Complete Corridor Air Planning: A Regional Strategy for Advanced Air Mobility (AAM)

March 2025

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SANDAG, in partnership with the San Diego County Regional Airport Authority, presents:

San Diego AAM Regional Strategic Implementation Toolkit

March 2025

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Executive Summary

Overview

The Advanced Air Mobility (AAM) Regional Implementation Strategic Toolkit outlines foundational information and strategic efforts that will provide the groundwork necessary for the eventual integration of AAM in the San Diego region. This initiative, led by the San Diego Association of Governments (SANDAG) in collaboration with Caltrans and the San Diego County Regional Airport Authority (SDCRAA), aims to enhance our regional multimodal transportation infrastructure by preparing our region for future technologies, including sustainable and efficient aerial mobility solutions.

Key Strategic Areas

AAM Fundamentals & Use Cases

AAM employs various novel concept vehicles, the most common of which are electric vertical takeoff and landing (eVTOL) aircraft, proposed for urban, suburban, and rural use cases. Applications are vast, but some include emergency response, medical transport, freight logistics, and urban and regional passenger mobility. This section provides planners and audience members with the required industry context to navigate this document.

Stakeholder Collaboration & Engagement

SANDAG established a multi-disciplinary AAM Collaborative, engaging government bodies, industry leaders, and academia. The Collaborative participated in various sessions and workshops that identified challenges and opportunities and shared essential insights critical to the development of this document.

Policy Framework & Strategy

This effort ensured coordination with federal (FAA), state, and local agencies. It assessed copious statutory and standards documents critical for keeping regulatory compliance at the forefront when beginning to plan for AAM infrastructure. A few key policy areas examined in this document include operational certification, safety, cybersecurity, environmental regulations, and infrastructure integration.

Infrastructure Development & Integration

Like any transportation modality, infrastructure and connectivity with existing transportation hubs are essential for AAM success. In this document, the audience will explore existing vertiport guidance, the anticipated need for additional electrical grid capacity, broadband infrastructure, and other data-reliant technological solutions to be aligned with AAM growth for a scalable integration approach.

Regulatory & Environmental Considerations

Compliance with FAA standards, California Environmental Quality Act (CEQA), and National Environmental Policy Act (NEPA) are required compliance considerations and should be integrated into planning efforts early. This document will help provide a basic understanding of navigating the plethora of compliance considerations required for planning and implementation efforts.

Case Studies

This document leverages case studies to assist planners, jurisdictions, and audience members in conveying potential planning outcomes based on various inputs. It also provides an approach for on-vertiport permitting and a high-level roadmap and considerations for future AAM projects.

AAM Outreach Toolkit

Paramount to the success of all transportation integration efforts is engagement. In Appendix D of this document, planners and audience members will find information on industry assumptions, stakeholder roles and outreach recommendations, key messaging, template outreach materials, and other relevant resources.

Executive Takeaways

- AAM presents significant opportunities for enhancing mobility and accessibility around the San Diego region in the long term.
- Multi-stakeholder collaboration is key to regulatory and policy streamlining and successful implementation.
- Infrastructure investment, safety considerations, and public participation are pivotal for long-term, scalable integration viability.
- The region must proactively plan for scalable AAM integration to ensure seamless multimodal connectivity for all next-generation systems.

This strategy positions San Diego as a leader in AAM readiness, ensuring that regulatory, operational, and infrastructure recommendations provide a foundation for future adoption efforts throughout the region.

1 | AAM Resources

Advanced Air Mobility (AAM) is a broad term encompassing the emerging aviation ecosystem that envisions advanced, highly automated aircraft technology to transport people and goods more efficiently and sustainably.

It uses new and innovative technologies to provide efficient, sustainable, and accessible air transportation solutions for urban, suburban, and rural mobility. Using predominantly electrically powered aircraft capable of autonomous flight, AAM can contribute to sustainable transport objectives and net-zero targets.

AAM can provide benefits to society that include:

- Disaster response
- New solutions for medical transport of passengers and supplies
- Easier access for travelers between rural, suburban, and urban communities
- Reduced commute times
- Rapid package delivery

Industry and regulatory agencies are working with regulators across the globe to develop and support potential standards and policies to build scalable AAM systems in anticipation of AAM aircraft entry into service.

1.1 Fundamentals of AAM

This section provides a synopsis of the fundamental components of AAM and is intended to serve as a brief, high-level reference guide. For detailed information, a full report assessing the current AAM industry is provided in Appendix E – AAM Industry & Market Assessment Report.

Elements of AAM

The primary elements of AAM include aircraft, airspace, and supporting infrastructure. The AAM ecosystem is a framework of rapidly evolving regulatory, technical, and operational solutions within these three domains.

Table 1 Elements of the AAM Ecosystem

Element of AAM	Aircraft	Airspace	Supporting Infrastructure
Regulatory, Technical, and Operational Considerations	• Airframe • Engines • Safety Systems • Communication Systems • Navigation Systems • Certification • Maintenance	• Policy • Airspace Regulation • Airspace Design • Airspace Management • Control Systems • Technology/Software • Digital Solutions • Routing/Mapping	• Ground-based services • Vertiports • Airports • Buildings • Power • Resilience • Communications • Facility development • Security

Aircraft

AAM aircraft are most commonly conceptualized as electric vertical takeoff and landing (eVTOL) aircraft, but include:

- Unmanned Aerial Systems (UAS) or drones
- Vertical Takeoff and Landing (VTOL): aircraft that can take off and land vertically without the need for a runway
- Short Takeoff and Landing (STOL): fixed-wing aircraft that can take off and land on short distances
- Conventional Takeoff and Landing (CTOL): fixed-wing aircraft that require a runway to take off and land, such as typical commercial aircraft

AAM aircraft can be powered with electric, hybrid, or hydrogen energy sources and are progressively designed to be autonomous or remotely piloted.

Airspace

Small drones and UAS operate in low-level airspace up to 400 feet above ground. Aircraft generally considered as part of AAM, such as Passenger Air Vehicles (PAVs), will operate in the UAM Corridor, the space between low-level airspace and commercial airliners. Airspace in the United States is split into six classes – five of which are above 1200 feet above ground and are controlled and regulated by the Federal Aviation Administration.

