performance of Data Services within a multi-modal sensor approach in a real-world environment over a longer (>12 months) period of time;
3. Assess the performance and use of a multi-model approach supporting Beyond Visual Line of Sight (BVLOS) flight in support of the ELSa-M3 project;
4. Assess the usability of Public Digital Services in supporting DAA service for BVLOS flight;
5. Assess the performance and benefit of the multi-modal approach to support Public Safety missions, both Drone as a First Responder (DFR) and Counter-UAS (cUAS);
6. Assess the cost profile (both deployment and O&M) along with potential services and benefits to residents to develop real world costing and ROI models; and
7. Develop valued-added user fee discussions and design through USS integration to begin identifying and developing a model for supportable infrastructure.

9.2 Introduction and Approach to Advanced Aerial Mobility Infrastructure

AAM is the combination of Uncrewed Aerial Systems (UAS) Traffic Management (UTM - sUAS, <55Lbs), Urban Air Mobility (UAM - large vehicles for transporting people and freight), Regional Air Mobility (RAM – electrification and autonomy), and traditional Air Traffic Management (ATM). The premise isn't just about drones – it's about enabling the next generation of aviation: remote, autonomous, accessible, and inexpensive. Doing this effectively requires a substantial expansion of capabilities – communications, planning, charting, airspace awareness and coordination, airspace management, and local zoning and planning.

An AAM Enhanced Aviation Safety Service Enablement (EASSE) needs to account for the development of infrastructure (physical, digital, policy, and configuration) while also charting a path that allows for the elements of infrastructure to be developed and deployed in a manner that is incremental and risk based. By charting a path for incremental roll-out of AAM infrastructure, we can manage the technical and performance risk of new infrastructure investments while also reducing total system cost by leveraging existing infrastructure and focusing new investment specifically where needed to address risk and demand. The result is a "MVI" approach to the roll-out of AAM focuses on the discovery of existing infrastructure that can be repurposed for AAM; the hosting of basic public information services by State and Local agencies; and supporting basic, reusable integrations that scale across vehicles and across the different components of the AAM spectrum. The infrastructure for AAM (excluding vehicles) will likely fall into four key categories:

- **Physical infrastructure**, consisting of both public and private infrastructure, on- and off-airport, such as: take-off and landing areas; Vertiports; Delivery Hubs; transfer facilities; and maintenance and operations facilities.
- **Digital infrastructure** consisting of ground-based sensors for vehicle position and navigation, environmental and weather sensors, navigation and charting services, and vehicle communications.
- **Policy infrastructure** clarifying basic operating rules on the ground, schedules, allowable supplemental rules, and common standards of use.
- **Configuration infrastructure** that supports localities describing how physical infrastructure can be used in a manner consistent with policy infrastructure and provided through digital infrastructure.

Critically, *much of the infrastructure listed above already exists in some form today*. The key is to identify, organize, and publish it to the AAM industry. We can approach the development of an EASSE plan through the following steps:

- **Establish Asset Governance**: Establish a basic, minimum-necessary governance activity that supports state and local agencies in consistently discovering, describing, configuring, and publishing physical and digital assets into the AAM system;
- **Asset Discovery and Publication:** Through the Governance activity, work with state and local agencies to discovery AAM assets (e.g., take-off and landing areas, existing sensors) that can be properly and consistently described and published into the AAM system;
- **Asset Integration:** Conduct basic data integration and asset publication through digital infrastructure for use by AAM operators and vehicles; and
- **Plan and Pilot Investment:** Identify targeted opportunities to invest in specific physical, digital, policy, and configuration infrastructure through asset integration to demonstrate functionality and performance of the EASSE.

One key aspect of FIX-MVI AAM infrastructure is a commitment to infrastructure sustainability as a key driver of an economically viable AAM industry. Current models' costs are in the range of $250,000 - $1,500,000 per square mile. Experience in Virginia and in ongoing work in states with enablement using the hybrid model suggests initial enablement costs in the range of $25,000 - $50,000 per square mile with long-term costs in the range of $1,500 - $2,000 per square mile by leveraging existing infrastructure and using hybrid public-private services. Not only is a lower cost model valuable in that it supports the ability to enable services over wider areas (especially for lower income and underserved communities), but it also results in lower long-term operations and maintenance costs, reducing the risk of under-maintained or abandoned infrastructure.

This initial roadmap for the AERIUM EASSE is intended to provide an initial assessment, design, and plan for an initial pilot rollout what is necessary to achieve “UTM 1.0” given the desired operations.

9.3 Summary Description of Proposed Concept of Operations

The AERIUM EASSE pilot rollout is focused on demonstrating AAM infrastructure for the ELSa-M3 SMART demonstration project in Cambria County and laying the groundwork for further development within the county. The EASSE is focused initially on two main classes of operations: public safety operations to demonstrate clear public benefit in the county, and support for the emergency medical delivery operations proposed for the ELSa-M3 project in Johnstown and Westmont. In both cases, the objective is to demonstrate and measure public and commercial benefit and to collect the data necessary to support the case for additional public and private funding. This section provides details on specific operational types that could be supported under the AERIUM EASSE to support the identification of specific operating areas and assess the risk levels to determine the level of fidelity of surveillance and groundspace description necessary to address the operational-specific risk mitigations. Operational types are based upon specific UAV mission objectives. They include:

- Public Safety Drone as a First Responder (DFR) for incident response types such as search and rescue and crisis situations;
- Medical Delivery (small package), emergency and non-emergency;
- Detection of UAS incursions for both public safety and protection of airport operations in support of local policy, critical infrastructure protection, and general public safety; and
- Part 107 Commercial Survey / Videography.

Additional operational types will be included as the AERIUM EASSE MVI progresses through sensor deployment, gathering of operational data, and evidence-based awareness of needs identified through primary implementation. The efforts will commence with Part 135 Beyond Visual Line of Sight (BVLOS) or Extended visual line of sight (EVLOS) operations, defined as operations monitored visually by an external observer other than the pilot and exploring larger (Group 3 and above) UAS operations under waiver that will allow us to collect the operating data to file for an FAA waiver, COA, or exemption operations for sUAS under either the Public Safety or NTAP programs.

The following table describes the initial planned Operational Types, including equipment specifications, control modes, approximate ranges, examples of Takeoff and Landing areas (ToLa), and examples of payloads. Note the operation type identification number in the left column:

#	Operation Type	Equipment	Control Mode	Range	ToLa Types	Payload
1	Public safety response / event response	sUAS <25Lbs	VLOS, EVLOS, BVLOS	1-3 Mi	Public	Imaging sensors
2	Emergency Medical delivery (NARCAN, AED, Epi, etc.)	sUAS <55Lbs	BVLOS, EVLOS	3-5 Mi	Public, and private	NARCAN, AED, EPI, Tour iquet, Glucose
3	Non-Emergency Medical Delivery	sUAS <55Lbs	VLOS, EVLOS, BVLOS	3-5 Mi	Private	Packages < 5Lbs (HAZMAT, Controlled)
4	Retail delivery	sUAS <55Lbs	VLOS, EVLOS, BVLOS	3-5 Mi	Private	Packages < 5Lbs
5	Survey / Videography	sUAS <5Lbs	VLOS	<1 Mi	Private and Public	Imaging sensors

Table 1: Operational Descriptions

The summary operational description above is the basis used to develop an operation-specific risk level model. Operations are categorized into four levels of risk, with increasing levels of failure modes, effects, and criticality analysis, referred to as FMECA Risk Tiers:

- Class D: This risk category is never acceptable and must either be engineered out of the system or the operational category must be prohibited.
- Class C: This risk category constitutes outcomes where specific, demonstrable mitigations and redundancies must be engineered into the solution to effectively lower the Class.
- Class B: This risk category consists of those risks for which likelihood or severity are low enough to not warrant specific mitigation but do warrant alerting to the operator.
- Class A: This risk category consists of those risks that do not warrant further action.

The operation specific risk breaks into categories of likelihood and severity per the FMECA matrix below. Based on the assessment of individual operations, the potential severity of the different risk categories can be assessed. This provides the ability to correlate across the proposed operations and the ground assessment to identify the level of service fidelity required for a given operation. The FMECA matrix defines the statistical likelihood of an event cross referenced to the level of risk, and results in the FMECA risk level of the operation:

Severity →

Likelihood ↓

	Catastrophic	Hazardous	Major	Minor	Negligible
Likely P>0.5	D	D	D	C	B
Possible 0.1<=P<0.5	D	C	C	C	B
Unlikely 0.05<=P<0.1	C	C	C	B	B
Rare 0.00025<=P<0.05	C	B	B	B	A
Nil 0<=P<0.00025	B	B	A	A	A

Table 2: FMECA Characterization

Based on the operational descriptions and the FMECA matrix above, the table below allows for a qualitative assessment of operational risk that allows us to describe specific risks and mitigations and place each expected operation type into a FMECA category that can then be used to plan the depth and fidelity of enablement coverage.

#	Complexity Elements	Specific Risks	Specific Mitigations	Risk Category
1 (DFR)	Potential for intersecting flight paths; other public safety activity	Loss of separation between UAVs or Manned Aircraft; Vehicle Failure; Exhausted Power Supply	Route/Groundspace design; DAA	Category B; possible minor to negligible

#	Complexity Elements	Specific Risks	Specific Mitigations	Risk Category
2/3/4 (Del)	Potential for intersecting flight paths; other public safety activity; lowering / delivering goods	Loss of separation between UAVs or Manned Aircraft; Vehicle Failure; Exhausted Power Supply; ensnaring delivery apparatus; potential loss of payload over populated areas	Route/Groundspace design; enhanced surveillance and awareness for route planning, deconfliction DAA	Category B/C; possible minor to major hazard
5	Potential for intersecting flight paths; vehicle malfunction	Same as 1	Route/Groundspace design; DAA; awareness	Category A

Table 3: Operational Risk Characterization

9.4 Service Volume Description

9.4.1 Ground Risk Tiers

The analysis of ground risk differs from overall operational risk in that we essentially only consider three factors and their interaction with the likelihood and severity of a ground impact: i) population density and exposure on the ground; ii) structures that either contribute to the likelihood of ground impact or mid-air collision or the severity of incident; and iii) topographical features that contribute to the likelihood of ground impact or mid-air collision. Further discussion about how to assess each of these factors follows:

- Population Density and Exposure: This risk considers ground population, population density, population activity, and the nature of structural cover to assess their contribution to the risk of mortality and morbidity in the event of a ground impact incident;
- Air Traffic Density: This risk considers the air traffic density of the specific service volume;

- Structure Risk: This risk considers degree to which ground based structures either contribute to the risk of a mid-air collision (in the case of cranes, towers, or RF interference) or the severity of a ground impact (as in the case of hazardous materials or flimsy cover;
- Climate Risk: This risk considers the region-specific weather patterns and microclimate risks associated with operational type, such as unpredictable winds and visibility due to topographical and structural features; and
- Topographical Risk: This risk considers specific topographical features that may contribute to challenging flight conditions (such as unpredictable winds), loss of communications (such as ridges), or navigational ambiguities (such as inability to assess terrain).

Within these factors, we can assess Low, Medium or High risk. Because these risks are difficult to quantify, the Low/Medium/High determination for a given factor within a service volume and the overall determination of ground risk for that volume should be narratively derived. That risk can then be matrixed against the operational risk analysis to derive an overall risk pairing, which will then provide a level of requirement enablement fidelity and currency.

In exploring how we segment a particular operational area into enabled volumes, the segmentation can be along topographical lines (because of natural communications barriers that will be required to treat the volumes separately), operational lines (because of the intended operating areas), or natural “risk” lines that divide a volume based on overall risk.

The risk analysis in the System Design document supports two key aspects of the enablement plan: Procedural Deconfliction and Systems and Sensor Integration Activities. The Systems and Sensor Integration components support real time event, environmental, and weather data advisories that support safe and compliant operations.

The premise in the Systems and Sensor integration activities is to focus on existing, functional systems and sensors that are currently available in the marketplace as the building blocks of FIX-MVI for the AERIUM EASSE. The key to FIX-MVI is to overlay “Tiers” of sensors to provide the right level of fidelity and currency relative to the combined operational / ground profile. The System Design Document will provide specific geospatial volumes for service enablement that represent the synthesis of operational goals, ground topography and assessment, and risk mitigations and tolerances.

The model assumes three Tiers of Performance Based Information provided by the sensor network:

- Tier 1 (Green) provides position, awareness and environmental services at the lowest Performance level, for a combination of lower risk, lower density service volumes and operations
- Tier 2 (Yellow) provides position, awareness and environmental services at a mid-Tier Performance level, for medium level risk, medium density service volumes and operations or for areas where a medium or high-risk operation occurs in a low risk service volume
- Tier 3 (Red) provides position, awareness, and environmental services at a high-performance level, commensurate with current General Aviation services, intended to support medium or low risk operations in a high-risk volume, such as adjacent to a General Aviation airport or over an urban core where the risk of injury is greater

Table 4 below provides examples of sensors, costs, and potential coverage areas by Tier. The intent is for Tier 1 to be implemented in Phase I, Tier 2 and Phase II, and Tier 3 in Phase III.

Tier	Example Sensors	Cost Profile	Example Coverage Area Type(s)
Tier 1 (Green)	Procedural deconfliction + • RemoteID • ADS-B • Weather • GNSS RTK beacons	Inexpensive <$5,000 / sq mi	Low Density Rural sUAS operations at low weight / altitudes / Part 107 Procedurally deconflicted AAM at higher altitudes
Tier 2 (Yellow)	Tier 1+ • Audio • Optical • RF / RDF	Mid-Cost $10,000 - $25,000 / sq mi	Low Density Rural Cargo Suburban Metro sUAS package delivery Group 2 long distance / Group 3 UAS conducting survey activities
Tier 3 (Red)	Tier 2+ • Radar/LIDAR	Higher Cost > $50,000 / sq mi	Major Urban Area, Airports UAM Vehicle Vertiport Areas sUAS package delivery at high weight

Table 4: Examples of Tiered Sensor Infrastructure

The AERIUM EASSE is focused on enabling detailed airspace characterization and supporting navigation and surveillance services initially for Group 1 / Group 2 sUAS, growing to Group 3 UAS, in selected identified service areas that can demonstrate clear public benefit and financial viability. The overall service area and the service volumes are described below. The AERIUM EASSE covers a set of high-benefit areas defined in Johnstown and Westmont by high dispatch volume, and demonstration services in South Fork to demonstrate and evaluate a potential regional rollout and support additional BVLOS infrastructure inspection services. Figure 1 below describes the final operating areas as deployed during the ELSa-M3 project.

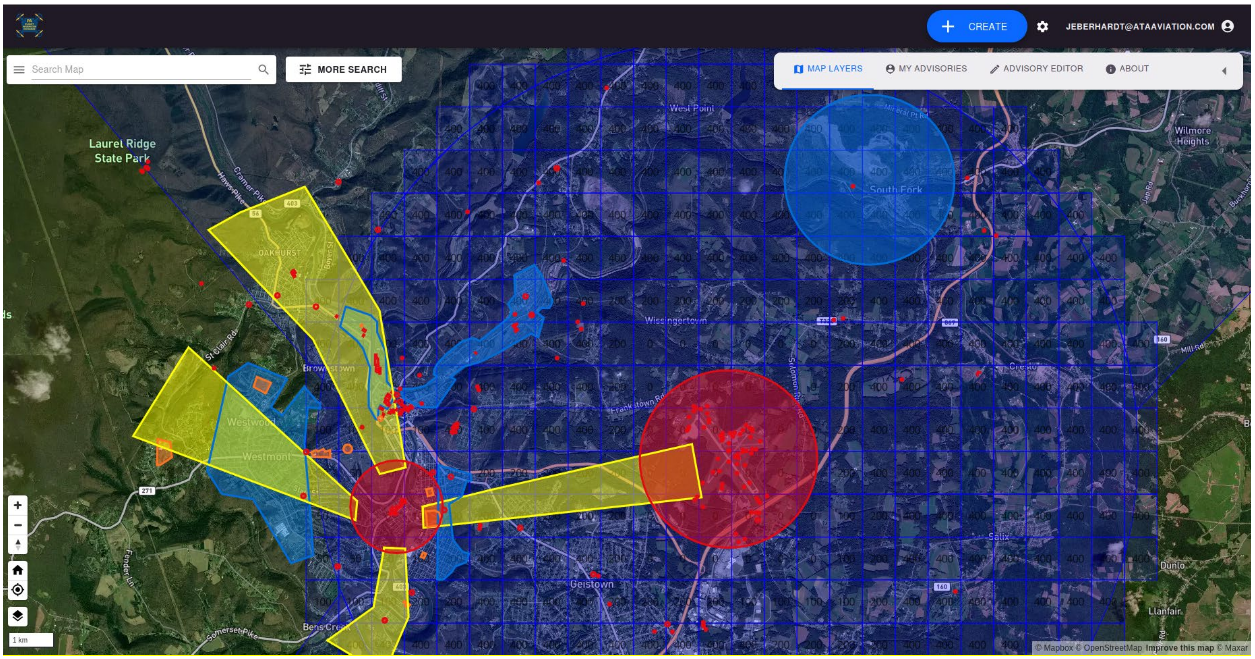

Figure 1: Deployed AERIUM EASSE

9.4.2 Area of Enablement – Physical Volumes

To enable an area for service, we need to identify specific physical volumes for service enablement. Each volume may be bounded by i) topographical features, iii) desired area of service, iii) risk boundaries, or iv) a combination of the above. The basic proposed service area creates a set of discrete service volumes in the populated areas of the Johnstown Urbanized Area in Cambria County and test areas in South Fork and Altoona. The AERIUM EASSE contains seven distinct service volumes, each with specific risk characteristics:

- Service Volume 1: Service Volume 1 consists of the East End of Johnstown. It includes central Johnstown, Dale Borough, Moxham, and Ferndale as well as neighborhoods that extend east along the Johnstown Expressway and Conemaugh River. It consists of a plain between hills to the East, West, and North. It constitutes a medium-density residential-commercial area consisting of primarily low-rise structures with a few taller (5-10 story) buildings, however it is adjacent to, but excludes, Conemaugh Memorial Medical Center, which includes a heliport. This Service Volume is supported by Seventh Ward Ambulance/EMS as an ambulance site, and is intended to be serviced by a central

drone hub site at the Central Park Complex at 110 Franklin St, Johnstown, PA 15901. Service Volume 1 consists of Cambria County Census Tracts 1, 2, 3, 5, 6, 7, and 110 with a total population of 11,861 over 3 square miles for a mean population density of 3,594.2 persons per square mile.
  - Will be operated as a contiguous service area with Service Volumes 2 and 3 with a total population of 24,334 over 9 square miles, with a mean population density of 2674.1 persons per square mile.
- Service Volume 2: Service Volume 2 consists of the West End of Johnstown. It includes central Johnstown, Cambria City, Minersville, Morrellville, Oakhurst, and Coopersdale as well as neighborhoods that extend west along PA-56 and the Conemaugh River. It consists of a plain between hills to the South and North. It constitutes a medium-density residential-commercial area consisting of primarily low-rise structures with a few taller (5-10 story) buildings. This Service Volume is supported by West End Ambulance/EMS as an ambulance site, and is intended to be serviced by a central drone hub site at the Central Park Complex at 110 Franklin St, Johnstown, PA 15901. Service Volume 2 consists of Cambria County Census Tracts 1, 12, 134, and 136 with a total population of 7,914 over 3 square miles for a mean population density of 2,729.0 persons per square mile.
  - Will be operated as a contiguous service area with Service Volumes 1 and 3 with a total population of 24,334 over 9 square miles, with a mean population density of 2674.1 persons per square mile.
- Service Volume 3: Service Volume 3 consists of the population centers along the Little Conemaugh river in the North End of Johnstown. It includes central Johnstown, Prospect, Woodvale, Franklin, and East Conemaugh. It consists of a plain between hills to the East and West. It constitutes a medium-density residential-commercial area consisting of primarily low-rise structures with a few taller (5-10 story) buildings. This Service Volume is supported by East Conemaugh Fire/EMS as an ambulance site, and is intended to be serviced by a central drone hub site at the Central Park Complex at 110 Franklin St, Johnstown, PA 15901. Service Volume 3 consists of Cambria County Census Tracts 102 and 134 with a total population of 3,365 over 3 square miles for a mean population density of 1,246.3 persons per square mile.
  - Will be operated as a contiguous service area with Service Volumes 1 and 2 with a total population of 24,334 over 9 square miles, with a mean population density of 2674.1 persons per square mile.
- Service Volume 4: Service Volume 4 consists of the suburbs of Westmont and Southmont. It consists of a plain and hills west of a large ridgeline to the East. It constitutes a medium-density residential-commercial area consisting of primarily low-rise structures. This Service Volume is supported by West Hills Fire / Hilltop EMS as an

ambulance site, and is intended to be serviced by a central drone hub site at the Hiram G Andrews Center, 727 Goucher St. Johnstown, PA 15905. Service Volume 4 consists of Cambria County Census Tracts 112 and 134 with a total population of 3,365 over 3 square miles for a mean population density of 1,246.3 persons per square mile.