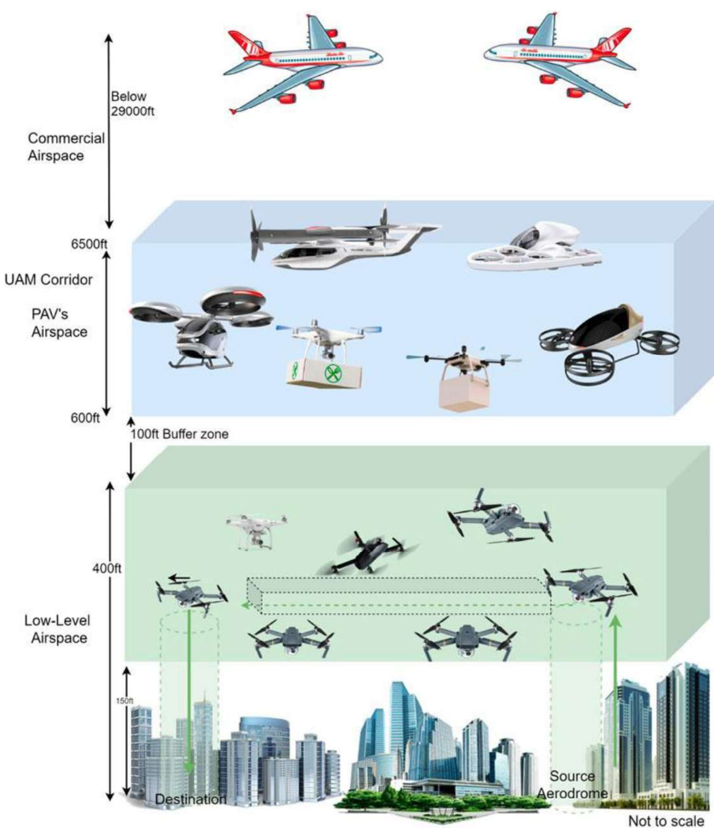


Figure 1 AAM Airspace

Ground Infrastructure and Facilities

Existing airports and heliports are anticipated to be used in the early phases of AAM. However, new fixed ground infrastructure solutions will need to be developed and integrated with existing transportation networks to support vertical takeoff, landing, and operations of AAM aircraft, currently referred to as "vertiports."

The exact type of infrastructure and facilities required at any vertiport will largely be governed by its location, size, and the type of operation it provides. This includes consideration of fuel sources, capacity for touchdown and lift-off, parking, maintenance, and ground support equipment. Additional facilities may also be required, depending on AAM use-specific needs, such as uninterruptible back-up power supply infrastructure for emergency services operations or passenger processing facilities for people movement operations.

AAM Actors

Policymakers and regulating agencies will form the basis of AAM operations. Infrastructure providers and operators will emerge as policies and regulations develop and the industry matures. The actors relevant to the AAM space in the SANDAG region are described in the table below.

Table 2 AAM Actors

Actors	Examples
Policy, Guidance, and Standards Makers	• International Civil Aviation Organization (ICAO) – a United Nations agency that acts as the global forum for international civil aviation. ICAO develops policies and standards to help countries develop aviation in a consistent manner. • National Aeronautics and Space Administration (NASA) – a United States federal agency operating independently and responsible for the civil space program. NASA's AAM research aims to provide the technical solutions required to enable AAM and is helping to inform emerging standards and regulations. • United States Department of Transportation (USDOT) – a United States federal agency that established an AAM Interagency Working group, consisting of 19 federal departments, to facilitate the coordination of safety, operations, infrastructure, and security to develop the AAM ecosystem. • State and Local Governments – Several state and local governments have developed or are in the process of developing frameworks, roadmaps, strategies, feasibility studies, and/or committees for AAM.
Regulators	• Federal Aviation Administration (FAA) – the aviation operating mode under USDOT responsible for the safety of civil and commercial aviation in the National Airspace System (NAS) in the U.S. The FAA also certifies manufacturers and operators.

Actors	Examples
	• European Union Aviation Safety Agency (EASA) – the equivalent agency to the FAA in regulatory and safety oversight for Europe, which can be monitored for best practices.
Original Equipment Manufacturer (OEMs)	• OEMs produce aircraft and, in some cases, operate them. • Secondary system suppliers are related to airspace, aircraft, and ground infrastructure, such as vertiport management systems that integrate aeronautical data, flight scheduling, air traffic coordination, and real-time air monitoring data.
Commercial and Operational Models of Vertiports	• Companies that plan and design vertiports • Companies that construct and/or operate vertiports
Infrastructure Providers	• Airport and airfield operators • Building owners/operators where vertiport facilities may be located • Power and charging providers • Data and communications providers • Weather monitoring and reporting mechanisms
Aircraft Operators	• Emergency services • Health services • Cargo/freight/logistics • Standalone AAM operators • National postal services • Airlines • Passenger-carrying service providers (E.g., Uber, Lyft)

AAM Use Cases

The specific scenarios or examples that illustrate the use of AAM to address various transport needs can be defined as use cases. Some of these use cases are already in the early stages of operation with delivery of freight and cargo by drones. As the strategy for the region develops, use cases relevant in the regional context will evolve.

Table 3 AAM Use Cases

Core Use Cases	Other Use Cases
Emergency and Public Services – this includes medical emergency evacuations, rapid air transfer of critical care patients, disaster response and relief, pharmaceutical and medical deliveries, and mobile field hospitals	**Maintenance, Inspection, Surveying** – this includes surveying of infrastructure, such as power lines, wind turbines, pipelines, bridges, railroads, or aircraft
Freight & Cargo – this includes autonomous delivery of time-sensitive or high-value cargo or goods such as groceries	**Research** – this includes assessments of air quality, biodiversity, and habitat using remote sensing and mapping
People Movement – this may include intra-city and inter-city connections or rural transit	**Testing and Simulation** – this includes assessing new technologies, evaluating aircraft system performance, and training personnel.

1.2 SANDAG AAM Collaborative

Purpose

AAM brings expansive opportunity, and like all new technological innovations that have the potential to significantly change our transportation landscape and transform our way of living, we must ensure our region is prepared for integration activities. Continued investment from the AAM industry and lessons learned from previous innovative transportation technologies, like micromobility and other autonomous vehicle integration, render the need for public agencies to (1) better understand the potential impacts to communities and (2) develop strategies to effectively prepare our regional efforts for seamless implementation.

Today, an integrated approach for planning and deploying AAM services does not exist. To better prepare the San Diego region for the anticipated widespread deployment of AAM, Caltrans awarded SANDAG and the San Diego County Regional Airport Authority (SDCRAA) a Sustainable Transportation Planning Grant. Stakeholder participation and insight were critical in shaping the deliverables of this regional strategy, ensuring that outcomes from this project place the community and public interests at the forefront. SANDAG's AAM Collaborative (Collaborative) provided critical, transparent feedback and direction on our regional strategy. This Collaborative served as a vehicle for quality assurance and the development of a comprehensive vision and uniform alignment for how AAM planning should be undertaken within the San Diego region.

Membership

Collaborative members hold a myriad of diverging perspectives, which include expertise from state, local, and regional public agencies. Niche industry leaders from airports, original equipment manufacturers, service providers, weather and climate professionals, academia, and beyond were also included. As members, participants were asked to attend meetings on a quarterly basis, providing technical expertise and feedback throughout the development of the project deliverables.

1.3 Collaborative Sessions & Stakeholder Engagement

Project Development Team

SANDAG utilizes a Project Development Team (PDT) as a best practice, ensuring that the agency's projects are well-informed and providing projects with quality assurance to achieve the greatest project outcomes within our region. The PDT met on a monthly cadence to discuss program progress, risks, and strategic direction. This practice was essential for the development of unified regional messaging, delineating regional roles and responsibilities, and ultimately forming a foundation for the San Diego region to more seamlessly integrate AAM into our transportation landscape.

The SANDAG AAM Project Development Team was comprised of the following regional stakeholders:

- **Caltrans – District-11 – *Project Sponsor***
  - Caltrans – District-11 serves both San Diego and Imperial Counties and oversees an extensive portfolio of regional and state priority projects while ensuring our region has the resourcing and support necessary to navigate the complexity of planning across our bi-national border region.
- **San Diego County Regional Airport Authority – *Project Partner***
  - The San Diego County Regional Airport Authority is a regionally independent agency charged with managing the day-to-day operations of San Diego International Airport (SAN) and is the responsible entity for the region's Airport Land Use Compatibility Plan (ALUCP).
- **City of San Diego – Airport Division – Project Partner**
  - The City of San Diego Airport Division is responsible for two general aviation airports within the region, both of which offer critical regional services, such as law enforcement, fire, and ambulatory services. The Airport Division is within the City's Economic Development Department.

Collaborative Session 1 – Kickoff & Project Introduction

Session Focus and Outcomes

In October 2023, the SANDAG AAM Collaborative was initiated with over 50 invitees. Our team established the following expectations and anticipated participation, informing the following:

- Establish a clear and uniform vision for integrating AAM into the San Diego region,
- Address major gaps, concerns, and anticipated needs,
- Define individual roles and responsibilities for all pertinent stakeholders,
- Identify non-negotiables as they relate to permitting requirements and transportation integration,
- Consider and inform on environmental requirements, including, but not limited to, the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA),
- Focus on designing efficient vertiport facilities and operational capabilities.

This session established our regional AAM vision to develop a comprehensive, equitable, sustainable, and resilient multi-modal transportation network with robust air transport that enables the safe, expeditious movement of goods, services, and people. Additionally, this session provided stakeholders with the SANDAG AAM Collaborative Guiding Principles, intended to provide a lens via which San Diego's regional values remained a core consideration as conversations evolved from diverse and varied perspectives.

Stakeholder Participation

Regional and Southern California Participants	
City of San Diego	Long Beach Economic Development Partnership
San Diego County Regional Airport Authority	LA2028
Caltrans – District-11	Los Angeles World Airports
City of Los Angeles – Department of Planning	CAL FIRE
Industry Experts & Academia	
Community Air Mobility	Wisk
AAM Institute	Eve Air Mobility
Skyports	ANRA
Tidal	Skyway
Palomar College	TESIAC
Joby Aviation	BETA Technologies
Harper4D	UPS Flight Forward
Federal Aviation Administration	

Collaborative Session 2 – Kickoff & Project Introduction

Session Focus and Outcomes

Hosted virtually in January 2024, the SANDAG AAM Collaborative invited over 80 participants to an interactive workshop-style collaborative session providing the following:

- ***Advanced Air Mobility 101***
  - Introducing AAM allowed our team to work alongside regional stakeholders without a breadth of industry knowledge to provide an overview of the technology and establish familiarity with the subject matter.
- ***SANDAG AAM Charter Exercise***

- Recognizing the plethora of backgrounds providing input and feedback into this strategy, the SANDAG AAM team worked with the Collaborative participants to finalize, approve, and adopt a project charter to level-set expectations and provide parameters for participants about what the Collaborative's role is, and how these inputs would be utilized in the development of our integration plans.

- ***Workstreams Strengths, Weaknesses, Opportunities, and Challenges***
  - Finally, this collaborative session culminated in an initial Strengths, Weaknesses, Opportunities, and Challenges exercise. Broken out by Guiding Principles Work Streams, the SANDAG AAM team facilitated four (4) conversations meant to stimulate dialogue around the unique qualities the San Diego region faces and establish a transparent rapport with our partners and stakeholder participants.

Stakeholder Participation

Regional and Southern California Participants	
City of San Diego	
San Diego County Regional Airport Authority	
Caltrans – District-11	
Industry Experts & Academia	
Community Air Mobility	Wisk
AAM Institute	Eve Air Mobility
Skyports	ANRA
Tidal	Skyway
Palomar College	TESIAC
Qualcomm	Archer

Collaborative Session 3 – In-Person Strengths, Weaknesses, Opportunities, and Challenges Exercise and Analysis

Session Focus and Outcomes

April 2024 provided a unique opportunity for the SANDAG AAM Collaborative on the heels of an industry conference hosted in Downtown San Diego. 35 participants joined the SANDAG AAM team for an in-person Collaborative session hosted at the SDCRAA administration building. This session began with a thought-provoking and well-engaged fireside chat, flowing naturally into the primary exercise of the day, the robust Strengths, Weaknesses, Opportunities, and Challenges (S.W.O.C.) exercise.