- Service Volume 5: Service Volume 5 consists of the immediate environs of John Murtha Johnstown-Cambria County Airport. It is not intended to be an immediately serviced volume, but will be enabled for data collection purposes for establishing safety baselines. Service Volume 5 consists of Cambria County Census Tract 107 with a total population of 3,122 over 9.3 square miles for a mean population density of 336.8 persons per square mile.
- Service Volume 6: Service Volume 6 consists of the immediate environs of South Fork, PA. It is intended to be enabled for demonstration of infrastructure inspection as part of a regional rollout and will be enabled for data collection purposes for establishing safety baselines. Service Volume 6 consists of Cambria County Census Tract 132 with a total population of 3,943 over 19.6 square miles for a mean population density of 201.6 persons per square mile.

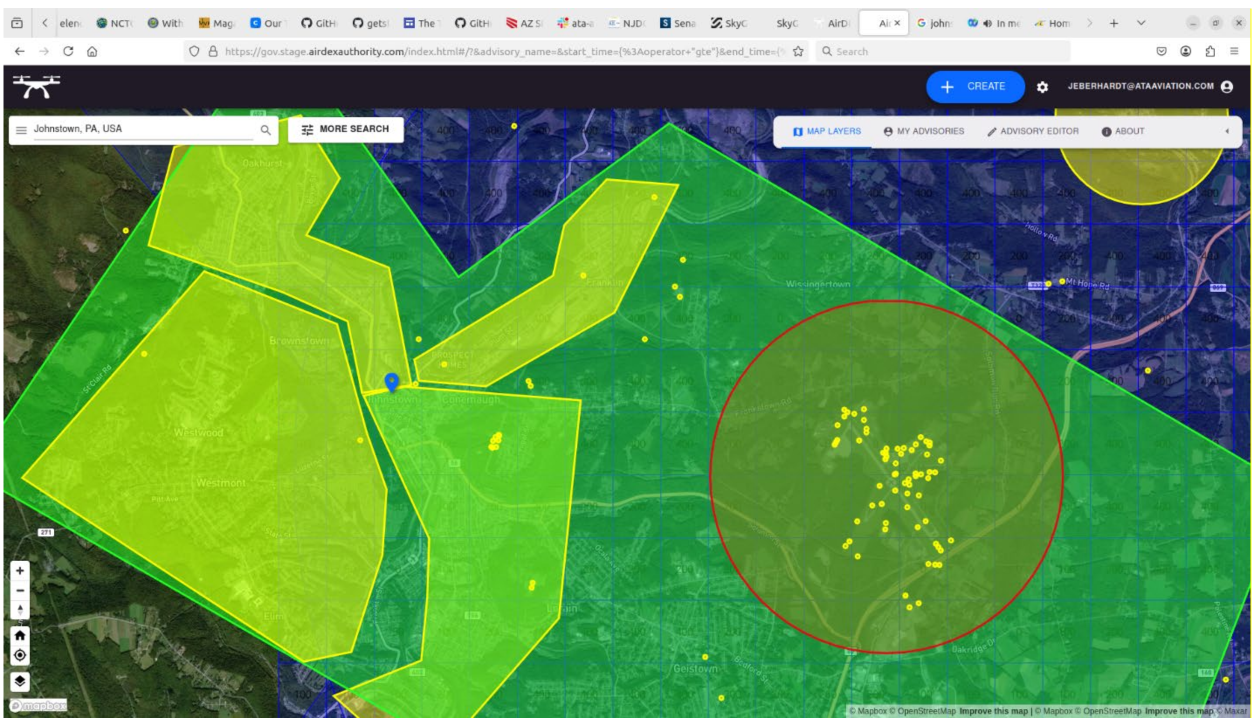

Figure 2: AERIUM EASSE Service Volumes 1 (Yellow, Southeast), 2 (Yellow, Northwest), 3 (Yellow, Northeast),4 (Yellow, Southwest) and 5 (Red Circle)

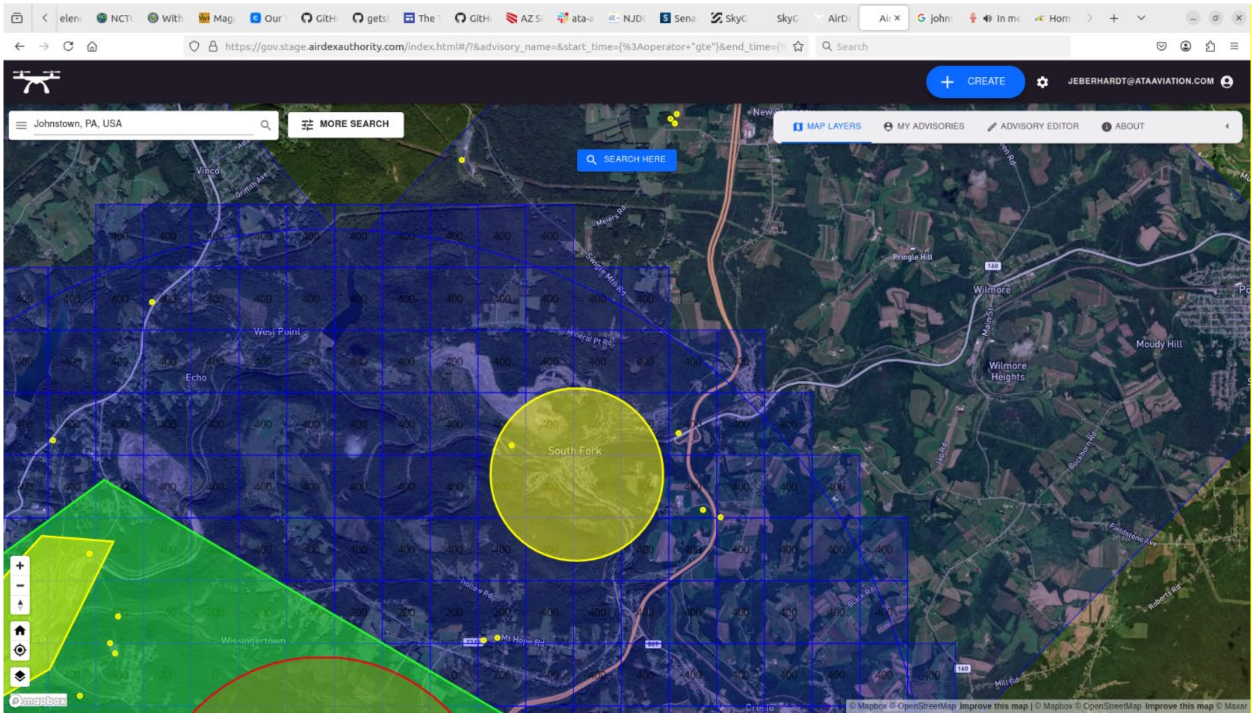

Figure 3: AERIUM EASSE Service Volume 6 (Yellow)

The service volumes and their characteristics are risk assessed and Tiered in the table below.

Volume	Population Risk	Air Density	Traffic	Structure Risk	Topography Risk	Climate Risk	Class
1	H	M		M	M	M	H
2	H	M		M	M	M	H
3	M	M		M	M	M	M
4	M	M		L	M	M	M
5	M	H		L	L	M	H
6	M	M		L	L	M	M

Table 5: Service Volume Risk Characterization

9.4.3 Operational and Ground Risk Matrix (Volume-Operational Risk Mapping)

This section describes the Operations Risk by Service Volume risk to create an overall risk assessment. This risk assessment then maps to the General Enablement Model to identify the specific enablement actions that need to be taken. The table below cross references the proposed operation types against the service volumes – the aggregate risk is then mapped to the general risk matrix and used to scope services for enablement to mitigate risks as described in a standard way.

Volume x Operation	**1**	**2**	**3**	**4**	**5**	**Overall**
1	B/H	C/H	C/H	C/H	A/H	Tier 3
2	B/H	C/H	C/H	C/H	A/H	Tier 3
3	B/M	C/M	C/M	C/M	A/M	Tier 2
4	B/M	C/M	C/M	C/M	A/M	Tier 2
5	B/H	C/H	C/H	C/H	A/H	Tier 2*
6	A/M	A/M	A/M	A/M	A/M	Tier 2

Table 6: Operational-Service Volume Risk Matrix and Tiering
** Tier 3 procedurally mitigated by not currently conducting non-VLOS operations*

9.5 General Enablement Model

9.5.1 Overview of Conceptual Standard Deconfliction and xTM Model

Conceptually we can leverage operating lessons learned from traditional Air Traffic Management, the FAA's UTM concept, ASTM UTM, and U-Space standards development work to develop a general model for integration of UAS operations, risk management, and most importantly, risk mitigation through the design and emplacement of infrastructure at the local level. Our conceptual model for deconfliction Is a layered approach consisting of four principal layers:

- Procedural Deconfliction – Configuration of the groundspace and airspace constraints, potential fixed hazards, and operational design to procedurally reduce the potential for conflict and loss of separation;

- Surveillance / Situational Awareness / Conformance – Provide digital services that allow pilots to be aware of transient hazards (weather, ground incidents and condition) and surveillance of and awareness of position of craft in the airspace;
- Operational Deconfliction – Common situational awareness of planned operations and operational intent for vehicles operating in proximate airspace; and
- Onboard Systems – Vehicle designs, piloting procedures, sensors, and detect and avoid systems to act as a definitive failsafe if the other three layers fail.

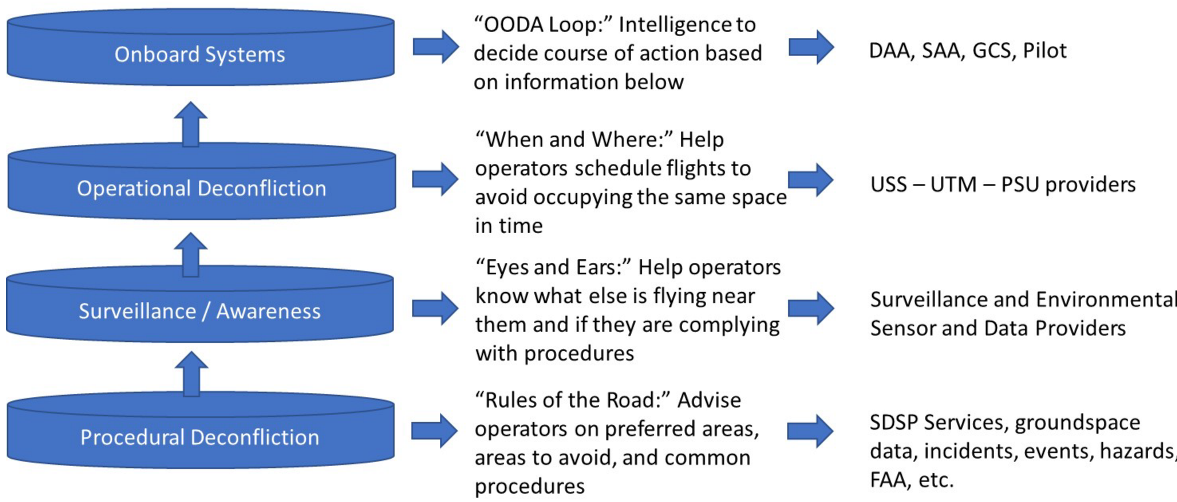

Figure 5: Layered Risk Mitigation Model – Conceptual Diagram

9.5.2 Discussion of Modalities and Components

This section discusses the potential components and modalities for Procedural Deconfliction, Operational Deconfliction, and Surveillance / Awareness. Table 7 below details different potential mitigations that can be applied within each layer of the four-layer model described in Figure 7. These can be used as specific proposed, planned mitigations in the overall EASSE Plan.

Safety Layer	Specific Examples
Procedural Deconfliction	State or Local Government Information Advisory
	State or Local Government Supplemental Rule Advisory
	Ground Operations Prohibited
	Hazard / Obstruction
	Take Off and Landing Area (Hobbyist, Public Safety, Commercial)

Safety Layer	Specific Examples
Operational Deconfliction	Sharing of Flight Intent / UTM Services Public Safety First Responder Emergency Incident Activity State or Local Agency Site Data Collection Public Safety Large Audience Event Public Safety Hazardous Materials Incident Public Safety Disaster Management Flight Operations / Operating Area (Hobbyist, Public Safety, Commercial)
Surveillance / Awareness	Weather, Visibility, Environmental Conditions Ground Environmental Conditions Detection and Position of Crewed Aircraft (ADS-B, Passive Detection, Active Detection) Detection and Position of Uncrewed Aircraft (RemoteID, Passive Detection, Active Detection)

Table 7: Examples of Layered Mitigations

Table 8 below details some of the specific modalities for Surveillance and Awareness that are available, including some of the characteristics of each mode, for consideration in the EASSE Plan.

Modality	Pros	Cons	Range*
Passive – RemoteID (UAS only, participatory)	Very inexpensive and FAA mandated, decent range; strong position accuracy; no RF interference; no privacy issues	Not implemented yet, requires participation, not clear what / when compliance will look like	1 – 5 miles, depending on topography, RF conditions, and unit

Modality	Pros	Cons	Range*
Passive - ADS-B (Manned only, participatory)	Manned aircraft, already universally available; FAA mandated; strong position accuracy; inexpensive; no RF interference; no privacy issues	Compliance is not universal, doesn't work for UAS; requires participation which is not universal	20-200 miles, depending on aircraft altitude and receiver
Passive – Decoding (UAS only)	Leverages existing comms on the vehicle; many provide information on operator as well; strong accuracy; can be inexpensive; no RF interference; does not require participation; strong position accuracy	Totally vehicle dependent, may not provide operator information, mixed performance, malicious actors can easily engineer around; cost profiles vary; privacy issues	1-5 miles, depending on quality of receiving unit, topography, and RF conditions
Passive – Audio (UAS and manned)	Audio signature detection; no RF interference, no privacy issues; relatively inexpensive; doesn't require participation	Lower detection rate and positional accuracy than participatory, decoding, or radar methods; need more than one sensor to really calculate location, bearing and heading; cost profiles mixed	2-5 miles, depending on quality of receiving unit, topography, unit positioning, and vehicle altitude and trajectory
Passive – Optical (UAS and manned)	Optical signature detection; no RF interference, no privacy issues; relatively inexpensive; doesn't' require participation	Lower detection rate and positional accuracy than participatory, decoding, or radar methods; need more than one sensor to accurately calculate location, bearing and heading; cost profiles mixed	2-5 miles, depending on quality of receiving unit, topography, unit positioning, and vehicle altitude and trajectory

Modality	Pros	Cons	Range*
Passive – RF (UAS only)	Triangulate RF signals; no RF interference, no privacy issues; relatively inexpensive; doesn't require participation	Lower detection rate and positional accuracy than participatory, decoding, or radar methods; need more than one sensor to accurately calculate location, bearing and heading; no current COTS solutions	1-10 miles, depending on quality of receiving unit, topography and RF conditions
Active – Small Radar (UAS and manned)	Detects all vehicles, participating or not; unlikely that a malicious actor can engineer around; no privacy issues; doesn't require participation; can achieve high rates of accuracy	Expensive; limited coverage area; dependent on line of sight; achieving accuracy requires siting and tuning; training	1-3 miles dependent on topography, conditions, siting and tuning
Active – Large Radar (UAS and manned)	Detects all vehicles, participating or not; unlikely that a malicious actor can engineer around; no privacy issues; doesn't require participation; can achieve high rates of accuracy	Very Expensive; dependent on line of sight; achieving accuracy requires siting and tuning; training	5-15 miles dependent on topography, conditions, siting and tuning

Table 8: Discussion of Potential Sensor Modalities in the Surveillance / Awareness Layer

9.5.3 General Enablement Performance Based Information Template by Risk

A key concept of the FIX-MVI model is to used shared services and data to create a "multi-modal" overlay that will provide a public MVI data stream through the FIX that can then be used by experts and various actors to conduct "track fusion" modeling and the development and provision of DAA services. It is important to note that the AERIUM EASSE is not intended to provide DAA services in its own right. The multi-model aspect of the overlay is critical, as the different surveillance modalities complement each other, and voting network and filtering techniques can be used to create an overall Service Volume detection performance that exceeds the performance of any one sensor modality. Finally, the use of physically and logically distributed, multi-modal sensors reduces the risk of catastrophic failure where all surveillance is down – instead this allows for graceful service degradation that can then be addressed procedurally through operational mitigations.

The overall performance baseline for the Service Volume must consider relevant performance standards such that DAA and USS providers can, together with the characterization of the Operational and Service Volume risk (see Table 6), provide an overall mitigation strategy and performance statement to pursue approvals from the FAA for operations. Explicitly relevant standards include the ASTM UTM Standard (ASTM F3548-21), ASTM DAA Standard (ASTM F3442/F3442M-23), and the ASTM SDSP Standard (ASTM F3623-23), which were considered in developing the baseline performance metrics below.

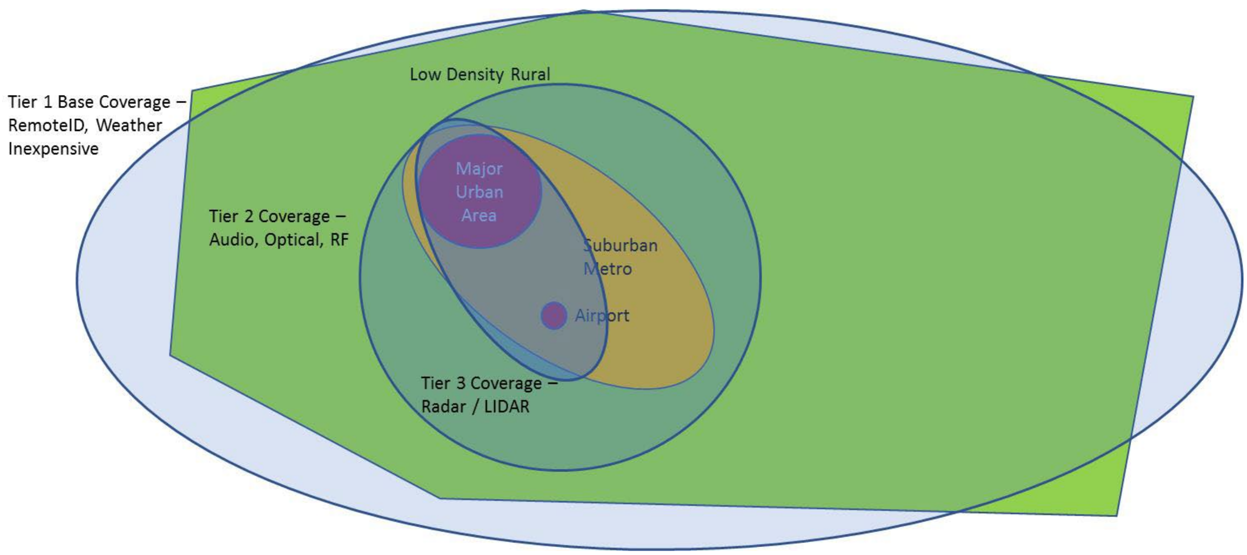

Figure 6: Tiered Performance Overlay Model – Conceptual Diagram

A key aspect of achieving the targeted level of risk mitigation is to establish a measurable performance baseline. Along with the expected performance baseline for the enablement services, we also need to develop a performance baseline for the data services themselves. Table 9 below discusses data service performance characterization metrics that can be built in and collected to characterize compliance to the proposed Service Performance Baseline.

Metric	Surveillance / Telemetry	Procedural / Configuration
Message Technical Latency	Metric: Milliseconds Evaluation: Elapsed milliseconds between relevant time stamps -- Are deviations within tolerance for the service?	
Message Completeness	Metric: Potential data elements Evaluation: Proportion of messages with fully reported elements	
Message Integrity	Metric: Expected message format Evaluation: messages validated for format -- What proportion of messages are malformed?	
Frequency / Refresh	Metric: Milliseconds frequency for the source service Evaluation: deviation in frequency delta between transmission timestamps and comparison to expected service level	NA
Message Precision / Confidence	Metric: Meters Evaluation: Underlying error of the source data -- Does the source data service report (decimal) at the expected level of precision? Are errors within tolerance?	
Geographic Availability	Metric: Geographic coverage Evaluation: Is the data service available for the geography -- Are messages generated within the geography for known characterized services?	

Table 9: Data Service Performance Characteristics

The matrix below leverages these concepts and describes potential surveillance / awareness performance benchmarks based on the overall Volume – Operational risk level (see matrix in Table 9 above). Procedural and Operational deconfliction are not listed generally, as these are general UTM foundational capabilities that cover the enabled area regardless of surveillance modality; however, specific requirements are discussed in the sections below. It is important to note that the initial proposed service performance baseline is notional and will need to be refined together with industry and the FAA. It is the goal of this notional performance baseline to meet or exceed the requirements for these types of ground-based data services as described in the reference standards. *Components that are not referenced in the standards or diverge are noted as such.*

Risk: Volume x Operation	**C**	**B**	**A**
L	TIER 3 - Special procedural considerations such as no-go and ditch areas - Coverage ceiling 1,200 Ft - Availability: 99.9% - Message Integrity: 99.9% - Maximum latency to syndication: 200ms - Message refresh/heartbeat: 1s - Scan Rate / Coasting Threshold: 4s - Published sensor SLA including scan, vertical accuracy, and EPU - MTTR: TBD - MTBF >500 hrs - Data Retention: 30 days - Vehicle On-Board PNT with high frequency (<1s) and accuracy (<3m) - Detailed microweather	TIER 2 - Procedural and NAVAID considerations - Coverage ceiling 1,000 Ft - Availability: 99.9% - Message Integrity: 99.9% - Maximum latency to syndication: 200ms - Message refresh/heartbeat: 1s - Scan Rate / Coasting Threshold: 4s - Published sensor SLA including scan, vertical accuracy, and EPU - MTTR: TBD - MTBF >500 hrs - Data Retention: >30 days - Data Retention: 30 days - Vehicle On-Board PNT with minimum frequency (<5s) and accuracy (<10m) - Basic weather conditions	TIER 1 - Procedural and NAVAID considerations - Coverage ceiling 1,000 Ft - Availability: 99.9% - Message Integrity: 99.9% - Maximum latency to syndication: 200ms - Message refresh/heartbeat: 1s - Data Retention: >30 days - Vehicle On-Board PNT with minimum frequency (<5s) and accuracy (<10m)
M	TIER 3 - Special procedural considerations such as no-go and ditch areas - Coverage ceiling 1,200 Ft - Availability: 99.9% - Message Integrity: 99.9%	TIER 2 - Procedural and NAVAID considerations - Coverage ceiling 1,000 Ft - Availability: 99.9% - Message Integrity: 99.9% - Maximum latency to	TIER 2 - Procedural and NAVAID considerations - Coverage ceiling 1,000 Ft - Availability: 99.9% - Message Integrity: 99.9% - Maximum latency to

Risk: Volume x Operation	C	B	A
	- Maximum latency to syndication: 200ms - Message refresh/heartbeat: 1s - Scan Rate / Coasting Threshold: 4s - Published sensor SLA including scan, vertical accuracy, and EPU - Published service volume with sensitivity and specificity - MTTR: TBD - MTBF >500 hrs - Data Retention: 30 days - Vehicle On-Board PNT with high frequency (<1s) and accuracy (<3m) - Detailed microweather	syndication: 200ms - Message refresh/heartbeat: 1s - Scan Rate / Coasting Threshold: 4s - Published sensor SLA including scan, vertical accuracy, and EPU - Published service volume with sensitivity and specificity - MTTR: TBD - MTBF >500 hrs - Data Retention: >30 days - Data Retention: 30 days - Vehicle On-Board PNT with minimum frequency (<5s) and accuracy (<10m) - Basic weather conditions	syndication: 200ms - Message refresh/heartbeat: 1s - Data Retention: >30 days - Vehicle On-Board PNT with minimum frequency (<5s) and accuracy (<10m)
H	TIER 3 - Special procedural considerations such as no-go and ditch areas - Coverage ceiling 1,200 Ft - Availability: 99.9% - Message Integrity: 99.9% - Maximum latency to syndication: 200ms - Message refresh/heartbeat: 1s - Scan Rate / Coasting Threshold: 4s - Published sensor SLA including scan, vertical accuracy, and EPU	TIER 3 - Procedural and NAVAID considerations - Coverage ceiling 1,000 Ft - Availability: 99.9% - Message Integrity: 99.9% - Maximum latency to syndication: 200ms - Message refresh/heartbeat: 1s - Scan Rate / Coasting Threshold: 4s - Published sensor SLA including scan, vertical accuracy, and EPU - Published service volume	TIER 2 - Procedural and NAVAID considerations - Coverage ceiling 1,000 Ft - Availability: 99.9% - Message Integrity: 99.9% - Maximum latency to syndication: 200ms - Message refresh/heartbeat: 1s - Data Retention: >30 days - Vehicle On-Board PNT with minimum frequency (<5s) and accuracy (<10m)

Risk: Volume x Operation	C	B	A
	- Published service volume with sensitivity and specificity - MTTR: TBD - MTBF >500 hrs - Data Retention: 30 days - Vehicle On-Board PNT with high frequency (<1s) and accuracy (<3m) - Detailed microweather	with sensitivity and specificity - MTTR: TBD - MTBF >500 hrs - Data Retention: >30 days - Data Retention: 30 days - Vehicle On-Board PNT with minimum frequency (<5s) and accuracy (<10m) - Basic weather conditions	

Table 10: Notional Performance Baseline – Overall Service Volume Performance

Note that the table above is intended to be a starting point, and that specific mitigation strategies in each of the layers should be refined based upon knowledge of the terrain and specific operational risk. This should involve specific considerations of frequency and accuracy based upon assessment of risk and knowledge of vehicle types and operators. We may install sensors below the standards for accuracy, range, and performance for use in an advisory (non-DAA) capacity if they are additive to airspace awareness.

9.6 Enablement of Deconfliction and Awareness Services

This section details our understanding of the current state of readiness in the proposed service volumes and identifies applicable integration requirements and regulatory requirements that may apply to the contemplated operations as understood at this time.

9.6.1 Assessment of Current Enablement Readiness

This section applies the risk assessments and system design discussed above to the individual service volumes, and provides the current baseline of service coverage by Service Volume as of April 2026, assessed at one of five statuses, as described in Table 11 below:

- Sufficient: There is sufficient service coverage within the Service Volume to meet the Performance Baseline;
- In Process: Currently in deployment;
- Incomplete: Some level of service coverage exists; additional existing local assets may be able to bring service coverage up to the Performance Baseline;

- Not Available: No existing service coverage or local assets, need to build from scratch;
- Unknown: Not known to exist, local assets may exist, further investigation needed; and
- Not Applicable: This particular service is not applicable to the Service Volume given the risk assessment.

Service Volume / Mitigation	Current State of Services / Gaps	Available Assets	Targets
Service Volume 1			
Groundspace Configuration	Sufficient	Cambria County has mapped relevant data, loaded in Keystone FIX	Continue to add / refresh configuration data
GNSS RTK / Nav	Not applicable	Not applicable	Not applicable at this time
Weather Services	Sufficient	Use AWOS, TAFS, METAR from KJST	Reports from KJST
Surv. – ADS-B	Sufficient	ADS-B mounted in service volume sensor install	Leverage SV-2 ADS-B Receiver
Surv. – RemoteID	Sufficient	RID received install in service volume sensor install	Finish install, acquire and install 1 additional sensor centered in volume
Surv. – RF	Not applicable	Not applicable	Not applicable at this time
Surv. – Optical	Sufficient	Optical sensor install in service volume sensor install	Optical assets cover central service volume
Surv. – Audio	Not applicable	Not applicable	Not applicable at this time

Service Volume / Mitigation	Current State of Services / Gaps	Available Assets	Targets
Surv. – Radar	Sufficient	Radar assets install in service volume	Radar assets installed to cover Conemaugh Memorial heliport
USS-UTM Services	Sufficient	Integrated Aloft, OneSky, DroneUp	Integrated USS providers
Service Volume 2			
Groundspace Configuration	Sufficient	Cambria County has mapped relevant data, loaded in Keystone FIX	Continue to add / refresh configuration data
GNSS RTK / Nav	Not applicable	Not applicable	Not applicable
Weather Services	Sufficient	Use AWOS, TAFS, METAR from KJST	Reports from KJST
Surv. – ADS-B	Sufficient	Services by ADS-B units in Service Volumes 3, 4, and 5	ADS-B available
Surv. – RemoteID	Incomplete	RID units in Service Volumes 3, 4 provide some level of coverage, incomplete for this service volume	Need to identify additional future installation location for RemoteID receiver
Surv. – RF	Not applicable	Not applicable	Not applicable at this time
Surv. – Optical	Incomplete	Optical units in Service Volumes 3, 4 provide some level of coverage,	Need to identify additional future installation location for Optical receiver

Service Volume / Mitigation	Current State of Services / Gaps	Available Assets	Targets
		incomplete for this service volume	
Surv. – Audio	Not applicable	Not applicable	Not applicable at this time
Surv. – Radar	Not applicable	Not applicable	Not applicable at this time
USS-UTM Services	Sufficient	Integrated Aloft, OneSky, DroneUp	Integrated USS providers
Service Volume 3			
Groundspace Configuration	Sufficient	Cambria County has mapped relevant data, loaded in Keystone FIX	Continue to add / refresh configuration data
GNSS RTK / Nav	Not applicable	Not applicable	Not applicable at this time
Weather Services	Sufficient	Use AWOS, TAFS, METAR from KJST	Reports from KJST
Surv. – ADS-B	Sufficient	Two units installed at north and south end of Service Volume	Two units in SV plus KJST unit
Surv. – RemoteID	Sufficient	Two units installed at north and south end of Service Volume	Two units in SV
Surv. – RF	Not applicable	Not applicable	Not applicable at this time
Surv. – Optical	Sufficient	Two units installed at north and south end of Service Volume	Two units in SV

Service Volume / Mitigation	Current State of Services / Gaps	Available Assets	Targets
Surv. – Audio	Not applicable	Not applicable	Not applicable at this time
Surv. – Radar	Incomplete	Two radar panels slated for installation in SV3	Need to complete installation at SV 3, Inclined Plane
USS-UTM Services	Sufficient	Integrated Aloft, OneSky, DroneUp	Integrated USS providers
Service Volume 4			
Groundspace Configuration	Sufficient	Cambria County has mapped relevant data, loaded in Keystone FIX	Continue to add / refresh configuration data
GNSS RTK / Nav	Not applicable	Not applicable	Not applicable
Weather Services	Sufficient	Use AWOS, TAFS, METAR from KJST	Reports from KJST
Surv. – ADS-B	Sufficient	Three units in Service Volume plus KJST	Two fixed installs plus mobile unit available in volume
Surv. – RemoteID	Sufficient	Three units in Service Volume	Two fixed installs plus mobile unit available in volume
Surv. – RF	Not applicable	Not applicable	Not applicable at this time
Surv. – Optical	Sufficient	Three units in Service Volume	Two fixed installs plus mobile unit available in volume

Service Volume / Mitigation	Current State of Services / Gaps	Available Assets	Targets
Surv. – Audio	Not applicable	Not applicable	Not applicable at this time
Surv. – Radar	Not available	Not applicable	Not applicable at this time
USS-UTM Services	Sufficient	Integrated Aloft, OneSky, DroneUp	Integrated USS providers
Service Volume 5			
Groundspace Configuration	Sufficient	Cambria County has mapped relevant data, loaded in Keystone FIX	Continue to add / refresh configuration data
GNSS RTK / Nav	Not applicable	Not applicable	Not applicable
Weather Services	Sufficient	Use AWOS, TAFS, METAR from KJST	Reports from KJST
Surv. – ADS-B	Sufficient	ADS-B unit in place at KJST	Leverage unit for adjacent SVs
Surv. – RemoteID	Incomplete	Need to complete installation of RemoteID unit at KJST	Unit in inventory, pending approvals
Surv. – RF	Not applicable	Not applicable	Not applicable at this time
Surv. – Optical	Incomplete	Need to complete installation of optical unit at KJST	Unit in inventory, pending approvals
Surv. – Audio	Not applicable	Not applicable	Not applicable at this time
Surv. – Radar	Not applicable	Not applicable	Not applicable at this time

Service Volume / Mitigation	Current State of Services / Gaps	Available Assets	Targets
USS-UTM Services	Sufficient	Integrated Aloft, OneSky, DroneUp	Integrated USS providers
Service Volume 6			
Groundspace Configuration	Sufficient	Cambria County has mapped relevant data, loaded in Keystone FIX	Continue to add / refresh configuration data
GNSS RTK / Nav	Not applicable	Not applicable	Not applicable
Weather Services	Sufficient	Use AWOS, TAFS, METAR from KJST	Reports from KJST
Surv. – ADS-B	Sufficient	ADS-B unit installed, plus service from unit at KJST	Units complete
Surv. – RemoteID	Sufficient	RID unit installed	Units complete
Surv. – RF	Not applicable	Not applicable	Not applicable
Surv. – Optical	Sufficient	Optical unit installed	Units complete
Surv. – Audio	Not applicable	Not applicable	Not applicable at this time
Surv. – Radar	Not applicable	Not applicable	Not applicable at this time
USS-UTM Services	Sufficient	Integrated Aloft, OneSky, DroneUp	Integrated USS providers

Table 11: Baseline by Service Volume

9.6.2 Manned Integration Requirements

While no specific integrations with manned aviation have been identified at this time, conversation with industry and FAA have identified both the potential risks associated with uncrewed operations in the proximity of primary/reliever and general aviation airports (hence why the three service volumes containing these airports are considered high risk) as well as the potential to use the surveillance / awareness sensors to develop additional notification and potentially safety enhancing services for general aviation pilots.

9.6.3 Applicable FAA and Industry Requirements

Based on the contemplated operations and initial risk characterization, the Performance Baseline and final design of the AERIUM EASSE should reflect requirements and performance parameters identified in the following rules and standards:

- FAA Part 107, regulating commercial small UAS operations;
- FAA Part 135, regulating charter operations, under which certain commercial package delivery operations will take place;
- FAA Part 44807 for general waivers;
- FAA guidance and approvals to date of EVLOS / BVLOS under waiver and COA;
- ASTM F3623-23 Surveillance SDSP Standard
- Operational Risk Assessment, ASTM F3178-16;
- Detect and Avoid ASTM F3442/F3442M-23;
- UAS Traffic Management ASTM F3548-21;
- Current FAA indications given by the current BVLOS NPRM / FAA Part "108", a notional regulation pertaining to extended commercial deliveries under a modified small UAS rule; and
- RTCA DO-365C, Minimum Operational Performance Standards (MOPS) for Detect and Avoid (DAA) Systems.

9.7 Enablement Plan and Implementation Schedule

9.7.1 Referenced Risk Matrix Enablement Requirements

The risk analysis and preliminary design approach described in this document have identified two risk categories of initially contemplated operations (A and B) and three levels Service Volume risk (Low, Medium, and High). Based on this analysis, the matrixed risk levels (A/L, B/L, A/M, B/M, A/H, B/H) translate into three logical infrastructure rollout tiers (Tier 1, Tier 2, and Tier 3). Table 12, maps the matrixed risk levels, tiers, and proposed Performance Baseline. *(Note: The Performance Baseline is notional and will be refined within the construct of the Regulatory Plan.)*

Tier	Matrixed Risk	Proposed Notional Performance Baseline
Tier 1	A/L, B/L	- Basic surveillance / awareness with minimum frequency (<1s) and accuracy (<50m) - Basic weather conditions
Tier 2	A/M, B/M, C/L	- Special procedural considerations such as no-go and ditch areas - Vehicle On-Board PNT with medium frequency (<30s) and accuracy (<10m) - Environmental surveillance with medium frequency (<30s) and accuracy (<10m) - Detailed microweather
Tier 3	A/H, B/H, C/M, C/H	- Special procedural considerations such as no-go and ditch areas - Vehicle On-Board PNT with high frequency (<1s) and accuracy (<3m) - Environmental surveillance with high frequency (<1s) and accuracy (<3m) - Detailed microweather

Table 12: Risk Assessment and Performance Baseline

The Enablement Plan that follows focuses on building out each of the Service Volumes to achieve the proposed Performance Baseline.

9.7.2 Regulatory Plan UAS Traffic Management (UTM) and Operator Services

Given the stated goals of the project, key aspects of the AERIUM EASSE are to support the development of UTM integration, approvals, and performance characterization for the FAA. The FAA is very interested in developing a more structured UTM policy, including requirements and mechanisms for approval – and the timing of the AERIUM EASSE is ideally suited to support this. Given this context, it is our intent to engage with staff at KJST, local government, local residents, USS providers, and local UAS Operators to develop specific operational ConOps, specific safety mitigation plans, and specific research data proposals for the FAA in the context of the AERIUM EASSE, including, but not limited to:

- Identified 3 USS partners (OneSky, Aloft, DroneUp) for direct bi-directional integration into Keystone FIX and the Public Digital Services developed in the AERIUM EASSE;
- Identified 2-3 Public Safety operators within the AERIUM EASSE, along with DRONERESPONDERS, to partner with the team to further develop the Public Safety /

Drone as a First Responder ConOps, develop Drone as a First Responder (DFR) capabilities and assess performance of the EASSE as well as further develop concepts that Public Safety agencies can include in FAA COAs;

- Identified Commercial operators (DroneUp, Horizon) to partner with to further develop commercial ConOps within the AERIUM EASSE, especially in support of Group 1/2 BVLOS operations; and
- In conjunction with the identified Commercial and Public Safety operators, developed and proposed AERIUM EASSE COAs waivers to the FAA, and developing additional waivers and COAs.