Leveraging the preliminary results from the former Collaborative session, the SANDAG AAM team designed a S.W.O.C. exercise that would test the initial assumptions developed during our earlier sessions, particularly as industry participants were provided with the opportunity to personally engage with the regional transportation systems. These discussions produced incredible insights, from climate-versus-weather deep-dives to the establishment of a public-engagement strategy. The session concluded with a multi-page qualitative analysis report, shared with participants. The report summarized key findings and offered further guidance for the SANDAG AAM team

Stakeholder Participation

Regional and Southern California Participants	
City of San Diego	
San Diego County Regional Airport Authority	
Caltrans – District-11	
Caltrans – Headquarters – Aeronautics Division	
Industry Experts & Academia	
Community Air Mobility	Eve Air Mobility
AAM Institute	ANRA
Skyports	Alcifo
UPS Flight Forward	TESIAC
Fullerton College	Rhoman Aero
Qualcomm	Crown Consulting
21IQLabs	Federal Aviation Administration
Harper4D	Flight Crowd
TruWeather Solutions	Nuair
North Central Texas Council of Governments	

Collaborative Session 4 – Project Development and the “Case Study” Concept

Session Focus and Outcomes

Building upon Collaborative 3, the SANDAG AAM team hosted the 4th virtual session in July 2024, during which the SANDAG AAM Team presented to the participants on project status, solicited feedback on the initial concept, and “Case Study” approach.

The SANDAG AAM team provided pre-read materials to participants to streamline discussion, including a draft annotated outline of the final deliverable and a "Case Study" concept that explores navigating infrastructure deployment, specifically around policy and regulatory hurdles that will be required to be addressed for efficient, streamlined integration. The SANDAG AAM team introduced draft concepts and received real-time feedback that would ultimately shape and reinforce the final deliverable.

Stakeholder Participation

Regional and Southern California Participants	
City of San Diego	
San Diego County Regional Airport Authority	
Caltrans – District-11	
Industry Experts & Academia	
Community Air Mobility	Eve Air Mobility
AAM Institute	ANRA
Skyports	North Central Texas Council of Governments
UPS Flight Forward	TESIAC
Nuair	Tidal
TruWeather Solutions	Harper4D

Collaborative Session 5 – Final Implementation Strategy Report Overview

Session Focus and Outcomes

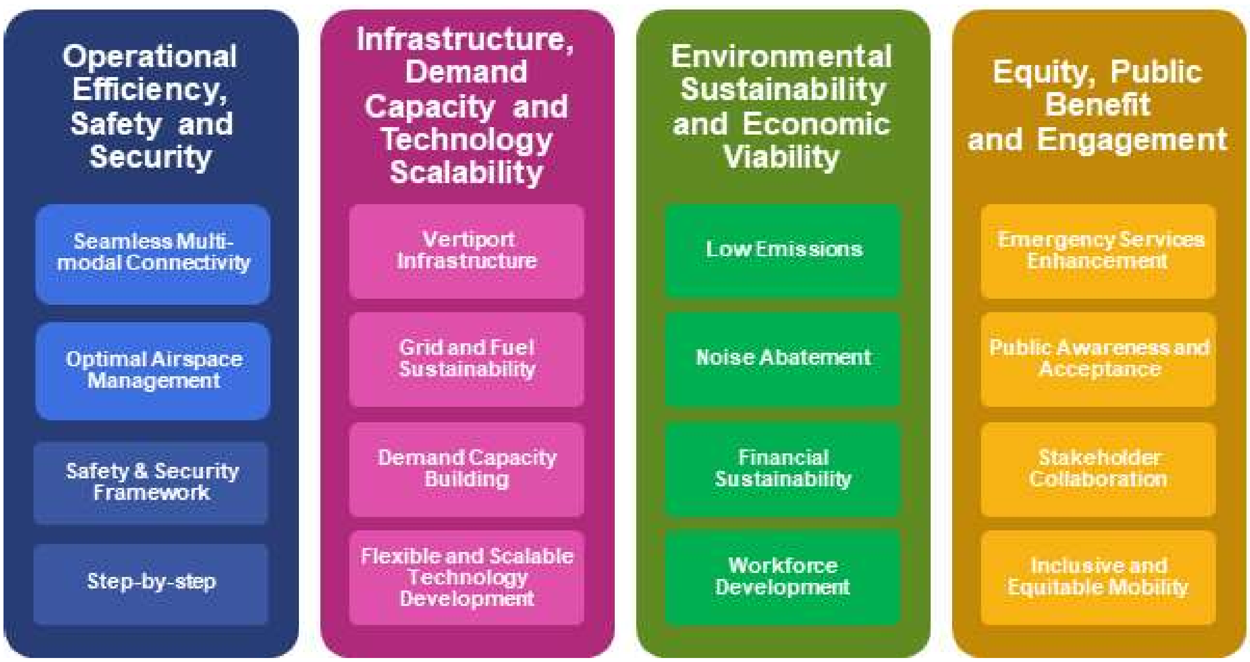
The 5th and final Collaborative session was held virtually in January 2025, during which the SANDAG AAM Team provided a summary of previous work completed and a deep dive into the final draft deliverable. The session provided an overview of the updated work completed and solicited real-time inputs valuable to finalizing the draft deliverable. The Collaborative participants' final call-to-action requested a thorough review of the draft deliverable and to provide feedback meant to improve the final product.

Stakeholder Participation

Regional and Southern California Participants
City of San Diego
San Diego County Regional Airport Authority
Caltrans – District-11

Industry Experts & Academia	
Alcifo	Eve Air Mobility
AAM Institute	ASPIRE NSF ERC
TruWeather Solutions	North Central Texas Council of Governments
Woolpert	APG
USU	Wisk Aero
Harper4D Solutions	Flyabout Strategies
Advanced Air Mobility Association	AUVSI CA Chapter
Ricondo & Assoc.	21iqlabs

1.4 AAM Guiding Principles for SANDAG



Preface

The San Diego region is primarily interested in achieving regional readiness for Advanced Air Mobility (AAM) as opposed to the early adoption of the technology. This involves a multi-modal approach to transportation and cross-jurisdictional collaboration for infrastructure investments. The focus is on achieving a connected, equitable, and safe AAM ecosystem, leveraging the collective insight and intelligence of various stakeholders.

Early-Stage Planning Focus Areas for AAM in San Diego Region

These emerging guiding principles will support the development of a comprehensive and scalable framework for the integration of AAM in the region.

Equity, Public Benefit, and Engagement

- **Emergency Services Enhancement**: Utilize AAM for faster and more efficient emergency response, including medical evacuations and wildfire control.
- **Public Awareness and Acceptance** - Conduct public outreach programs with transparency to educate communities about the benefits and challenges of AAM.
- **Stakeholder Collaboration** – AAM is developed with a community-first approach, with early identification and tools to engage in ongoing dialogue with stakeholders.
- **Inclusive and Equitable Mobility** - Develop strategies to make AAM services accessible and affordable for various communities, including low-income and underserved populations, thereby fulfilling social equity objectives in transportation.

Operational Efficiency

- **Seamless Multi-modal Connectivity** - AAM services are well-integrated with existing transportation modes, offering hassle-free transitions between AAM and ground-based services such as micro-mobility, public transit, and ride sharing.
- **Optimal Airspace Management** - Collaborate with relevant regional authorities and stakeholders to develop a dedicated and optimized airspace management strategy and tools that minimize conflicts with other air traffic and optimize network efficiencies.

Safety and Security

- **Comprehensive Safety and Security Framework** - Consider a multi-faceted approach to safety and security that encompasses safe vehicle design and operation, robust physical and digital infrastructure, secure operational protocols, and a strong focus on personal safety for passengers and operators.
- **Crawl-Walk-Run - Adopt a "Crawl-Walk-Run" methodology in alignment with FAA guidelines** to facilitate Entry into Service (EIS) operations using existing services and infrastructure as a foundation, while concurrently developing a strategic pathway for the integration of advanced AAM technologies, capabilities, and interoperability within the region, thereby supporting increasing scale and automation.

Environmental Sustainability and Economic Viability

- **Low Emissions** - Promote energy-efficient technologies and practices in line with environmental policies.
- **Noise Abatement -** Understand potential noise impacts at the source and recommend noise reduction technologies and initial operational procedures to minimize community impact.
- **Financial Sustainability –** Consider a sustainable business model that attracts investments and maintains operational viability over the long term.

- **Workforce Development** - Utilize the integration of AAM to foster local employment opportunities in various domains, including operations, maintenance, and administrative roles.

Infrastructure, Demand Capacity, and Technology Scalability

- **Vertiport Infrastructure:** Update local government land development codes via a model vertiport permitting process to enable efficient AAM operations.
- **Grid and Fuel Sustainability:** Address the stress on the electrical grid, plan for appropriate infrastructure improvements, and supporting policies.
- **Demand Capacity Building (DCB):** The implementation strategy should provide a foundation that can support DCB from market entry to scalable operations and usage.
- **Flexible and Scalable Technology Development: Plan to build architecture for AAM services** that is flexible and scalable.

2 | Policy Framework & Strategy

This document serves as a roadmap for the AAM planning process, designed to support decision-makers and planners across SANDAG member communities in preparing for and implementing AAM facilities and operations. It aims to inform stakeholders and community members about AAM concepts and the planning processes applicable to local municipalities.

While this framework does not address every process, regulation, or consideration that may be encountered, and some elements may be updated as new guidance or industry developments emerge, it remains a valuable resource for developers, operators, municipalities, and residents. This framework provides an overview of the nature of AAM operations and facilities, along with the regulations relevant to their planning, development, and implementation.

This section identifies critical components and key considerations in the context of an AAM Regulatory Framework, or process framework, and organizes them into the following subsections:

2.1: AAM Operations

2.2: AAM Safety

2.3: Intergovernmental Coordination

2.4: Environmental

2.5: AAM Integration

2.6: Infrastructure Connectivity

2.7: Case Study

Each section discusses key topics relevant to AAM program planning, facility design, and operations implementation phases. Each topic concludes with relevant guidance, regulations, and educational reference materials. The references provided are not wholly inclusive of all possible considerations or resources but do provide a starting point for understanding AAM within a relevant context. Many references also include resources and contextual links to applicable laws, standards, and background information.

The Section 2.7 case study example integrates content from prior sections to provide a roadmap of the steps required to permit a vertiport on an airport property, specifically Brown Field Municipal Airport (SDM) in San Diego, California. The case study assumes existing permitting procedures and regulatory requirements for heliports and airports would also apply to vertiports.

2.1 AAM Operations

Understanding the specifics of the intended operations is an important component in developing a successful vertiport. The guiding questions below regarding AAM operations should be considered during the planning, design, and implementation phases of development.

- Who will be the market for this service, and is there exclusivity?
- Are the AAM operations intended to be publicly or privately operated?
- Will eVTOL vehicles remain in a fixed network with other exclusive vertiports, or will itinerant or transient operations be permitted?
- Would a vertiport be able to accommodate other operations or be limited to one vehicle type?
- Does the vertiport plan to operate autonomous flights in the future?
- What is the general range of AAM operations?
- Would there be restrictions on when operations are permitted to occur?
- Do the AAM facilities connect to other facilities, such as airports or other transportation hubs?
- What types of eVTOL vehicles have the capabilities to provide these services?

AAM Markets

Establishing a specific AAM market defines the type of AAM users and the origins and destinations (O&D), or the origin point from which the vertiport's services will be offered and the destinations the aircraft will fly to. However, the process of defining the AAM market is just as valuable. The AAM market should be defined through a process that includes market cost-benefit analyses (CBAs), forecasts, market viability studies, and profitability studies. This process helps AAM stakeholders understand the demand for AAM services and the anticipated market growth that would be necessary to generate the revenues needed to see a return on investment (ROI) and to fund the continued operations and maintenance of the vertiport facility.

In the planning phase, ideas on what markets are viable begin to take shape. During this phase, potential O&D locations can be proposed based on defined interest and anticipated demand. Discussions with business entities such as the local airport, airlines, fixed-base operators (FBO), and other tenants can provide valuable insight into interest in connectivity and other public-private partnerships (P3).

In the design phase, an AAM service area can be established based on travel times and multi-modal connectivity. Then, statistical analyses based on historical and projected socioeconomics can confirm the financial feasibility of the region supporting the market. Other investigations, such as market studies with forecasted demand, growth, and types of AAM operations, should be completed for the proposed vertiport's intended market or service region, as well as CBAs to determine the profitability and possible ROI for the market in question.

In the implementation phase, a defined AAM market will be shaped based on interest from other businesses, specific analyses, and forecasts. Each of these valuable inputs will act as a resource for establishing a well-defined AAM market.

AAM Markets Guidance

Airport Master Plan Forecasts: Provide insight on airport service areas and the future growth of commercial passenger growth and other aircraft operations, where applicable.