The Local Engagement plan included dedicated meetings with KJST Airport Management, the KJST Air Traffic Control Tower, Cambria County Board of Supervisors, Johnstown City Manager, Johnstown City Council, a dedicate local press and outreach campaign, and two dedicated local open houses to educate residents about services and gain feedback.

9.7.3 Service Volume Specific Enablement Plans

In developing the rollout plans for each of the Service Volumes, each Volume's Performance Baseline was considered, as was the current baseline for each Volume. As each Service Volume was planned, overlapped coverage areas were deconflicted in order to develop a set of specific roll-outs that account for overlapping coverage that may be provided by other already enabled, or to be enabled, Service Volumes. Each plan considers the Service Volume Size, notional Performance Baseline, Matrixed Risk, and service requirements relative to the current baseline. Service volume 7 is not included at this time, as we plan no specific work for that Service Volume.

9.7.3.1 Service Volume 1

Service Volume 1, The Tier 3 service volume servicing the East End of Johnstown, includes central Johnstown, Dale Borough, Moxham, and Ferndale as well as neighborhoods that extend east along the Johnstown Expressway and Conemaugh River. It consists of a plain between hills to the East, West, and North. It constitutes a medium-density residential-commercial area consisting of primarily low-rise structures with a few taller (5-10 story) buildings. This Service Volume is supported by Seventh Ward Ambulance/EMS as an ambulance site, and is intended to be serviced by a central drone hub site at the Central Park Complex at 110 Franklin St, Johnstown, PA 15901. Service Volume 1 consists of Cambria County Census Tracts 1, 2, 3, 5, 6, 7, and 110 with a total population of 11,861 over 3 square miles for a mean population density of 3,594.2 persons per square mile.

Additional considerations for Service Volume 1 are that it sits on a plain between hills and is adjacent to, but excludes, Conemaugh Memorial Medical Center, which includes a heliport. The table below details key aspects of the enablement plan for the Service Volume.

Service Volume 1: East End				
Size: ~3-5 square Miles				
Matrixed Risk Assessment Score:	B/H, C/H, C/H, C/H, A/H – Tier 3			
Proposed Performance Baseline:	Tier 3			
Groundspace Configuration	Very high groundspace configuration level			
Required Build Components	**Coverage**	**Units**	**Cost**	**Total**
GNSS RTK / Nav	NA	NA	$3,500	$0
Weather Services	Available	Available	$1,500	$0
Surv. – ADS-B	Available	SV-2 shared	$1,500	$0
Surv. – RemoteID	3 sq mi	1	$2,200	$2,200
Surv. – RF	10 sq mi	NA	$10,000	$0

Surv. – Optical	4 sq mi	Add +1 units	$20,000	$20,000
Surv. – Audio	10 sq mi	NA	$50,000	$0
Surv. – Radar	2 sq mi	Add +2 Panels	$40,000	$80,000
Other Costs (Site, Consumables, Bandwidth)	NA	2	$5,000	$10,000
Total Estimated Cost				$109,700
Rationale / Notes	Leverage existing and in process services at SV-2, cover south end especially around curve of hill, procedurally deconflict from heliport			

9.7.3.2 Service Volume 2

Service Volume 2 represents a Tier 3 West End service volume servicing central Johnstown, Cambria City, Minersville, Morrellville, Oakhurst, and Coopersdale as well as neighborhoods that extend west along PA-56 and the Conemaugh River. It consists of a plain between hills to the South and North. It constitutes a medium-density residential-commercial area consisting of primarily low-rise structures with a few taller (5-10 story) buildings. This Service Volume is supported by West End Ambulance/EMS as an ambulance site, and is intended to be serviced by a central drone hub site at the Central Park Complex at 110 Franklin St, Johnstown, PA 15901. Service Volume 2 consists of Cambria County Census Tracts 1, 12, 134, and 136 with a total population of 7,914 over 3 square miles for a mean population density of 2,729.0 persons per square mile.

Service Volume 2: West End and Central				
Size: Approx. ~3-5 Square Miles				
Matrixed Risk Assessment Score:	B/H, C/H, C/H, C/H, A/H – Tier 3			
Proposed Performance Baseline:	Tier 3			
Groundspace Configuration	Very high groundspace configuration level			
Required Build Components	**Coverage**	**Units**	**Cost**	**Total**
GNSS RTK / Nav	NA	NA	$3,500	$0
Weather Services	Available	Available	$1,500	$0
Surv. – ADS-B	25 sq mi	Add single unit to cover SV-1, 2, 3, 4	$3,000	$3,000
Surv. – RemoteID	3 sq mi	Add +1 RID units	$2,200	$2,200
Surv. – RF	10 sq mi	NA	$10,000	$0
Surv. – Optical	4 sq mi	Add +1 EO/IR	$20,000	$20,000

Surv. – Audio	10 sq mi	NA	$50,000	$0
Surv. – Radar	2 sq mi	Add +2 Panels	$40,000	$80,000
Other Costs (Site, Consumables, Bandwidth)	NA	1	$5,000	$5,000
Total Estimated Cost				$110,200
Rationale / Notes	Mount Southern site at Incline Plane and cover Southern SV 2, Central Johnstown SV-3, and part of SV-1; Optical will support SV 1, 2, 3, and 4; ADS-B will serve SV-1, 2, 3, 4			

9.7.3.3 Service Volume 3

Service Volume 3 represents a Tier 2 North End service volume servicing central Johnstown, Prospect, Woodvale, Franklin, and East Conemaugh. It consists of a plain between hills to the East and West. It constitutes a medium-density residential-commercial area consisting of primarily low-rise structures with a few taller (5-10 story) buildings. This Service Volume is supported by East Conemaugh Fire/EMS as an ambulance site, and is intended to be serviced by a central drone hub site at the Central Park Complex at 110 Franklin St, Johnstown, PA 15901. Service Volume 3 consists of Cambria County Census Tracts 102 and 134 with a total population of 3,365 over 3 square miles for a mean population density of 1,246.3 persons per square mile.

Service Volume 3 – North End and Central				
Size: ~3-5 Square Miles				
Matrixed Risk Assessment Score:	B/M, C/M, C/M, C/M, A/M – Tier 2			
Proposed Performance Baseline:	Tier 2			
Groundspace Configuration	Very high groundspace configuration level			
Required Build Components	**Coverage**	**Units**	**Cost**	**Total**
GNSS RTK / Nav	25 sq mi	NA	$2,500	$0
Weather Services	Available	Available	$1,500	$0
Surv. – ADS-B	25 sq mi	Available	$3,000	$0
Surv. – RemoteID	3 sq mi	Add +2 RID	$2,200	$4,400
Surv. – RF	10 sq mi	NA	$10,000	$0
Surv. – Optical	4 sq mi	Add +1 EO/IR	$20,000	$20,000
Surv. – Audio	10 sq mi	NA	$50,000	$0

Surv. – Radar	2 sq mi	NA	$40,000	$0
Other Costs (Site, Bandwidth)	NA	1	$5,000	$5,000
Total Estimated Cost				$29,400
Rationale / Notes	Will leverage SV-2 coverage, focused on extending to East Conemaugh			

9.7.3.4 Service Volume 4

Service Volume 4 represents a Tier 2 suburban service volume servicing the suburbs of Westmont and Southmont. It consists of a plain and hills west of a large ridgeline to the East. It constitutes a medium-density residential-commercial area consisting of primarily low-rise structures. This Service Volume is supported by West Hills Fire / Hilltop EMS as an ambulance site, and is intended to be serviced by a central drone hub site at the Hiram G Andrews Center, 727 Goucher St. Johnstown, PA 15905. Service Volume 4 consists of Cambria County Census Tracts 112 and 134 with a total population of 3,365 over 3 square miles for a mean population density of 1,246.3 persons per square mile.

Service Volume 4 - Westmont				
Size: ~4-6 Square Miles				
Matrixed Risk Assessment Score:	B/M, C/M, C/M, C/M, A/M – Tier 2			
Proposed Performance Baseline:	Tier 2			
Groundspace Configuration	Very high groundspace configuration level			
Required Build Components	**Coverage**	**Units**	**Cost**	**Total**
GNSS RTK / Nav	25 sq mi	NA	$2,500	$0
Weather Services	Available	Available	$1,500	$0
Surv. – ADS-B	25 sq mi	Available	$3,000	$0
Surv. – RemoteID	3 sq mi	Add +2 RID	$2,200	$4,400
Surv. – RF	10 sq mi	NA	$10,000	$0
Surv. – Optical	4 sq mi	Add +2 EO/IR	$20,000	$40,000
Surv. – Audio	10 sq mi	NA	$50,000	$0
Surv. – Radar	2 sq mi	NA	$40,000	$0

Other Costs (Site, Bandwidth)	NA	2	$5,000	$10,000
Total Estimated Cost				$54,400
Rationale / Notes	Can leverage ADS-B, RID, and Optical coverage from SV-2 south site, will add 1 fixed site and 1 mobile site			

9.7.3.5 Service Volume 5

Service Volume 5 consists of the immediate environs of John Murtha Johnstown-Cambria County Airport. It is not intended to be an immediately serviced volume, but will be enabled for data collection purposes for establishing safety baselines. Service Volume 5 consists of Cambria County Census Tract 107 with a total population of 3,122 over 9.3 square miles for a mean population density of 336.8 persons per square mile.

Service Volume 5 - KJST				
Size: Approx. ~5 Square Miles				
Matrixed Risk Assessment Score:	B/H, C/H, C/H, C/H, A/H – Tier 2			
Proposed Performance Baseline:	Tier 3 (procedurally downgraded to Tier 2)			
Groundspace Configuration	Very high groundspace configuration level			
Required Build Components	**Coverage**	**Units**	**Cost**	**Total**
GNSS RTK / Nav	25 sq mi	NA	$2,500	$0
Weather Services	Available	Available	$1,500	$0
Surv. – ADS-B	25 sq mi	Available	$3,000	$0
Surv. – RemoteID	3 sq mi	Add +1 RID	$2,200	$2,200
Surv. – RF	10 sq mi	NA	$10,000	$0
Surv. – Optical	4 sq mi	Add +1 EO/IR	$20,000	$20,000
Surv. – Audio	10 sq mi	NA	$50,000	$0
Surv. – Radar	2 sq mi	NA	$40,000	$0
Other Costs (Site, Bandwidth)	NA	1	$5,000	$5,000

Total Estimated Cost				$27,200
Rationale / Notes	Collect UAS data and non-ADS-B compliant data; pending install on the education building			

9.7.3.6 Service Volume 6

Service Volume 6 consists of the immediate environs of South Fork, PA. It is intended to be enabled for demonstration of infrastructure inspection as part of a regional rollout and will be enabled for data collection purposes for establishing safety baselines. Service Volume 6 consists of Cambria County Census Tract 132 with a total population of 3,943 over 19.6 square miles for a mean population density of 201.6 persons per square mile.

Service Volume 6 – South Fork				
Size: Approx. ~3 Square Miles				
Matrixed Risk Assessment Score:	A/M, A/M, A/M, A/M, A/M – Tier 2			
Proposed Performance Baseline:	Tier 2			
Groundspace Configuration	Very high groundspace configuration level			
Required Build Components	**Coverage**	**Units**	**Cost**	**Total**
GNSS RTK / Nav	25 sq mi	NA	$2,500	$0
Weather Services	Available	Available	$1,500	$0
Surv. – ADS-B	25 sq mi	Add 1 unit	$3,000	$3,000
Surv. – RemoteID	3 sq mi	Add +1 RID	$2,200	$2,200
Surv. – RF	10 sq mi	NA	$10,000	$0
Surv. – Optical	4 sq mi	Add +1 EO/IR	$20,000	$20,000
Surv. – Audio	10 sq mi	NA	$50,000	$0
Surv. – Radar	2 sq mi	NA	$40,000	$0
Other Costs (Site, Bandwidth)	NA	1	$5,000	$5,000

Total Estimated Cost				$30,200
Rationale / Notes	Support basic, lower risk ISR missions			

9.7.3.7 Service Volume 7 – Future Planned

Service Volume 7 consists of the immediate environs of the Norfolk Southern Rail Yard in Altoona, PA. It is intended to be enabled for demonstration of infrastructure inspection as part of a regional rollout and will be enabled for data collection purposes for establishing safety baselines. Service Volume 7 consists of Blair County Census Tract 107.01 with a total population of 3,490 over 5.1 square miles for a mean population density of 684.1 persons per square mile.

Service Volume 7 – Altoona				
Size: Approx. ~3 Square Miles				
Matrixed Risk Assessment Score:	A/M, A/M, A/M, A/M, A/M – Tier 2			
Proposed Performance Baseline:	Tier 2			
Groundspace Configuration	Very high groundspace configuration level			
Required Build Components	**Coverage**	**Units**	**Cost**	**Total**
GNSS RTK / Nav	25 sq mi	NA	$2,500	$0
Weather Services	Available	Available	$1,500	$0
Surv. – ADS-B	25 sq mi	Add 1 unit	$3,000	$3,000
Surv. – RemoteID	3 sq mi	Add +1 RID	$2,200	$2,200
Surv. – RF	10 sq mi	NA	$10,000	$0
Surv. – Optical	4 sq mi	Add +1 EO/IR	$20,000	$20,000
Surv. – Audio	10 sq mi	NA	$50,000	$0
Surv. – Radar	2 sq mi	NA	$40,000	$0
Other Costs (Site, Bandwidth)	NA	1	$5,000	$5,000

Total Estimated Cost				$30,200
Rationale / Notes	Planned future deployment for inspection missions			
Proposed Roll Out Window(s)	**Start**	**End**	**Notes**	

Total coverage area 24-27 square miles covering three regional localities covering 40,722 lives. Total estimated sensor and installation consumables budget, excluding install and integration labor costs, is $441,000, or $17,640 per square mile / $10.83 per covered life.

9.8 Service Volume Census Tracts and Population Data

Service Volume	Census Tract(s)	Population	Size	Density
1	3/42021000300	1,554	0.4	4,214.6
1	135/42021013500	2,727	0.7	3,846.8
1	5/42021000500	1,488	0.3	4,280.6
1	2/42021000200	604	0.4	1,502.4
1	6/42021000600	1,606	0.3	4,726.2
1	110/42021011000	1,547	0.4	3,979.0
1	7/42021000700	2,335	0.8	3,109.7
	Total	11,861	3	3,594.2
2	1/42021000100	1,194	0.2	5,322.6
2	134/42021013400	2,005	1.8	1,097.2
2	12/42021001200	2,795	0.4	6,773.8
2	136/42021013600	3,114	0.7	4,275.2
	Total	7,914	3	2,729.0
3	134/42021013400	2,005	1.8	1,097.2

3	102/42021010200	1,360	0.9	1,557.3
	Total	3,365	3	1,246.3
	Total SV 1, 2, 3	23,140	9	2,674.1
4	112/42021011200	2,045	1.1	1,943.1
4	113/42021011300	4,982	2.4	2,106.5
	Total	7,027	4	2,007.7
5	107/42021010700	3,122	9.3	336.8
6	132/42021013200	3,943	19.6	201.6
7	Blair 107.01 / 42013010701	3,490	5.1	684.1

9.9 Site Deployment Plan

The table below provides the final listing of sensor sites and deployed equipment.

Service Volume	Site #	Site	ADS-B	RID	Optical	Radar
1	1 – Center	Greater Johnstown High School	0	1	1	0
1	2 – South	Ferndale Junior/Senior High	0	0	0	1
2	3 – South	Incline Plane	1	1	1	2
3	4 – Center	CamTran	0	1	1	1
3	5 – Northeast	Franklin Borough Municipal Building	0	1	1	0
4	6 – North	Johnstown Elementary School	0	1	1	0
4	7 – South	Mobile Unit (not permanently deployed)	0	1	1	0
5	8 – East	KJST	0	1	1	0
6	9 – South Fork	South Fork	1	1	1	0

In addition to the 8 deployed sites, an additional three sites were evaluated and deemed unsuitable due to obstructions, structure, or lack of approvals from the structure owner. Figure 7 below details the final site deployments, as denoted by pink rings for RemoteID/ADS-B/Optical deployments, and yellow cones to represent radar coverage.