FAA Terminal Area Forecasts (TAF): The FAA documents historical and forecasted enplanements, airport operations, Terminal Radar Approach Control (TRACON) operations, and based aircraft and forecasts future data for FAA towered airports, FAA contract tower airports, TRACON facilities, and non-FAA airports.[1]

FAA Airport Benefit-Cost Analysis Guidance: Clear and thorough guidance to airport sponsors on how to conduct project-level CBA for capacity-related airport projects.[2]

Socioeconomic Data: Historical and projected socioeconomic data from the U.S. Census Bureau or other similar sources.[3]

Stakeholder Input: Discussions with airlines and other stakeholders on interest in specific AAM users and operations.

AAM Network and Operation Types

Setting up the AAM network as a point-to-point or a hub-and-spoke system plays a major role in the diversity of the operations.

The level of operational exclusivity is determined in the planning phase. When multiple uses are permitted, the destinations of passengers, cargo, and services will also likely expand, causing greater diversity for businesses, a community, and the overall region.

The distance from the vertiport to areas of interest to the AAM user, such as hospitals, entertainment hubs, and other transportation facilities, should be assessed in the design phase. Then, depending on the destination and uses, the anticipated hours of operation should begin to take shape.

A network plan of service is established in the implementation phase. This network plan ultimately determines who can use the facilities, when they can use them, and what limitations exist. Depending on how exclusive the network plan is, the limitations may restrict the operations to certain vehicle types, transient, itinerant, or local users, and very specific hours of service.

AAM Network Guidance

Passenger and cargo airline schedules

FAA TAF: The FAA documents historical and forecasted enplanements, airport operations, Terminal Radar Approach Control (TRACON) operations, and based

[1] FAA TAF Data Query. https://taf.faa.gov/

[2] https://www.faa.gov/sites/faa.gov/files/regulations_policies/policy_guidance/benefit_cost/FAA_Airport_Benefits_Guidance.pdf

[3] United States Census Bureau Data Query. https://data.census.gov/

aircraft and forecasts future data for FAA towered airports, FAA contract tower airports, TRACON facilities, and non-FAA airports.[4]

Helicopter Emergency Medical Service (HEMS) data: Any local publicly available data on the utilization of HEMS, locations of deployment, destination locations, and more.

Section 2.5: AAM Integration: See Section 2.5 for more considerations for integrating an AAM network and operations into existing airport and transportation plans.

Operational Certification

Applications for operational certification directly relates to the use of the AAM services for passengers and cargo. As a result, many AAM operations would fall under Part 121 or Part 135 certifications.

1. An initial step in the certification process for air taxi and commercial passenger services identifies whether the AAM operation is common or noncommon carriage. The FAA defines common carriage as an applicant that makes services available to the public by "holding itself out" through advertisements or other means to transport people and property for compensation or hire. A noncommon carriage applicant conducts operations for compensation or hire without holding out to the public.
2. Either an air carrier or an operating certificate is issued. Air carrier certificates are issued for services that are interstate, foreign, or overseas transportation or to carry mail. Operating certificates are for intrastate transportation.
3. Next, operating rules and kinds of operations are determined. For air carriers and commercial operators, services will be provided under Part 121, 135, or both.

In the planning phase, an understanding of the AAM network and uses establishes what type of operational certification is necessary for an operator to pursue.

In the design phase, the Part 121 or Part 135 certification process should be completed. This includes but is not limited to the preapplication steps, formal application steps, design assessments, and performance assessments.

In the implementation phase or the administrative functions part of the process, the FAA will issue the certificate of operations specifications and complete the certification process.

Operations Resources:

FAA Advisory Circular (AC) 120-49A, *Parts 121 and 135 Certification*: Provides the requirements and process for applying and obtaining an FAA Part 121 or Part 135 certification for operations. [5]

[4] FAA TAF Data Query. https://taf.faa.gov/

[5] FAA Advisory Circular 120-49A, Parts 121 and 135 Certification. https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_120-49A.pdf

2.2 AAM Safety

The second component in the development of a successful vertiport is understanding the concerns related to AAM safety. The guiding AAM safety questions below are to be considered during the planning, design, and implementation phases of development.

- What emergency management plans are in place currently?
- How would the community or airport's emergency response system be used by the vertiport?
- How is safety addressed for each AAM user type?
- How are eVTOL vehicle safety concerns addressed?
- How is inclement weather handled?
- How are cybersecurity safety concerns addressed?
- How are electrical safety concerns addressed?

Public Safety

Public safety is a critical component of successful AAM operations. To ensure that public safety is upheld, safeguards must be put in place to protect the passengers, AAM support staff, and the public in the general vicinity of the vertiport. Public safety risks and mitigation can be addressed in a safety management system (SMS), which may be developed voluntarily or created per regulatory requirements. AAM stakeholders should stay informed on evolving SMS regulations and their applicability to AAM.

In the planning phase, public safety risks are identified in relation to AAM operations. This may include the security of the passenger processing facilities, ticketing, baggage areas, auto parking areas, and the vertipad. Transportation Security Administration (TSA) requirements for the terminal and airport operation area (AOA) provide a starting point for vertiports to follow. In the planning stages, stakeholders should review safety Standards and Recommended Practices (SARPS) and incorporate the methodology into the planning, design, implementation, and operation of AAM.

In the design phase, facilities should be strategically configured to ensure public safety while meeting FAA and TSA standards.

In the implementation phase, the necessary facilities are constructed with the required equipment, staff, policies, and procedures put in place. Vertiport and AAM operators should develop and adopt an SMS to proactively manage risks and formalize systems safety practices.[6]

Public Safety for AAM Operations Guidance

- ***FAA Engineering Brief (EB) #105, Vertiport Design, Chapter 6.2:*** Provides interim guidance regarding security screening and access control measures.
- ***Program for Applied Research in Airport Security (PARAS) Security Considerations for AAM Operations at Airports:*** Authored by industry professionals and key stakeholders, this document discusses security

[6] SMSs are currently required for Part 139 airport operators, Part 121 air carriers, Part 91.147 air tour operators, and certain Part 21 type certificate and production certificate holders. SMS requirements may be extended to AAM in the future.

regulations and considerations for AAM implementation on airport property, although official standards or regulations have yet to be published.[7]

FAA AC 150/5390-2D Heliport Design: Standards and regulations for heliport design. Not specific for VTOL aircraft, but referenced as interim guidance for many design elements. Chapter 7: Heliport Site Safety Elements includes standards for marking obstructions, security, and safety on-site.[8]

14 Code of Federal Regulations (CFR) Part 5, Safety Management Systems: Federal regulatory requirements for SMS, applicable to certain operators, OEMs, and landing facilities.[9]

FAA Safety Management Systems: This webpage provides information about SMSs, training materials, and reference materials. The Policy and Requirements page in the Reference Library includes a comprehensive list and links to the regulatory framework.[10]

ICAO Annex 19, Safety Management: International provisions for safety management of aviation, including SARPS.[11]

Electrical, Thermal, and Chemical Safety

With the electrical demand of eVTOL vehicles, significant safety efforts are required to manage electrical and thermal energy, as well as any chemical materials that are used in the batteries or other equipment and operations.

In the planning phase, specific policies or procedures to promote safety are identified. For electrical energy, this may include management and security of high voltage areas; the storage; use of batteries; electrical charging processes and equipment; electromagnetic interference; and security of electrical utilities and facilities. For thermal energy, this may include cooling systems, fire codes, and other safeguards that reduce thermal energy, adding protection from electrical fires. For chemical materials, this may include the disposal of batteries and the handling of any other hazardous materials.

In the design phase, analyses efforts are made to determine if the required policies and procedures dedicated to safety can be obtained. To determine this, additional studies may be necessary to calculate whether the infrastructure and facility can supply the resources for the anticipated demand.

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[7] Program for Applied Research in Airport Security (PARAS) Security Considerations for AAM Operations at Airports. (2023). https://www.sskies.org/images/uploads/subpage/PARAS_0041.AAMOperations_.FinalReport_.pdf

[8] FAA AC 150/5390-2D Heliport Design. (2023). https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_150_5390_2D_Heliports.pdf

[9] 14 CFR Part 5, Safety Management Systems. https://www.ecfr.gov/current/title-14/chapter-I/subchapter-A/part-5

[10] FAA Safety Management Systems. https://www.faa.gov/about/initiatives/sms
Policy and Requirements: https://www.faa.gov/about/initiatives/sms/reference_library/policy_and_requirements

[11] ICAO Annex 19, Safety Management. https://elibrary.icao.int/reader/250466/&returnUrl%3DaHR0cHM6Ly9lbGlicmFyeS5pY2FvLmludC9leHBsb3JlO3NlYXJjaFRleHQ9YW5uZXglMjAxOSUyMCVFMiU4MCU5NCUyMHNhZmV0eSUyMG1hbmFnZW1lbnQ7cGhyYXNlTWF0Y2g9MC9wcm9kdWN0LWRldGFpbHMvMjUwNDY2?productType=ebook

In the implementation phase, any policy or procedure that is at risk of not being upheld due to the increasing equipment, batteries, electrical loads, or frequency of usage should be modified so that it is consistent with industry safety standards and requirements for electrical and thermal energy and chemical materials.

Electrical, Thermal, and Chemical Safety Guidance

Overview of Potential Hazards in Electric Aircraft Charging Infrastructure: Identifies potential hazards associated with the deployment of electric aircraft and associated charging infrastructure.

2021 International Fire Code: Contains regulations to safeguard life and property from fires and explosion hazards. Topics include general precautions, emergency planning and preparedness, fire department access and water supplies, automatic sprinkler systems, fire alarm systems, special hazards, and the storage and use of hazardous materials.

National Fire Protection Association (NFPA) 400 Hazardous Materials Code: Minimum NFPA standards for the storage and handling of hazardous materials such as lithium batteries.[12]

29 CFR Section 1910.176, Handling Materials – General: Provides the minimum requirements for the storage and handling of hazardous materials such as lithium batteries.[13]

Pipeline and Hazardous Materials Safety Administration (PHMSA) Lithium Battery Guide for Shippers A Compliance Tool for All Modes Of Transportation: Demonstrates scenario-based situations that outline the requirements for those who may be packaging and shipping lithium-ion batteries for all modes of transportation.[14]

Lithium Battery Recycling Regulatory Status and Frequently Asked Questions: Clarifies how hazardous waste and universal waste regulations pertain to recycling lithium-ion batteries and answers frequently asked questions. Directs readers to associated regulations and resources.[15]

Forecast of AAM activity: Provides input on the electrical load that will be necessary for charging, as well as the number of vehicles and batteries to accommodate them.

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[12] NFPA 400 Hazardous Materials Code. https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=400

[13] 29 CFR Section 1910.176, Handling Materials – General. https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.176

[14] Lithium Battery Guide for Shippers A Compliance Tool For All Modes Of Transportation. (2023). PHMSA. US Department of Transportation. https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/2023-07/Lithium%20Battery%20Guide.pdf

[15] Environmental Protection Agency (EPA). Lithium Battery Recycling Regulatory Status and Frequently Asked Questions. (2023). https://rcrapublic.epa.gov/files/14957.pdf

Cybersecurity Safety

Essential data for AAM departure and arrival, flight paths, alternate destinations, conflict management, and more will be exchanged through networks. This data, accessed or operated by the FAA, AAM operators, pilots, UAS Service Suppliers (USSs), Providers of Services for UAM (PSUs; also applicable to AAM), Supplemental Data Service Providers (SDSPs), vertiport operators, and more, is critical for safe and efficient operations and therefore must be safeguarded against potential cyberattacks.

In the planning phase, collaboration with providers and users of secure networks should occur to establish protocols in line with existing and upcoming needs and standards. Public agencies may also have an interest in the exchange of data for the protection of people and property on the ground and in the air. Agencies that provide public safety services should begin collaborating with the FAA, USSs, and associated private industry stakeholders to discuss protocols for secure and timely data requests.[16] In addition, collaboration should also occur with agencies that operate in sensitive airspace that is prevalent in the San Diego region, including the U.S. Department of Defense (DoD), U.S. Immigration and Customs Enforcement (ICE), and U.S. Department of Homeland Security (DHS).

In the design phase, the requirements necessary for AAM facilities are identified. These may include overall network security such as firewalls, intrusive detection systems (IDS), and other means of security; secure channels of communication; aircraft systems security; data encryption and privatized sources of data; monitorization of cybersecurity infrastructure and processes; and others as applicable.

In the implementation phase, a cybersecurity plan is established, adding in customized protocols and systems that are specific to the vertiport's protection. The plan must be able to accommodate the forecast of AAM activity and vehicle types, as well as updated and new cybersecurity safety protocols that change over time.