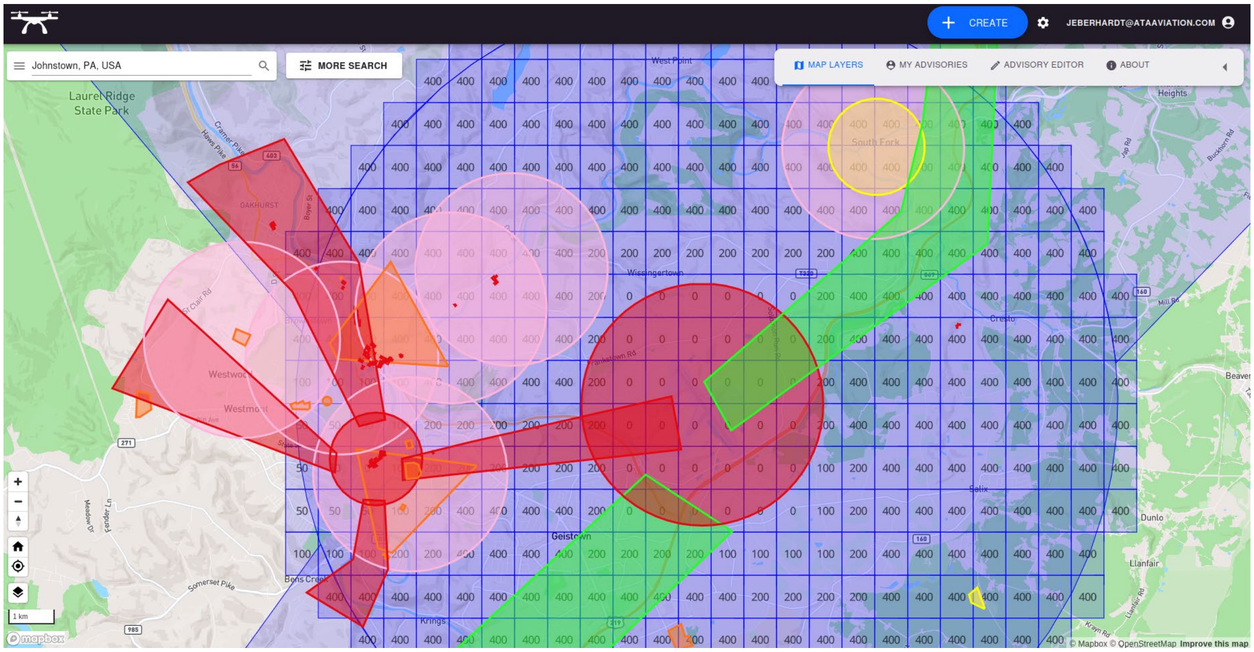

Figure 7: Equipment Deployments, Aerium EASSE

ELSa-M3 Sensor, Drone Deployment, and EMS Locations

Version 1.0, 24 April 2025

Final EMS Sites (Ambulance Services Affected)

Site	Location
Seventh Ward EMS /	314 Cedar St, Johnstown (Dale Borough)
West End EMS	175 Garfield St, Johnstown (Oakhurst - Morrellville)
Hilltop EMS	1000 Luzern St, Johnstown
Upper Yoder EMS	320 Warren St, Johnstown

Final Drone Deployment Sites

Site	Location
Dale Borough Fire Co (Arthur Street)	810 Bedford St, Johnstown, PA 15902
Hiram G Andrews Center (West Suburban)	727 Goucher St; Johnstown
CamTran Bus Depot	502 Maple Ave, Johnstown

10 APPENDIX C: Data Collection Card

ELSa-M3 Data Collection Call Card, V2.0, 6 June 2025

CCES CAD Response Incident #: 25-________________________

CCES CAD Call Date: ______________

Nature Code: ___ 2-E ___ 2-D ___9-E ___ 9-D ___ 13-D ___21-D ___ 23-D ___ 23-E ___27-D ___30-D

Data Item	Source	Answer	Instructions
Time Call Received	CAD		Insert HH:MM:SS
Drone En Route Time	CAD		Insert HH:MM:SS
Time "INFLIGHT" Added	CAD, DroneUp		Insert HH:MM:SS
Flight Complete	DroneUp	___ Yes ___ No	Obtain from pilot
If not complete, why?	DroneUp		Describe reason
Drone On Scene Time	DroneUp		Insert HH:MM:SS
Delivery Complete?	DroneUp	___ Yes ___ No	Obtain from pilot
If not complete, why?	DroneUp		Describe reason
Drone Distance Traveled	DroneUp		Insert, in meters, work with pilot
Flight Adverse Events (Describe)	DroneUp		Describe any unexpected failures or incidents. Obtain from pilot

Patient Status at EMS Arrival	EMS Station	___ Conscious, Breathing ___ Unconscious, Breathing ___ Unconscious, Not Breathing ___ Conscious, Not Breathing	Get EMS dispatch, follow up with EMS service using contact list
Ambulance Charges for Call	EMS Station		Dollar charges, get EMS dispatch, follow up with EMS service using contact list
Ambulance Distance Traveled	EMS Station		Insert, in miles, get EMS dispatch, follow up with EMS service using contact list
Hospital Length of Stay	Conemaugh Memorial		LOS in Days

Test flight and CAD dispatch data collection used a data collection table that included the following elements:

- Call Time
- Call Location (Drone Test Address)
- Nature Code
- Call Time
- Dispatch Time
- En Route Time
- On Scene Time (Delivery Time)

11 APPENDIX D: Data Sets Collected

11.1.1 General Study Methodology for Data Collection and Analysis

SAP&DC collected the Stage 1 Prototype Evaluation Measures by conducting controlled testing that facilitates controlled data collection that will allow us to compare prototype performance to baseline and also compare prototype performance directly to a paired surface ambulance response in order to control for potential confounding variables. Evaluation and Stage 2 planning data will be collected using one of four collection methods:

1. Paired case control data method, consisting of live flight tests where the dispatch of a drone delivery of emergency medical articles is paired with the dispatch of an ambulance response (e.g., intervention benefit) obtained from the CAD system;
2. Population data method, where paired drone-ambulance interventions are compared to a data set on baseline ambulance interventions in the same service area (e.g., intervention benefit, cost benefit) and data are normalized to estimate potential performance gains; and
3. Descriptive data method, where cost and performance of equipment and sensors are collected and analyzed using descriptive statistics for reporting and comparison to external reference data sources and metrics (e.g., cost and performance metrics, community benefit).

11.1.2 Collection of Data Sets

The goal of ELSa-M3 is to support the Project Objectives and Stage 2 planning requirements by measuring the cost-benefits of ELSa-M3 including: i) drone response times to that of the peered ambulance traveling by surface; ii) differences in resident medical status at arrival of ambulance, post-event hospitalization requirement, and overall morbidity as it relates to speed of service; iii) cost of the UAS operations and infrastructure and per-call cost of service of the program; v) estimated per-call cost benefits of reduced medical transport, reduced hospital stay, and improved quality of life; and (vii) new workforce and job creation impact to ultimately operate a long-term program. These performance measures will be used to evaluate the Stage 1 prototype and develop the revenue-neutral sustainment plan for a Stage 2 capital investment rollout to the SAP&DC region.

Data collection and evaluation activities were achieved by conducting four sets of data collection activities: i) collecting medical and cost benefit data from conducting paired drone-ambulance interventions (paired case-control method); ii) collecting medical and cost benefit data from paired ambulance-only interventions (paired case-control method); iii) collecting design and cost data for the supporting UAS infrastructure (descriptive data method); and iv) collecting general statistics about the SAP&DC region, the region’s geography, the region’s service needs, and the region's cost structure to support economic sustainability modeling (population data method and descriptive data method).

No Protected Health Information (PHI) was collected under the ELSa-M3 study protocols, nor will any health or medical data be used outside of the current, normal course of business in the Cambria County dispatch center. Limited Personally Identifying Information (PII) was transmitted from the dispatch center to DroneUp to facilitate delivery, however this data was not published as part of the study data sets and shall only be retained during the project for FAA regulatory purposes. Further, pursuant to 45 CFR 46 (HHS Office for Human Research Protections Common Rule) we sought a determination from the Cambria County Medical Director as to whether the ELSa-M3 project is exempt from Institutional Review Board (IRB) review as a quality improvement activity, or requires expedited IRB review, pursuant to Commonwealth of Pennsylvania and Cambria County emergency services protocols.

Tables 4a-4f below describe the specific data sets that will be collected and published as part of the ELSa-M3 Stage 1 prototype, including collection methods and elements.

Data Set: Intervention Benefit Data Set	
Collection Method	Data collected during subject dispatch interventions (cardiac arrest, anaphylactic or diabetic shock, traumatic bleeding, or opioid overdose) through active drone-ambulance paired intervention or paired baseline ambulance-only intervention
Data Collection Participants	CCES, SCEM
Data Elements Collected	Time to dispatch, time to response, time on scene, distance traveled, adverse events
Measures Supported	Response Time, Intervention Time, Total Travel Distance, Adverse Events
Requirements Supported	Demonstration of Performance Requirements, Cost-Benefit and Sustainment
PII/PHI Considerations	Any PHI collected will be collected under normal Emergency Services protocols and will not be shared with the ELSa-M3 team. Limited PII (address) for dispatch services will be shared from CCES to DroneUp, which data will be destroyed at the conclusion of Stage 1.

Data Set: Intervention Benefit Data Set	
Supporting File(s)	Overall_Stats.csv Input_Completed_Drone_Flight_ExportTable.csv Drone_DroneTelemetry_ExportTable_CompletedDelivery.csv Optimized_Drone_Dispatch.csv

Table 4a: Intervention Benefit Data Set Description

Data Set: Infrastructure Design Data Set	
Collection Method	Descriptive data method
Data Collection Participants	CCES, ATAA
Data Elements Collected	Siting plan (GIS), risk and siting analyses, deployed service volume maps, bill of materials, deployment guides and data
Measures Supported	Infrastructure Cost Measurement, planning
Requirements Supported	Cost of Infrastructure and Time to Deployment
PII/PHI Considerations	This data set contains no PII or PHI
Supporting File(s)	System Design Document – Appendix B of the Final Report

Table 4c: Infrastructure Design Data Set Description

Data Set: Infrastructure Cost and Performance Data Set	
Collection Method	Descriptive data method
Data Collection Participants	CCES, ATAA

Data Set: Infrastructure Cost and Performance Data Set	
Data Elements Collected	Site costs, sensor and materials costs, deployment costs, sensor detection characterization, sensor accuracy and error, sensor uptime and availability characterization, system and network latency, system uptime and availability, characterized service volume
Measures Supported	Availability, Flight Plan Performance
Requirements Supported	Cost of Infrastructure and Time to Deployment, Demonstration of Cost-Benefit and Sustainment
PII/PHI Considerations	This data set contains no PII or PHI
Supporting File(s)	ELSa-M3 Program Costs.csv ELSa-M3 Costing Model.xlsx

Table 4d: Infrastructure Cost Data Set Description

Data Set: Flight Safety Data Set – UAS Safety	
Collection Method	Descriptive data method
Data Collection Participants	DroneUp, ATAA, Aloft, OneSky
Data Elements Collected	Deidentified flight plans, flight tracks, diversions, reason for diversion, malfunctions or adverse events
Measures Supported	Flight Plan Performance, Air Safety, Adverse Events
Requirements Supported	Safe Integration of Scalable UAS Operations
PII/PHI Considerations	This data set contains no PII or PHI
Supporting File(s)	DroneUpTelem_JohnstownSummary.csv DroneUpTelem_JohnstownTelemetry.csv

Table 4e: Flight Safety Data Set – UAS Safety Description

Data Set: Flight Safety Data Set – Airspace Characterization	
Collection Method	Descriptive data method
Data Collection Participants	ATAA
Data Elements Collected	Flight tracks
Measures Supported	Air Safety
Requirements Supported	Safe Integration of Scalable UAS Operations
PII/PHI Considerations	This data set contains no PII or PHI
Supporting File(s)	OpticalMerge_jtwn6nm_811thru27.csv Converted_ADSB_ConvertedADSB_All_ADSB_jtwn6nm_8XX.csv

Table 4f: Flight Safety Data Set – Airspace Characterization Description

12 APPENDIX E: System Performance and Latency Analysis

Systems integration data was collected over five days (Aug 11, 12, 14, 15, and 18) to analyze overall uptime and latency for the integrated ELSa-M3 system. The analysis consisted of 3,290,616 messages, and key latency and uptime metrics were collected for each day. Overall system uptime was 99.9%+, and Total Process times were approximately 1 second for syndication of airspace awareness data and 5-8 seconds to deliver the automated tasking message for dispatch of the drone, as described in Table 1 below.

Performance Metric	Mean Min	Mean Max	Median Min	Median Max	Interpretation	Total Process
Sensor Pull to AirDEX Data (latency, milliseconds)	752	4247	759	991	< 1 sec	
Sensor Push to AirDEX Data (latency, milliseconds)	1281	4202	494	546	< 1 sec	
Email forward to FIX CAD (latency, milliseconds)	4823	383340.6667	4518	7140	5-7 sec	**Total < 1 sec**
Sensor Push Process (latency, milliseconds)	2	4	2	2	Negligible	
CAD to Advisory Creation (latency, milliseconds)	114	158	110	120	~100 ms	
Advisory Creation to Reservation (latency, milliseconds)	549	1163	472	1000	~1 sec	
Reservation to Order (latency, milliseconds)	235	686	219	751	~1 sec	**Total 5-8 seconds**
AirDEX Data Message Malformation (percent)	0	3	0	0	Negligible	

Table 1: Summary of System Performance Statistics

13 APPENDIX F: Response and Intervention Time Methods and Analysis

To evaluate the potential performance of ELSa-M3 as a standing production system, we integrated across the Computer Aided Dispatch (CAD) system to the AirDex Flight Information Exchange software, integrated airspace awareness feeds, and passed this data, along with Cambria County Emergency Communications Center dispatch data, to the DroneUp PRISM drone via the DroneUp UNCREW control software. This integrated system was used to dispatch the drone automatically from the CAD system in response to the identified nature codes where it was determined that a drone intervention could complement an existing ambulance response.

This integrated system was then used to undertake a series of shakedown, test, and data collection flights that would allow the team to compare drone response times to ambulance response times to: i) make an assessment if UAS emergency response was feasible in a meaningful timeframe; ii) identify potential challenges with UAS emergency response; and iii) identify specific requirements for the successful future deployment of ELSa-M3 as a permanent capability. A total of 100 flights were conducted, including 48 shakedown flights occurring in July 2025, and 52 test and data collection flights occurring in August 2025.

Upon completion of the test and data collection flights, the system was in service for four weeks during August and October 2025. During this period, there were 20 serviceable 911 calls within the testing area; however, ELSa-M3 was unable to service them due to structural limitations. These limitations consisted of two specific structural limitations: i) limited funding, combined with an expensive and labor intensive contractor model, resulted in limited service hours (approximately six hours per day) that severely limited the ability to respond to 911 calls that are normatively distributed throughout the day; and ii) the Certificate of Authorization (COA) used by DroneUp for the testing was originally designed to support commercial package delivery in areas with relatively flat topography, and therefore resulted in disjointed service areas. The result was that the 911 calls either occurred outside of service hours for the day, or outside of the COA areas for operation on any given day. As a result, we do not have head-to-head comparisons between the UAS and the ambulance, however, we do have significant case-control data that allowed for a comparative analysis of response time and identification of requirements for a future deployment.

Analysis was conducted on a case-control set of 52 UAS test and collection flights that occurred in August 2025 and a paired set of 81 CAD dispatches within the study area, for the identified nature codes, collected in July, August, and October 2025. Of the 52 test and data collection flights, 16 had to be scrubbed due to weather, communication, or UAS failure (31% dispatch failure rate). Of the remaining 36 flights, 29 resulted in a successful delivery (81% success rate), resulting in an overall success rate of 56%. Reasons for non-delivery included: i) excessive crowding on the ground, ii) non-viable delivery location due to obstructions; or iii) loss of communications. While moving to an optimized platform would likely reduce the dispatch failure rate, it is unlikely that we could improve upon the delivery success rate. It is therefore reasonable to assume a 50-60% overall success rate.

Successful delivery, however, only derives benefit if the delivery precedes the ambulance and allows the 911-caller of bystander to render aid. Therefore, understanding the relative response time of the UAS compared to the existing ambulance dispatch is critical. To support this analysis, the team used the paired case-control data to compare ambulance response times with those of the UAS. This comparison was conducted using three analyses:

- Direct statistical comparison of response times and distance between UAS test flights and EMS dispatch;
- Statistical comparison of “normalized” UAS response times to EMS dispatch using actual dispatch addressing and application of UAS performance data; and
- Sensitivity analysis of how an optimized UAS platform might improve comparative response times.

Prior to discussing analysis, it is important to describe four key time-series data points:

- Call Time: This is the time at which the dispatcher receives the call – this time was not use din analysis;
- Dispatch Time: This is the time at which the dispatcher completes coding the incident and dispatches apparatus, including EMS and the UAS; this time is the baseline for analysis;
- En Route Time: This is the time at which the EMS or UAS unit reports that they are “en route” to the scene; the difference between this time and Dispatch Time is the first performance metric; and
- On Scene Time: This is the time at which the apparatus arrives on scene, the difference between this time and “En Route Time” is the total travel time.

The initial direct statistical comparison focused on understanding the differences in overall response time in the raw data, and seeking to understand how relative performance broke down between “En Route” – or the time to complete the dispatch of the vehicle – and “On Scene” – how long it takes the vehicle to transit to the scene. These two factors contribute to the Total Response Time. The mean and median for each cohort, and the p-value using the student’s t-test, are reported in Table 1 below.

Metric	Ambulance (Mean/Median)	UAS (Mean/Median)	p-Value
Distance (Km)	2.9 2.0	3.4 3.3	0.34 (no significant difference)
En Route Time Difference (from Dispatch, seconds)	165.2 170.5	267.9 257.0	<0.01 (significant difference)
On Scene Time Difference (from En Route, seconds)	333.1 300.0	264.9 256.5	0.08 (meaningful difference)
Total Response Time (from Dispatch, seconds)	498.2 458.5	531.0 532.5	0.43 (no significant difference)

Table 1: Comparison of Mean and Median Performance, Ambulance v UAS

The table above demonstrates no significant difference in overall distance or response time, however does demonstrate meaningful differences in time to en route and time to on scene – with the UAS being significantly slower to dispatch than the Ambulance, however the UAS is much faster in transit once dispatched. Further, given the relatively short distances, the in-transit time advantage of the UAS is minimized, leading to an inherent negative bias toward UAS transit times. However, this transit time advantage is cancelled out by the relatively slow dispatch time for the UAS. This finding is counter-intuitive, given the high degree of automation in the ELSa-M3 system and extremely low system latency (<1 second for airspace awareness, 5-8 seconds for automated dispatch).

Based on field testing and data collection, it was observed that the DroneUp dispatch process and vehicle were not optimized for emergency dispatch. The project utilized DroneUp as a contractor to support rapid deployment using existing systems and regulatory authorities, however, these systems were designed and optimized for commercial last-mile deliveries rather than emergency logistics. Several challenges dogged accelerating dispatch to en route times:

1) Because of the original design, DroneUp had to use a “pick-pack-load” system and process that consumed 30-60 seconds at the front-end of dispatch – because this was both required in their safety manual (part of the FAA regulatory package) and tightly integrated into their software, this process could not be removed, even though it was unnecessary four our service program;

2) This process also required the package to be "loaded" onto the delivery platform for each dispatch, a process which required a further 30-60 seconds – for safety reasons, this process could not be accelerated, however if we could have had our medical articles box pre-loaded onto the UAS, this time would be saved; and
3) The design of the vehicle software and process meant that a "pre-flight" check of the UAS could not be completed until items 1 and 2 were complete, at which point the pre-flight and calculation checks consumed 45-90 seconds, depending on bandwidth.

The result was that, by reusing existing processes, approvals, hardware, and software for "pick and pack" commercial logistics, dispatch was 60-120 slower than necessary – even without any attempt to optimize the vehicle, vehicle pre-flight checks, or other steps. In the next Stage, with time to work through regulatory approvals with the FAA, we estimate that the median En Route Time Difference would fall to 150-190 seconds, comparable to an EMS ambulance. Further savings may also be possible.

To further assess the impact of dispatch time for the UAS, we conducted an additional analysis where, for the actual 81 EMS CAD dispatches, we used the actual sites and calculated what the drone response times would have been, had ELSa-M3 had the resources to match every single dispatch. The results were illuminating, and in particular provide clear operating requirements for a successful Stage 2 project.

In this normalized analysis, the initial comparison was run against the actual EMS response times using the median en route speed of the UAS of 25.3 KPH (as opposed to a 53KPH stated vehicle top speed). This median speed includes time to raise and lower the vehicle. Based simply on this metric alone, the mean En Route Time Difference of the UAS would have been 312 seconds, and the UAS would have beaten the Ambulance on en route time 41% of the time. However, using the median UAS dispatch to en route time, of 257 seconds, this performance falls to 25% of the time.

As noted above, the dispatch to en route time was handicapped by repurposing processes, regulatory approvals, and software that were not optimized for the task at hand. Therefore, the team used the available data to identify specific performance requirements for the next deployment to ensure that the UAS service was consistently arriving prior to the ambulance. Table 2, below, details the results of the Stage 1 optimization and Stage 2 requirements analysis. Reducing dispatch time by 60 seconds (pick-pack-load step) increases the UAS success rate to 34%; reducing dispatch time to 150 seconds (pre-loading the cargo) improves the success rate to 40%.

In addition to reduction in dispatch time, we assumed a 190 second dispatch time (removing the pick pack load step) and also modeled the impact of improvements in overall vehicle speed – during the Stage 1 project, the PRISM vehicle operated at approximately 50% of rated speed.

New UAS that could be applied to a Stage 2 project, such as the Inspired Flight or Sifly UAS, have 80-90 KPH rated speeds, so the modeled speed improvements are well within the possible performance envelopes of available commercial vehicles. Modest, 20-50% improvements in vehicle performance by moving to a commercial off-the-shelf solution will bring successful pre-ambulance delivery to over 50%.

Optimization Case	Ambulance (mean/median actual)	UAS (mean/median estimated)	UAS arrives ahead of Ambulance, % of time
Existing Base Performance	498.2 458.5	762.0 569.4	25.0%
190 Second UAS optimized dispatch, no speed improvement	498.2 458.5	695.0 502.4	33.8%
150 Second UAS optimized dispatch, no speed improvement	498.2 458.5	655.0 462.4	40.0%
190 Second UAS optimized dispatch, 5 KPH improvement	498.2 458.5	615.7 453.4	42.5%
190 Second UAS optimized dispatch, 15 KPH improvement	498.2 458.5	509.3 387.5	56.3%
190 Second UAS optimized dispatch, 25 KPH improvement	498.2 458.5	445.4 348.0	63.8%

Table 2: Estimated Performance Using Optimized Dispatch and UAS Speed, Total Response Time

14 APPENDIX G: Airspace Safety Data Performance Analysis

14.1 Sensor Analytical Results

For the purposes of analysis, we selected data specific to our coverage of operations in the Johnstown Urbanized area, establishing a 15 x 15 kilometer grid and selecting optical and ADS-B data points within that grid and below 1,000 ft above ground level (AGL) collected during the period August 11-27, 2025, resulting in a total data set for analysis of 62,219 ADS-B messages, 4,116 ADS-B tracks, and 41,429 corresponding optical points. Further, for each sensor array (emplacement site) we developed a 5 x 5 array of 1,000 x 1,000-meter grids centered on the array emplacement to assess the performance of the sensor and characterize expected performance for a given geometry.

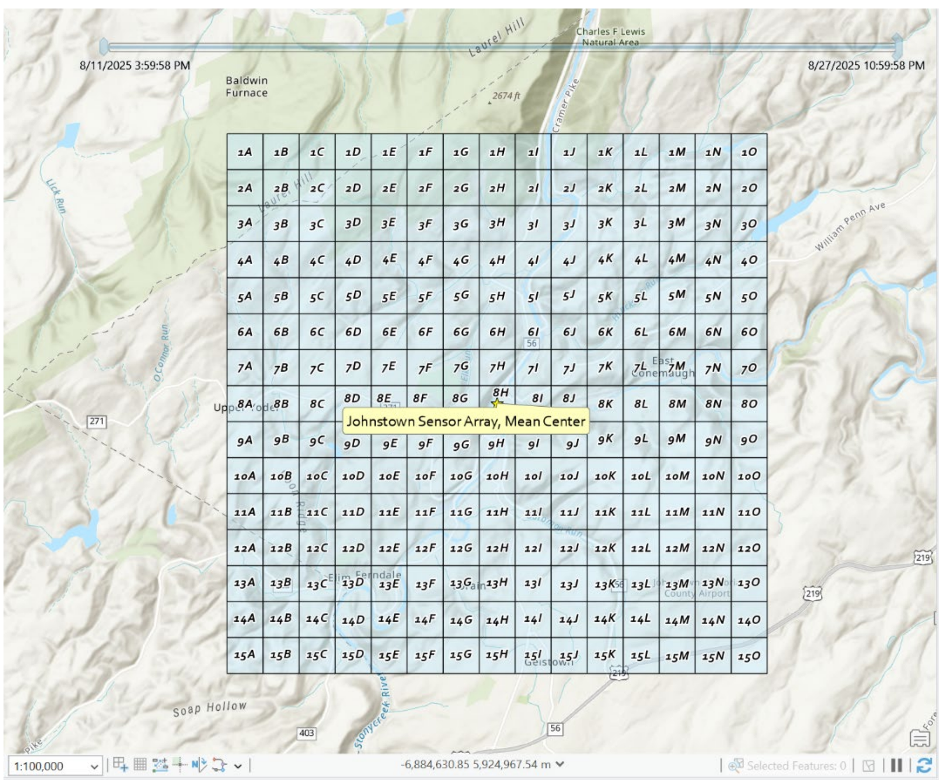

Figure 1: Full Johnstown Assessment Grid

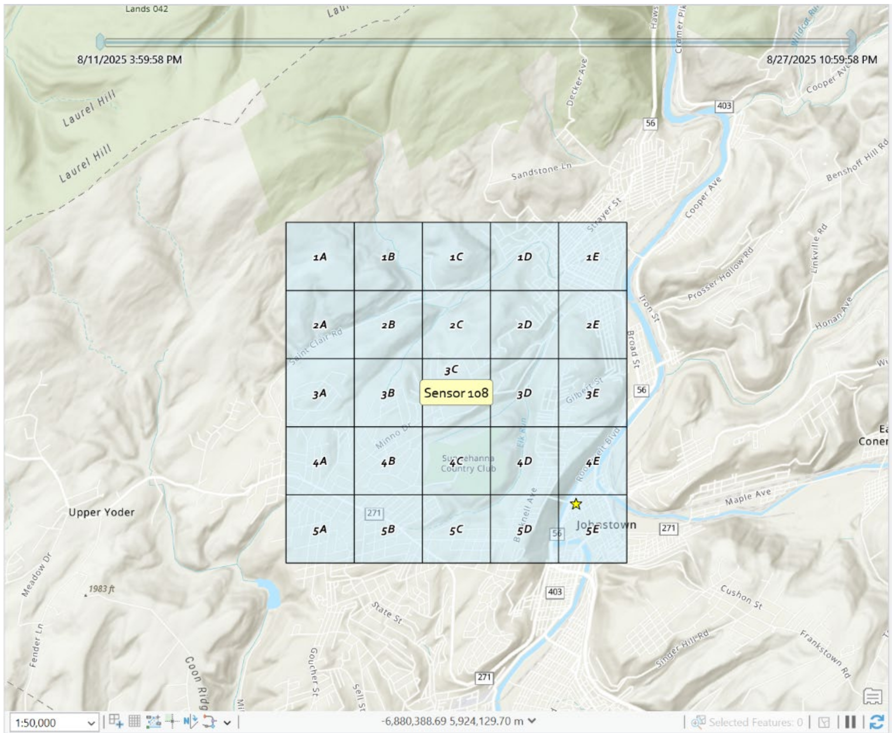

Figure 2: Individual Array Assessment Grid – Emplacement 108 Example

We describe the observed field performance of the optical sensors by individual sensor emplacement and for the overall Johnstown service volume by comparing the observed optical detection points from the optical sensors with the observed ADS-B tracks to identify co-occurent points (within 400 meters estimated and 20 seconds detection time) in order to assess range, sensitivity of detection, and estimated false positives. Examples of the co-occurrence analysis are provided in the figures below.

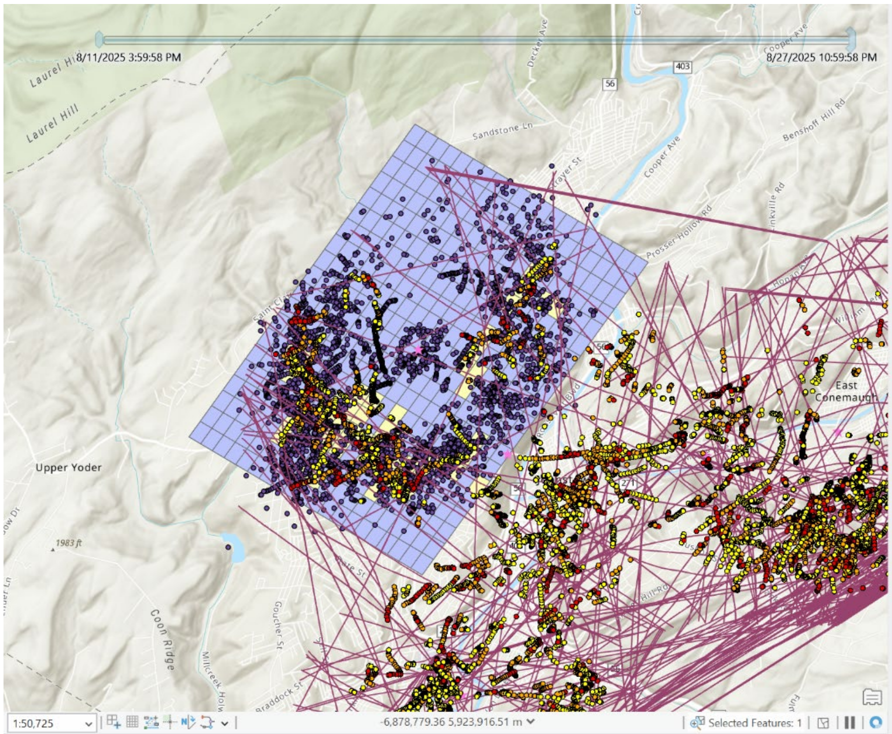

Figure 3: Optical Point and ADS-B Track Co-Occurrence Analysis – Initial Assessment

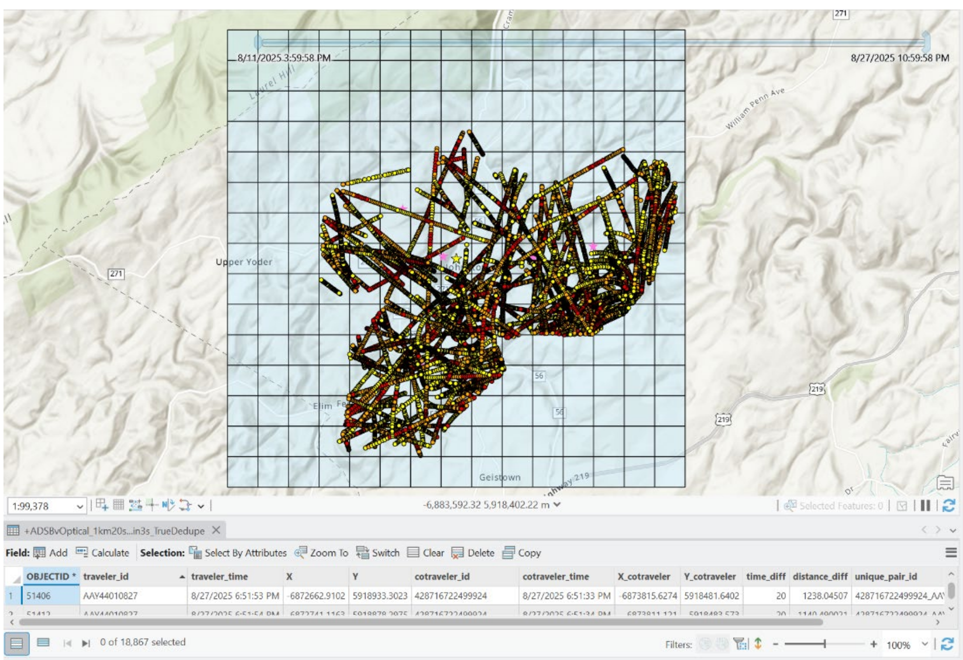

Figure 4: Optical Point and ADS-B Track Co-Occurrence Analysis – Final Set Example

Using the co-occurrence analysis, we have calculated and are reporting the following metrics:

- ADS-B Oversampling Ratio describes the number of sensors detecting the same track for a given emplacement grid (e.g., excess coverage); this statistic is not relevant for the overall grid as the samples are de-duplicated;
- Maximum False Positive Estimate accounts for the number of non-co-occurent optical points in the grid; this statistic represents the total number of points that could not be identified as co-occurrent with a corresponding ADS-B track (within 400 meters within 20 seconds) in the grid – it is important to note that this is not a true false positive rate, as we have observed non-ADS-B transmitting aircraft, however the rate is significantly higher than the expected rate of non-equipage, therefore we treat this statistic as a maximum estimate of false positives;
- ADS-B Point Sensitivity represents the rate of co-occurrence (within 400 meters and 20 seconds) of known ADS-B points to optical points, relative to the total ADS-B points for the grid; it is important to note that, because of the differential in sampling rates it is not a true sensitivity metric but rather provides a minimum sensitivity estimate for the grid; and
- Track Detection Capable: for each emplacement, we compared the matching optical track detection co-occurent points to the volume of tracks to determine if the sensor was able to detect all of the tracks in the grid (0 or 1).

In addition to the discussion of specific metrics above, it is also important to note that performance is a specific function of multiple environmental factors. The presence of these factors means that grid-specific performance. These factors include:

1) Actual baseline of air traffic within a given grid – if a grid has insufficient background traffic, then detection performance cannot be characterized; therefore a “zero” grid may be the results of insufficient background detection rather than insufficient detection performance and may, over time, become detection capable;
2) Visual obstructions relative to array – as the comparative mode is optical, any physical obstruction to field of view, such as trees and structures, would reduce performance of the sensor, and further, weather and environmental factors such as rain and fog will reduce camera performance; and
3) Sensor Design Field of View – the design of the optical sensor creates a torus in which no detections can occur.

While we strove to optimize placement to minimize these environmental factors, it is obviously not feasible to control for all of them. Therefore, our analytical approach is to use a wide set of data from the study period to characterize sensor performance in a wide range of conditions and geographies, and to publish the actual observed performance and align operating areas with expected functional grids. Table 1 below describes the observed field performance of the optical sensors by individual sensor array and for the overall Johnstown service area as described above.

Array	N	ADS-B Oversampling Ratio (Mean/Median)	Maximum False Positive Estimate	ADS-B Point Sensitivity	Track Detection Capable Grids
108		3.4x / 3.5x	73% / 76%	30% / 37%	15 of 25
109		7.4x / 6.0x	62% / 68%	24% / 25%	18 of 25
110		3.6x / 3.6x	0% / 56%	36% / 34%	21 of 25
111		3.2x / 3.3x	51% / 56%	42% / 43%	19 of 25
112		7.5x / 7.4x	0% / 40%	30% / 28%	20 of 25
Aggregate Area		NA	77% / 78%	32% / 33%	55 of 94*

Table 1: Summary Performance Statistics by Array and Service Area, Mean/Median Performance (Grids for which data is present)*

As a result of this analysis, track detection capable grids can be created and marked as polygons and published through the Keystone FIX for use in dynamic flight operations and planning. An example if provided in the figure below.

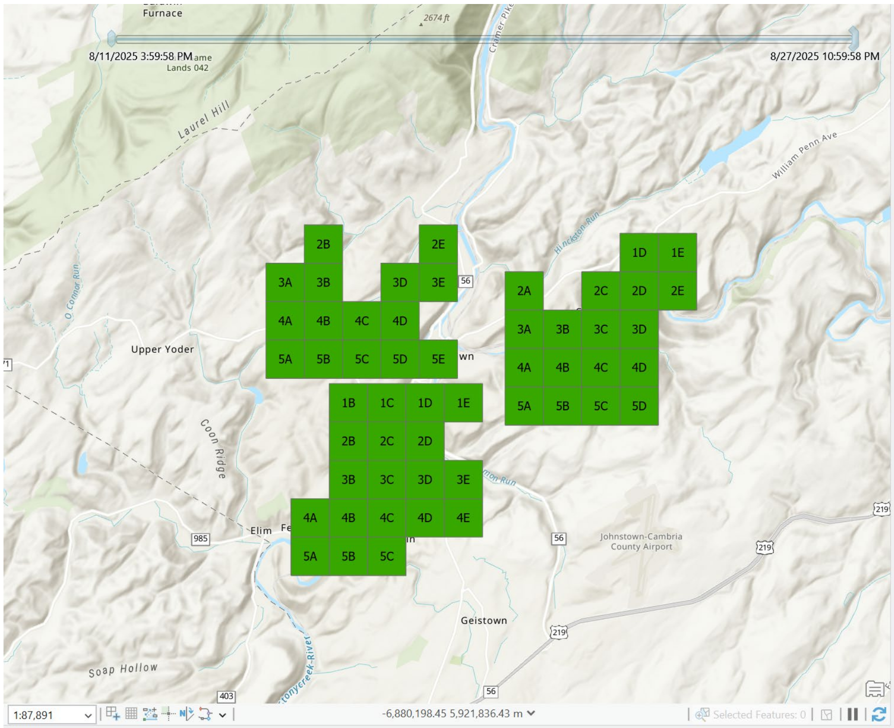

Figure 5: Track capable detection grids, Array 108 example

In addition to understanding sensor performance by geometry, we also assessed potential sensor range. While the Detect Capable Grids analysis provides specific performance data by array, an additional separate analysis of sensor ranging provides additional data that allows us to estimate where potential future performance may accrue with sufficient flight data. In order to assess negatively to positively biased ranging estimates and assess the potential gap between these estimates, we calculated estimated range (including positional uncertainty) at the 50th, 75th, and 90th percentile (negative to positive bias). Table 2 below details ranging percentiles.

Array	50th Percentile Range	75th Percentile Range	90th Percentile Range
108	1396	1647	1825
109	1376	1646	1837
110	1386	1600	1777
111	1232.	1526	1737
112	1371	1607	1783

Table 2: Estimated Range Percentiles by Sensor Array, meters

The range percentiles provide a fairly tight range of 1300-1400 meters on the negatively biased end, to 1775-1825 meters on the positively biased end, a difference of approximately 500 meters. Figure 6 below details range for individual detections, while Figure 7 displays the range percentiles.

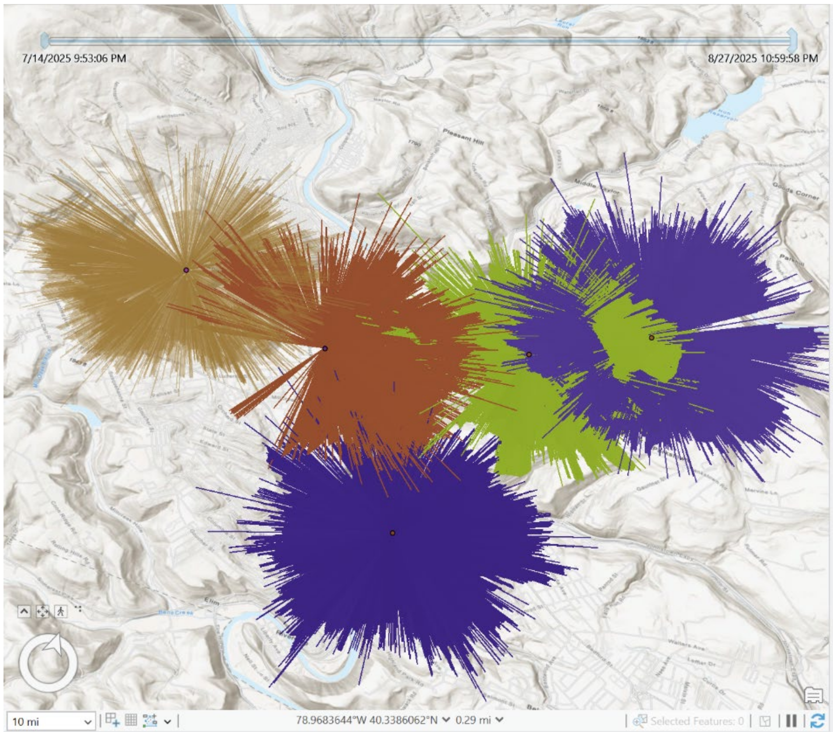

Figure 6: Display of Point Range by Array

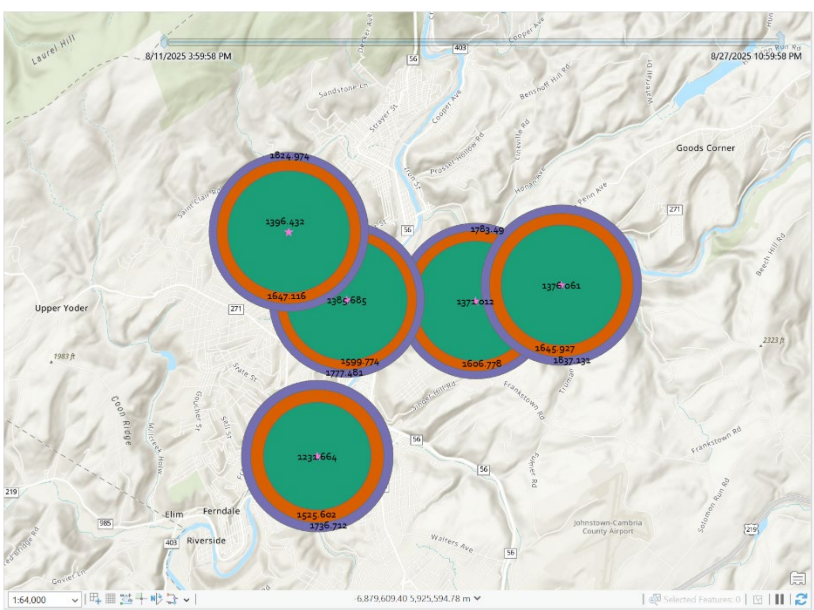

Figure 7: Percentile Ranges – Map Display

In addition to range, the co-occurrence analysis was also used to estimate lateral positional uncertainty for the optical sensors vs the ADS-B. The mean positional uncertainty was 727 meters, the median was 728 meters.

14.2 Analytical Methods

The Johnstown area has multiple sensor installations spread across the area. Sensor installation locations were chosen due to sensor needs and willingness to host the technology at those locations. Sensors required an accessible rooftop location, reliable access to a power source, and open visual of the airspace above and around the sensor location—topography and building geometry impact optical detection if they are blocking or occluding sensor cameras. Table 3 below is a table listing the sensor number and location as referenced in the analysis

Sensor 108	Suburban School
Sensor 109	Public Landmark
Sensor 110	Borough Building
Sensor 111	Central School
Sensor 112	Public Transportation Building

Table 3: Sensor Location Coding

Sensor deployments in the Johnstown area have been successfully feeding live airspace data into the FIX system since install. These systems operate continuously alongside our other sensor installations in different locations. The characterization analysis process used for the historical Johnstown data is a process that can and will be applied to other sensor installations as part of a post-installation characterization process, both for internal and external validation of sensor capabilities.

Data collection occurs passively from the point where a sensor installation becomes active, and the data is then presented in the FIX while simultaneously being logged in a system database to be retained for a period. This retained data is where the data used in this analysis was sourced from; airspace data comes through our system, is logged, and then can be exported for various purposes. Data is queried from the system based on what specific sensors of interest we have—this allowed us to, in this instance, pull data from the system for specific dates where we were active in the Johnstown area with the DroneUp team for Drone814 operations, and to select the sensors in the specific Johnstown sensor range.

It should be noted that for the Johnstown airspace datasets, some periods of Drone814 related flight-testing data are excluded. Two sensors that were part of the deployment did not have their data included in this analysis for technical reasons, and airspace data for the period preceding August 11th were not included due to database limitations.

Data points captured by the sensor arrays are consumed by and presented within the FIX, presenting live airspace data within the web application for situational awareness. Within the FIX, data is represented by aircraft type (airplane, helicopter, and drone), and contains additional information about the craft as captured by the sensor system. Information about elevation, heading, and the type of data capture are shown to the user to provide context for the data being represented on-screen—ADS-B information is tagged as such for relevant aircraft broadcasting this information, Optical sensor data is specified as being such, and Remote ID tags are represented where applicable (for this analysis, no RID hits were logged and were not part of this analysis.).

The initial fields contained within each datapoint from the sensor are as follows:

OBJECTID*	Assigned by default, assigns a unique ID to each feature within the layer. *Assigned by ArcGIS.
Shape*	Describes the geometry. Aircraft position geometry = points. *Assigned by ArcGIS
source	Designates which sensor captured the positional data of the specific point feature.
aircraft_id	The ID tied to each point feature. This value is dependent on the type of data capture: ADS-B points utilize the aircraft tail number that is being broadcast and is reliably tied to that craft even over different days. <u>In cases where a **Null** value was identified for the Track ID, a default value of -8888 was assigned.</u>

	Optical points are assigned a number string by the Iris system as the system captures the aircraft and maintains visual of the craft. Persistence of the Aircraft ID from one point to the next varies and is dependent on visual fidelity and the hardware's ability to keep track of the craft as it transits the airspace. In cases where a **Null** value was identified for the Track ID (the system assigned **all UAV points** with a **Null** track ID), a default value of -9999 was assigned.
timestamp	The time the airspace object was recorded at that position in that instant. The feature's timestamp is recorded as YYYY-MM-ddTHH:mm:ssZ with Z designating the timestamp as Zulu, or GMT. This timestamp attribute is used to create a new Date field that ArcGIS can use for Time based analysis (see: timestamp_Converted).
altitude	The altitude recorded for the feature. The altitude value depends on the units used, and the reference units, which are dependent on the data type and type of craft. Optical UAV positions are recorded in Meters, while conventional aircraft are recorded in Feet. ADS-B features have their altitudes also recorded in Feet, but the source of this altitude comes from the Barometric instrumentation onboard the aircraft that is then transmitted via ADS-B (potentially introducing some error resulting from aircrafts' onboard instrumentation not being calibrated properly). Altitudes were converted to Meters to make data features align properly (see: AltConverted, or Z).
altitude_units	The unit of measurement used for the altitude value. Either in Meters or in Feet, depending on the data type and type of craft.
reference_units	The altitude reference of the altitude value. Depends on data type and type of craft.

	BARO describes craft that use Barometric altitude readings as their altitude reference. This is used for ADS-B broadcasting conventional aircraft. MSL is used for optical sensor readings, both UAV and conventional craft.
heading	The heading of the aircraft at the moment its position was captured. This value is based on a 0-360 directional system, in which 0 and 360 are North, 90 is East, 180 is South, 270 is West. These values allow for modification of feature symbology to represent them as 3D arrows within a Scene using the heading value to determine the direction to point the feature (helpful for visualization).
meta	The meta attribute contains supplemental information about each individual feature, allowing for querying and sorting based on values contained within the feature using this field. The meta string contains its values as such, with ___ designating a variable: {“detection-type”:”___”,”emitter-type”:”___,”icao-address”:___,”speed”:___,”speed-units”:___”,”classification”:”___”,”confidence”:___} By using the Select By Attributes tool in ArcGIS, queries can be formed using the meta field to select for ADS-B points specifically, UAV points only, or to query by confidence rating.

Data from the system is extracted into a GeoJSON format and then converted to layers in ArcGIS using the JSON to layers tool. All layers are projected in WGS84, and the analysis environments (maps and scenes) use the WGS84 projection—besides instances where data operations required a re-projection to projected spatial reference rather than geographic, e.g. the creation of 3d sensor volumes. Data also has undergone application of the altitude reading contained within each data point’s attributes, appending Z values to the data layers to allow for correct placement and spatial reference for objects above the ground; such Z values were also converted to a uniform altitude measurement of Meters, as this is the unit of reference for WGS84.

The ADS-B data that was located far outside the study area were excised from the dataset by determining a range around the Optical datapoints. By selecting the Optical points within the dataset, a Select by Location operation is conducted on the data to scope it to a geographic range—for this analysis a range of 6 Nautical Miles was chosen. Per Part 107, visibility of 4 Statute Miles is needed for conducting UAS flight operations; to account for the approach of faster moving conventional aircraft, an additional 2 NM was added to allow for an ample 6 NM scope of ADS-B points to be included in the data. Altitude readings far outside the scope of analysis were removed as well. These points were assumed to be errors of the altimeter (many were centered above Johnstown airport; likely an artifact of onboard equipment being turned on or off on takeoff and landing) or high-flying stratospheric aircraft. Lastly, Null values that were recorded for the Aircraft ID of ADS-B points were modified to be non-Null—while this creates some mixing of certain flight IDs, Null values also inhibited the function of certain GIS operations. By reassigning the Null values, the tools worked properly, and Nulls containing the new Flight ID of -8888 can be grouped but not removed from the data.

DroneUp telemetry data was queried from the DroneUp flight logs and extracted into a .csv Excel Spreadsheet. The ArcGIS tool, XY Table to Layer was used to introduce the DroneUp dataset to the analysis environment. Latitude and Longitude values were plugged in, and Z values were assigned based on the “altitudeWgs84Meters” field. This spreadsheet included the following fields:

Flight_id	A unique Flight ID assigned to each flight contiguous to each individual flight instance. Used for identifying flight tracks.
Event_timestamp_UTC	A timestamp for the Drone’s position at that moment in time taken every second. Allows for sequencing flights’ directions and for knowing the position of the drone at each moment.
Longitude	The longitudinal coordinate position of the drone.
Latitude	The latitudinal coordinate position of the drone.
altitudeWgs84Meters	The altitude of the drone, using WGS84 as the elevation reference. **This is the altitude unit utilized for analysis, as the spatial reference of the other datasets was also WGS84**.
altitudeMslMeters	The altitude of the drone, using MSL as the elevation reference.

DroneUp flight telemetry data (onboard telemetry regarded as most precise for purposes of analysis), ADSB data recorded from conventional aircraft broadcasting and capture on AirDex data system within sensor array (regarded as next-most precise; used as “anchor points” for conventional aircraft positions in flight, despite variables in aircrafts’ instrumentation), and finally

Iris Optical sensor data captured by the MVI system (the primary focus of this analysis and characterization modeling). All datapoints contained timestamps that allowed for cross-referencing of both time and spatial characteristics of airspace data. Temporal and spatial dimensions of the data are key features of the datasets that allow for determining objects' locations in the airspace, and for being able to index and analyze the corresponding instances of objects in the airspace between the sensor detection modes (ADS-B, Optical, and Telemetry).

After bringing the data into ArcGIS, formatting it, and correctly displaying it, Optical sensor data from each individual sensor was extracted and isolated. This sorting allowed for analysis of individual sensors. Data across multiple days were then combined to create composite data layers for each sensor, conglomerating these data points into large datasets that allowed for deeper analysis and mining of patterns, and helping to characterize each sensor's performance. This process of formatting, separating, sorting, and compositing was conducted on Optical and ADS-B datasets for individual sensor data analysis and characterization. These larger composite datasets also allowed for the creation of Sensor Envelope Volumes, representing in 3 dimensions the effective Optical sensor areas based on observed airspace data. Using the Minimum Bounding Volume tool in the 3D Analyst toolbox, a 3D model can be created using a composite airspace dataset for an individual sensor; by selecting a Concave Hull shape, a fully enclosed model will be made with the walls of the 3D model being mapped to the outermost points of the dataset. This characterization process allows for visualization of an individual Optical sensor's performance and capabilities. The 3D Sensor Envelope Volumes include data from the Drone814 operational window, and subsequent sensor characterizations could use more or less data—there is no specifically defined number of data-days that should go into such a characterization, but it is assumed that too few data points is insufficient while too many may give diminishing returns.

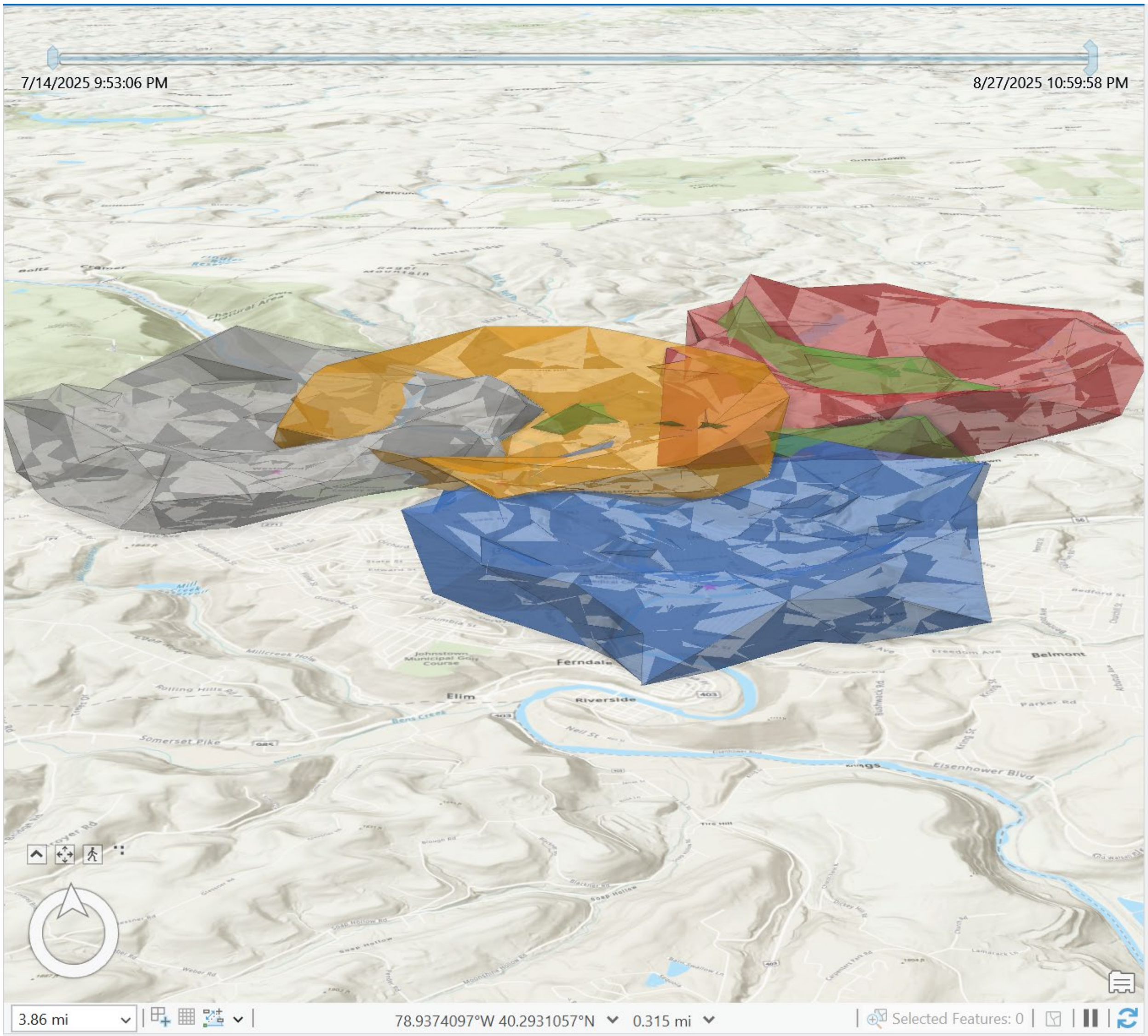

Figure 8: 3D Detection Volumes in view at the same time. Visualizes Optical sensor overlaps across Johnstown.

Iris sensors utilize optical sensors using onboard cameras to capture visual data of aircrafts, recognized using the manufacturer's AI models/algorithms to determine craft type, location, “confidence”, heading, etc. Sensors also require some level of masking to configure sensors to focus optical capture on airspace to prevent capture of local groundspace obstacles or horizon level features that could be misidentified as aircraft.

Optical sensor positions collected, projected into an ArcGIS scene to display the Iris sensor’s points within a 3d geographic space, and measurements were converted as necessary to ensure consistent positioning of data points to be represented as meters (conventional aircraft measured in feet, UAS measured in meters; conventional craft altitudes thus converted to meters to match projection of Scene and Z-values of UAS positions within the same data layers). Optical sensor data is also collated to create composite datasets of multiple days of airspace data into single data layer, allowing for creation of sensor profiles using observed airspace data collected over multiple days—composite data layers could then be used to create 3d multipatch models to represent sensor envelopes in 3d geographic space based on collected historical airspace data.

ADS-B points are broadcast to the system by conventional aircraft that have their ADS-B communications turned on. As a result of this, the data is the “anchor” for which Optical analysis points are referenced to. It should be noted that this does not necessarily mean that ADS-B is always the most accurate or calibrated, it is simply the data that we have reference for outside of the Optical data—ADS-B is within some level of standard for conventional aircraft flights etc. but we have no way to verify the calibration or accuracy of the onboard devices of aircraft. The limitations of ADS-B are also what allows Optical sensor detection to fulfill a role to assist in detection: if a craft that does not have its broadcasting turned on to transmit ADS-B, the optical sensor is able to detect the aircraft within its sensor range. To reiterate, this characterization analysis method is developed to determine the capabilities of individual optical sensor installations, so that a determination of effective optical detection range of aircraft (conventional and uncrewed) can be made.

Additionally, ADS-B data was further pared down during Co-Occurrence analysis. Altitudes were converted to Meters from Feet and assigned to the layers’ Z values to format the data. The altitudes that were far outside the effective detection altitudes of the Optical sensors were excised from the datasets to create new layers that were under a certain altitude range. Various altitude maximums were set for sorting the new ADS-B datasets, but for the Co-Occurrence analysis a maximum altitude of 2000 Meters was selected. Choosing 2km as the highest point filtered out points that were outside the scope of low-altitude flights. The highest point detected by the Optical sensor was <1800 Meters, meaning that choosing 2km as the maximum altitude in the ADS-B layer would allow additional space for making Co-Occurrence determinations. If the Optical sensor had incorrectly gauged the altitude of a point that is higher according to ADS-B, including ADS-B points at 2km would allow for the Co-Occurrence to be identified in the cases of the 200m and 400m search radii.

To better understand the rate at which the Optical sensor is able to detect aircraft transiting its effective area, the point data retained for both the ADS-B and Optical data were compared directly against each other. One of the variables with sensor technologies across the various modes (radar, lidar, optical, etc.) is distance—the assumption being that an object further away from the sensor will be more difficult to detect, or more likely to be missed by the sensor. By using the airspace data, we are able to map the spatial relationship between the optically observed airspace data, the broadcasted aircraft position, and the (approximate) sensor locations to view the patterns of detection.

First, by using the composite airspace datasets derived from multiple days of data collection, they can be sorted by sensor. Sorting by sensor is of particular necessity for the Optical datasets, as they are more tightly bound to the Optical sensors' locations. ADS-B data on the other hand spans a much larger area than its optical counterpart, even if the same aircraft being detected is being picked up by multiple sensors over time. For this portion of analysis, ADS-B data was bounded to 5800 ft MSL to encompass aircraft tracks which were below roughly 1000 ft AGL over Johnstown. This was done to filter out aircraft that were at no risk of transiting across low-altitude airspace, and to remove extraneous data that would have impacted the results of the analysis. One characteristic of the ADS-B data is that it is much more "dense" (there are generally more ADS-B points contained in the dataset as the object transits space), likely due in part to multiple sensors picking up on the GPS tracks. ADS-B may also potentially be broadcasting updated positions from onboard the aircraft faster than the Optical sensor on the ground is detecting and processing. This denser characteristic of the ADS-B data is expected to impact the hit-rate, as there are more datapoints contained in the airspace datasets. Additionally, ADS-B points were not sorted out by sensor; the data tracks for flights in the ADS-B datasets are a mix of points from different sensors, and to sort them out individually would not be significantly impactful to the data compared to sorting the Optical, which required sorting by sensor.

15 APPENDIX H: Infrastructure Cost Analysis and Cost Modeling Methods

15.1 Program Operating Components

This cost overview of the ELSa-M3 system describes three financial metrics: i) the actual program cost breakdown of the project; ii) a "de novo" cash stand-up cost estimate applying our lessons learned to a new locality of similar scope, without repeating integration and regulatory learning and excluding overheads; and iii) estimated annual operating cost excluding overhead costs. In conducting these analyses, costs are broken into seven key categories, described further in Table 1 below:

- Program Management
- Airspace Awareness
- Data Integration and Syndication
- UAS Logistics Equipment
- UAS Flight Planning and Control Software
- Pilots and Equipment Operations
- System Deployment and Integration, cost to deploy and integrate sensors in the field

Program Activity Category	Description and Components
Program Management	Program management includes policy and procedures, day to day management, data analysis, and community outreach
Airspace Awareness	Components to ensure awareness of the air and ground space to avoid conflicts, including sensor equipment, the cost of supporting hardware equipment and consumables, and deployment and integration of equipment
Data Integration and Syndication	Costs to integrate data feeds and ensure the ability to support automated dispatch, airspace awareness, flight planning, and deconfliction, including integrating CAD, sensors, and UAS flight planning and control
UAS Logistics Equipment	Drones, spares and medical articles for delivery

UAS Flight Planning and Control Software	Software to conduct UAS flight planning and control during operations
Pilots and Equipment Operations	Cost of personnel to operate and maintain UAS
System Deployment and Integration	Cost to integrate sensors with software platforms in the field to support the air side of airspace awareness, and integration with other flight planning and compliance tools to support full airspace awareness

Table 1: Program Operations and Cost Categories

The categories described above represent the major operational components of an emergency medical logistics program, including hardware, software, personnel, integration, and management. These will be used to categorize the actual costs of the ELSa-M3 pilot, and what the expected costs of a new, similar deployment would be, as well as the expected operating costs of the system.

15.2 Actual Program Costs

Table 2, below, details actual allocation of program spending by category, including a discussion of the specific activities within the cost category. This allows us to develop a “de novo” budget by differentiating between those costs associated with the ELSa-M3 project that related to research and solutioning that would not need to be repeated in a de novo, “production” roll out of the program.

Category	Cost	Discussion
Program Management	$633,944	Program Management activities included contract administration and reporting, day-to-day administration of the program and activities, development of policies and procedures, data collection, analysis, and research, program marketing and community outreach, and identification of community benefits. For the purposes of the SMART grant, this activity was heavy on the initial development of policies and procedures, community outreach and marketing, and data collection and analysis.

Category	Cost	Discussion
Airspace Awareness - Hardware	$288,908	Airspace Awareness – Hardware included the actual cost of acquiring airspace awareness sensing equipment, including ADS-B, Radar, RemoteID, and Optical.
Airspace Awareness - Deployment	$94,049	Airspace Awareness – Deployment activities included the cost of labor, bandwidth, and mounting / installation equipment and consumables necessary to deploy the airspace sensing equipment according to the System Design Document. During the project, we standardized mounting hardware and approaches and focused exclusively on public buildings to keep the cost manageable.
Data Integration and Syndication	$276,900	Data Integration and Syndication includes the cost of software and tools necessary to support sharing of data across participants, including UAS and aircraft operators not participating in the actual emergency medical delivery program.
UAS Logistics Equipment	$87,685	UAS Logistics Equipment included the cost of the vehicle, spares, and medical articles for delivery.
UAS Flight Planning and Control Software	$96,200	UAS Flight Planning and Control Software including the specific costs of software for flight planning and control of the delivery drone.
Pilots and Equipment Operations	$270,345	Pilots and Equipment Operations includes the cost of personnel to operate and maintain the equipment, and related operational costs.
System Deployment and Integration	$177,225	System Deployment and Integration includes the costs of integrating across the sensors, CAD tools, flight planning and control tools, and testing and validating data and data interfaces. As many of these integrations were novel, a substantial amount of time was invested in creating robust integrations.

Category	Cost	Discussion
Total	$1,925,256	Total project cost.

Table 2: Actual Program Costs by Category

Given the operating area of the system (25 square miles) and the covered population (40,000), the stand-up cost of the Stage 1 ELSa-M3 system was $77,000 per square mile and $48 per covered life.

15.3 Estimated De Novo Program Costs

Table 3, below, restates what the de novo stand-up costs would be if the team were to deploy a "new" system with the same specifications, taking advantage of the work to date, re-using existing integrations and templates, and focusing on program stand-up and regulatory rather than developing process, integrations, and deployments.

Category	Cost	Discussion
Program Management	$300,000	Program Management for a de novo system would focus on policies, procedures, training, and regulatory oversight and approvals. Data collection would be highly automated and standardized for reporting purposes. This would substantially reduce the program management costs for stand up of a new program.
Airspace Awareness - Hardware	$288,908	Airspace Awareness – Hardware would largely remain the same cost. While the team believes there are further efficiencies to be gained here, we conservatively estimate that these costs would remain the same.
Airspace Awareness - Deployment	$80,000	Airspace Awareness – Deployment activities would be slightly reduced in a de novo deployment, as we would rely on standard configurations and approaches. However, cost savings would be modest, as it still requires physical presence, hardware, and labor.
Data Integration and Syndication	$100,000	Data Integration and Syndication in a de novo standup would focus only on the tools necessary for data syndication, and

Category	Cost	Discussion
		would allocate the cost of participation to specific operators, which reduces this cost for the overall program. There is also opportunity here for amortizing this component across multiple programs.
UAS Logistics Equipment	$75,000	UAS Logistics Equipment costs representing the cost of commercial vehicles, spares, and medical articles for delivery.
UAS Flight Planning and Control Software	$50,000	UAS Flight Planning and Control Software including the specific costs of software for flight planning and control of the delivery drone using a standard commercial product.
Pilots and Equipment Operations	$50,000	Re-allocation of cost for Pilots and operations away from contractor personnel to internal cost allocation for existing personnel, which results in a much higher degree of system availability at a substantially lower cost.
System Deployment and Integration	$25,000	System Deployment and Integration would focus on test and validation of the system using existing integrations, rather than new integrations.
Total	$968,908	Total project cost.

Table 3: De Novo Program Costs by Category

In terms of developing a de novo cost deployment estimate for going forward, the team reviewed the project and actual areas of operations and identified several major areas for cost savings in a de novo deployment. These cost savings rest on two principles: i) re-use of existing tools, policies, procedures, and integrations so that these do not have to be re-developed; ii) brining the actual operations of the house and the UAS vehicle "in house" so that cost would be based on allocations of existing personnel cost on an "as needed" basis rather than funding external contractors. Re-use of tools, policies, procedures, and integrations is based on a successful system deployment that demonstrated the required functional and performance characteristics for re-use. While the use of contractors in the Stage 1 SMART grant allowed for more rapid deployment, test, and validation of the system, bringing the system in-house aligns to our long-term program goals as provides a much more cost-effective operating model. De Novo costs savings accrue in five key areas:

- Program Management: As a research and pilot project blazing new trails, the Stage 1 SMART grant needed to invest in development of policies, procedures, approaches, integrations and more extensive research and data analysis than would be expected in pure operations program; therefore, we estimate that in-house program management by emergency services would cut the program management costs in half;
- Data Integration and Syndication: As a new, unproven program, the project funded the participation of a number of flight control providers in order to test and validate the benefits of the integrations to their aircraft operator customers; as that value has been validated, under a new program these providers would receive the benefits of the program at now cost and would be expected to bear their own costs in return;
- UAS Control Software: In line with partnering with a contractor provider, the UAS was operated by a custom-developed flight planning and control software; going forward, the program would select the flight planning and control software from a number of commercial, off-the-shelf options that would integrate with selected vehicles;
- UAS Operations Personnel: This is likely the biggest cost savings, and a transformational change to the program – the reality of emergency operations being that you must be available for low-frequency, high-severity events, the use of contractors was prohibitively expensive; the contractors are scaled to conduct multiple operations per hour with a high degree of automation – the reality of emergency operations is that operations require rapid response to high-severity incidents at a relatively low frequency; therefore, the most cost-effective model is to actually staff and operate the system (using automation) with existing emergency services personnel where personnel costs are largely already covered; and
- System Deployment and Integration: Many of the integrations developed in the ELSa-M3 project were new integrations between systems and therefore required a substantial amount of development and testing; a de novo program would leverage these developed integrations and would therefore focus on testing and validation of integrations.

The development of a de novo deployment model estimates that the cost of deploying a “new” Johnstown system, or a system in a new environment (such as Altoona) would cost approximately $970,000. Given the operating area of the system (25 square miles) and the covered population (40,000), the stand-up cost of a de novo system is estimated to be $38,750 per square mile and $24 per covered life.

15.4 Estimated Operating Costs

In addition to estimating the stand-up costs of a de novo system, the team also estimated the operating costs of the system in order to evaluate potential sustainability over the long term. Using the de novo cost analysis, and assuming that certain system costs (such as Program Management and Data Integration and Syndication) are not amortized across multiple departments, the team developed the following "high baseline" for annual operating costs, as described in Table 4 below.

Category	Cost	Discussion
Program Management	$100,000	Program Management annual costs estimate 1 FTE for overall program management, focused on policies, procedures, training, and regulatory oversight and reporting. This cost allocation is likely high; however, the intent is to provide a conservative estimate.
Airspace Awareness - Hardware	$181,548	Airspace Awareness – Hardware would largely remain the same cost as in the initial year, given the costs to maintain and operate equipment.
Airspace Awareness - Deployment	$80,000	Airspace Awareness – Deployment activities would be focused on the maintenance and support of the sensors in the field, including maintenance, monitoring, and upgrades. Actual costs may be lower than the estimate.
Data Integration and Syndication	$100,000	Data Integration and Syndication operating costs would largely remain the same year-to-year, as they consist of hosting, bandwidth, and software licensing costs. However, this is a base cost and there is an opportunity to amortize this component across multiple programs.
UAS Logistics Equipment	$25,000	This represents an estimate for maintenance and spares, based on known costs.
UAS Flight Planning and Control Software	$50,000	This represents an estimate for commercially available UAS Flight Planning and Control Software, based on known costs.

Category	Cost	Discussion
Pilots and Equipment Operations	$25,000	This includes allocation of personnel costs for Pilots and operations, including ongoing training costs.
System Deployment and Integration	$0	System Deployment and Integration would focus on test and validation of the system using existing integrations, rather than new integrations.
Total	$561,548	Estimated Annual Program Operating Cost

Table 4: High Baseline - Annual Program Costs by Category

Given the operating area of the system (25 square miles) and the covered population (40,000), the stand-up cost of a de novo system is estimated to be $22,440 per square mile and $14 per covered life.

15.5Cost Model

Using the known project costs, de novo costs, and annual operating cost estimates, the team was able to develop a simple model that supports cost estimation for additional programs. The model looks at three categories of cost:

- Program Wide Fixed (Amortizable) Costs: These are program wide fixed costs that remain the same whether the program supports one site or multiple sites; key cost metrics decline as sites are added to the program;
- Program Wide Variable Costs: These are the costs required for vehicles, equipment, and personnel to operate a given UAS service site – based on ELSa-M3 data, we would expect a site to service approximately 25 square miles at a radius of 5 miles from the site; and
- Airspace Awareness Variable Costs: These are the variable costs derived from the number of sensor emplacements needed to support the service area, using the method described in the System Design Document (Appendix B) – it is important to note that the ELSa-M3 was an especially challenging Service Area due to the terrain, airspace traffic, and the physical layout of the city and suburbs.

Figure 1 below describes the Program level costs in the model, and Figure 2 describes the Airspace Awareness and total costs.

Program	Cambria Vounty Emergency Services			
Service Area	Johnstown Urbanized Area			
Program Wide Fixed (Amortizable) Costs				
			Program Costs	
			Startup	Operating
Program Management			$300,000	$100,000
Data Integration and Syndication			$100,000	$100,000
System Deployment and Integration			$25,000	$0
UAS Flight Planning and Control Softw			$50,000	$50,000
		Total	$475,000	$250,000
Program Wide Variable Costs				
Operating Sites	1			
Vehicles / Site	2			
Personnel / Site	5		Costs, per Site	
			Startup	Operating
UAS Logistics Equipment			$37,500	$12,500
Pilots and Equipment Operations			$10,000	$5,000
	Total Vehicles Cost		$75,000	$25,000
	Total Personnel Cost		$50,000	$25,000
		Total	$125,000	$50,000
Total Program Costs			$600,000	$300,000

Figure 1: Program Level Costs Model

Airspace Awareness Variable Costs								
			Startup	Operating				
ADS-B			$21,024	$4,664				
RemoteID			$2,649	$2,649				
Optical			$18,856	$17,284				
Radar			$30,000	$10,000				
				Modes				
Service Volume	Site	Tier		ADS-B	RemoteID	Optical	Radar	
1	1	2		0	1	1	0	
	2	3		0	0	0	1	
2	3	3		1	1	1	2	
3	4	3		0	1	1	1	
	5	2		0	1	1	0	
4	6	2		0	1	1	0	
	7	2		0	0	1	0	
5	8	2		0	1	1	0	
Total Equipment				1	6	7	4	
Tier Totals	Tier 1	0		Site Deploymen Costs				
	Tier 2	5		Startup	Operating			
	Tier 3	3		$10,000	$10,000			
	Total	8	Total	$80,000	$80,000			
				Awareness Sensor Costs				
				Startup	Operating			
Equipment Costs	ADS-B			$21,024	$4,664			
	RemoteID			$15,894	$15,894			
	Optical			$131,990	$120,990			
	Radar			$120,000	$40,000			
			Total	$288,908	$181,548			
Total Airspace Awareness Costs				$368,908	$261,548			
Total Program Costs				$968,908	$561,548			

Figure 2: Airspace Awareness Costs Model

16 APPENDIX I: Terms used in the Project Evaluation Plan

- 49 U.S.C. §44807: The portion of FAA regulations that authorizes the FAA to provide exemptions or waivers to FAA regulations
- 14 CFR Part 91 (FAA Part 91): the portion of the FAA regulations that regulates general aviation, e.g., those portions of aviation not explicitly regulated by another part
- 45 CFR Part 46 (HHS Office for Human Research Protections Common Rule): The Health and Human Services rule for managing safety in research involving interactions with human subjects
- Accuracy: The quantified precision of measurements in the system over a defined period, accounting for false positives and false negatives
- Adverse events: any unexpected negative event
- Anaphylactic Shock / Epi Pen: A severe allergic reaction typically resulting in swelling that blocks the trachea, treated with an Epi Pen that suppress the auto-immune reaction
- ASTM F3548 – 21 (UAS Traffic Management (UTM) Standard): The ASTM standard for the technical implementation of UTM, including exchange of flight intent and constraints
- ASTM F3442/F3442M − 23 (Detect and Avoid Standard): The ASTM standard for implementation and performance requirements of Detect and Avoid safety systems for UAS
- ASTM F3623-23 (Airspace Surveillance Supplemental Data Service Provider (SDSP)): The ASTM standard for implementation and performance requirements of airspace surveillance and awareness systems
- Automatic Dependent Surveillance Broadcast (ADS-B): A type of aircraft transponder that transmit data on location, heading, altitude, and speed via a radio broadcast
- Availability: Service accessible for a given geography and time as expected
- Beyond Visual Line of Sight (BVLOS): operations where the UAS operations are conducted beyond the pilot’s line of sight, typically conducted under a waiver, COA, or 14 CFR Part 135 (FAA Part 135)
- Caller: The individual that calls the incident in the dispatch center
- Cardiac Arrest / Automatic External Defibrillator (AED): A condition in which the heart is no longer pumping blood effectively, treated in the immediate response using an AED to re-start / re-set the heart
- Certificate of Authorization (COA): An agreement under which the FAA allows the recipient exemptions or extended interpretations of FAA regulations
- Characterization: A formal evaluation and measurement of the accuracy and precision of the system
- Completeness: Measure of how many potential data elements are included in the message

- Confidence/Certainty: For a given expected error in and underlying source datum, the expected distribution of quantified error, e.g., to what degree do we expect error to be centrally consistent versus random with a high level of variance
- Deconfliction: the identification of conflicting flight plans and the process of modifying plans to avoid two aircraft sharing the same airspace at the same time
- Diabetic shock / Oral glucose or insulin: a condition where a low-blood sugar condition causes a diabetic's body to begin to enter a state of shock, treated by providing oral glucose and/or insulin
- Dispatch: The action taken by the dispatcher notifying the Pilot or Responder that equipment is required
- Dispatcher: The individual at the dispatch center who receives the call and is responsible, pursuant to training and policy, for making decisions about how to dispatch resources to the victim
- En Route: The term referring to the phase of operations where the public safety apparatus has left base and is en route to the incident
- Frequency/Refresh: The expected frequency of messages for a given service source based on underlying expected source performance
- Geospatial Information Systems (GIS): A class of information technology systems used to store data using location-based references, usually latitude, longitude, altitude, and time
- Information: Data in context, e.g., a specific piece of data provided by the data services in the context of sharing rules or presentation mode
- Integrity: For a given Data Service, does the data message conform to the expected message format and payload
- Intervention Time: The time elapsed between Response Time and Time on Scene
- Latency: From the time a particular piece of data generated, calculation of total time to receipt
- Medical Director: The CCES director responsible for Cambria County policies, protocols, and procedures pertaining to medical interventions
- Morbidity: the downstream impact on patient health of an incident or treatment, inclusive of, but exclusively mortality
- National Airspace (NAS): That portion of the airspace that is regulated by the FAA
- On Scene: The time at which the UAS arrives at the scene
- Opioid Overdose / NARCAN: A condition in which an overdose of opioids places the victim's body into shutdown, revived using a NARCAN nasal spray
- Performance: Use of a Performance Characteristic to describe fitness of a service
- Performance Characteristic: Specific, measurable, testable characteristics that can be used to quantitatively and objectively characterize the relative performance of a data service
- Personally Identifying Information (PII): information that identifies a specific individual or could be used to identify a specific individual

- Precision: The underlying quantified expected error in the source data of a particular service
- Project Open Data Metadata Schema (DCAT): A U.S. government project to standardize descriptive metadata for data sets (https://resources.data.gov/resources/dcat-us/)
- Protected Health Information (PHI) (as defined under HIPAA): Information that specifically references patient medical records, medical data, medical conditions, or that could be used to infer health status
- Public operations consist of FAA-deemed operations conducted by a public agency for public purposes
- Radar: A type of sensor that detects the location of objects using reflection of radio waves
- Remote Pilot: The FAA certificated pilot operating the UAS
- RemoteID: A type of UAS transponder that transmits location and altitude
- Responder: The CCES personnel operating the ambulance and/or rendering aid to the victim
- Response Time: The time elapsed between the dispatcher ordering the dispatch and the response being en route
- Service Volume: A specific denoted volume in space and time consisting of a latitude and longitude boundary, minimum and maximum altitude, and a time period of validity
- Surveillance: any technique that identifies the presence, location, and potentially altitude, heading, and speed of any aircraft
- Time on Scene: The time at which equipment arrives at the dispatched location
- Traumatic bleeding / Tourniquet: Any injury that cause a sudden, high volume of blood loss and resulting loss of blood pressure, treated in the immediate response by using a tourniquet to apply pressure to the injured area
- Uncrewed Aircraft Systems (UAS): An aerial system operating by the pilot remotely or autonomously
- UAS Traffic Management (UTM): A FAA concept for how UAS flight operations can be integrated through software and automation
- Uptime: Total amount of time the system is operational during the study period
- Virginia Flight Information Exchange (VA-FIX): A reference program of public navigational aids and surveillance data hosted by the Virginia Department of Aviation
- Visual Line of Sight (VLOS): UAS operations conducted where the pilot can see the vehicle at all times, typically conducted under 14 CFR Part 107 (FAA Part 107)