Cybersecurity Guidance

Addressing Electric Aviation Infrastructure Cybersecurity Implementation: Provides input on various cybersecurity components and interconnections. It reviews the sensitivities and the criticality of operational data, with best practices for identifying gaps.[17]

National Cybersecurity Strategy: National strategy that aims to defend critical infrastructure, disrupt and dismantle threat actors, shape market forces to drive security and resilience, invest in a resilient future, and forge international partnerships to pursue shared goals.[18]

International Air Transport Association (IATA) Cybersecurity Risk Assessment Guidance Material: Offers a risk assessment approach and guidelines for operators to handle cybersecurity.

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16 FAA ConOps v.2. 2023. FAA. https://www.faa.gov/researchdevelopment/trafficmanagement/utm-concept-operations-version-20-utm-conops-v20. See for details on service providers and air operations.

17 https://www.nrel.gov/docs/fy23osti/82856.pdf

18 National Cybersecurity Strategy https://www.whitehouse.gov/wp-content/uploads/2023/03/National-Cybersecurity-Strategy-2023.pdf

- **IATA Cybersecurity Supply Chain Oversight Guidance Material**: Provides guidance to operators on cybersecurity best practices and aviation-specific supply chain activities.
- ***International Aviation Trust Framework (in progress):*** Guidance material published by the International Civil Aviation Organization (ICAO) contains policies, requirements, and best practices relevant to stakeholders for newly emerging technologies, such as AAM. More guidance and requirements relating to cybersecurity for aviation systems are expected to emerge from the working group.[19]

Pilot & Operator Certification

Pilot and AAM operator requirements to obtain licenses to pilot AAM vehicles are currently being developed by the FAA, ICAO, and European Union Aviation Safety Agency (EASA). In October 2024, the FAA published final rules for training and certifying pilots for AAM under a new aircraft classification for powered-lift.

In the planning phase, AAM stakeholders should review further material on the processes and requirements for AAM pilots and operators as it is released. Proponents should consider if the vertiport will accommodate training and certification operations. Stakeholders may consider creating partnerships with organizations that will support the AAM pilot workforce, including local flight training programs geared toward AAM. The Association for Uncrewed Vehicle Systems International (AUVSI) published the "Blueprint for Autonomy" to guide the industry to enable increasing automation capabilities.[20] It describes existing autonomous flights within the National Airspace System (NAS) today, including drones operating beyond visual line of sight (BVLOS) with remote pilots monitoring, and provides a framework for how full automation will be realized by the AAM industry as it continues to develop.

In the design phase, facilities to support pilots, including training facilities, rest areas, flight planning areas, and more, can be considered and incorporated into the design.

In the implementation phase, procedures and tools to ensure that pilots and operators flying in and out of the vertiport have the proper licenses and documentation may be developed. Additional requirements regarding pilot and operator certification will need to be met.

Pilot Safety Guidance

- **Integration of Powered-Lift: Pilot Certification and Operations; Miscellaneous Amendments Related to Rotorcraft and Airplanes – Final Rule:** Published in October 2024, the powered-lift proposed rule adopts permanent amendments and a Special Federal Aviation Regulation (SFAR) to facilitate the certification of powered-lift pilots, clarify operating rules applicable to operations involving

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19 ICAO. International Aviation Trust Framework (IATF). https://www.icao.int/airnavigation/IATF/Pages/default.aspx#:~:text=The%20IATF%20is%20comprised%20of%20a%20set%20of,and%20among%20both%20traditional%20and%20newly-emerging%20system%20stakeholders.

20 AUVSI Blueprint for Autonomy: https://www.auvsi.org/sites/default/files/Blueprint-for-Autonomy-Building-Blocks-for-Our-Collective-Future.pdf

a powered-lift, and finalize other amendments that are necessary to integrate powered-lift into the National Airspace System (NAS).[21]

***FAA AAM Implementation Plan*:** Discusses pilot requirements for AAM.[22]

California Public Utilities Code (PUC) Chapter 3. Regulation of Aeronautics: Describes liability for aircraft owners and operators, including alcohol testing for aircraft operators under reasonable suspicion, and reinforces airman certification and permit requirements, including the requirement to have certifications on hand while operating.[23]

eVTOL Vehicle Certification

The development of a vertiport and its associated facilities are not dependent on an eVTOL's FAA certification; however, for AAM operations to occur at the vertiport, all eVTOL vehicles operating there must be FAA-certified. The FAA sets the requirements for an eVTOL's design, production, airworthiness, and operations.

In the planning phase, the vertiport should begin to identify interested operators and vehicles that have successfully completed or are working to complete the FAA eVTOL vehicle certification process.

In the design phase, FAA-certified eVTOL vehicles and their specifications are reviewed and used to develop concepts for facility development.

In the implementation phase, a preferred development plan should be selected based on the AAM use, operator, and FAA certification status. Vertiport operations, vehicle operators, and safety officials should understand the specifications of the vehicles and be trained on how to respond to hazards related to the vehicles.

eVTOL Vehicle Safety Guidance

FAA AC 21.17-4 Type Certification-Powered-Lift: The draft FAA advisory circular provides airworthiness design criteria for OEM vehicles that meet certain requirements common in AAM vehicles.[24]

California PUC Chapter 3. Regulation of Aeronautics: States that proper licensure and certifications for aircraft is required and must be within the aircraft.

Inclement Weather and Interference

Inclement weather and various forms of interference may pose significant threats to the safety of AAM operations. Interference with AAM operations may be in the form of physical or visual obstructions, electronic interference, and atmospheric interference.

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[21] Integration of Powered-Lift: Pilot Certification and Operations; Miscellaneous Amendments Related to Rotorcraft and Airplanes. (2023). **https://www.federalregister.gov/documents/2023/06/14/2023-11497/integration-of-powered-lift-pilot-certification-and-operations-miscellaneous-amendments-related-to**

[22] FAA Innovate28. **https://www.faa.gov/sites/faa.gov/files/AAM-I28-Implementation-Plan.pdf**

[23] California Public Utilities Code Section 21001 et seq. relating to the State Aeronautics Act. (2019). **https://dot.ca.gov/-/media/dot-media/programs/aeronautics/documents/puc_ssa_r3_2019.pdf**

[24] FAA AC 21.17-4 Type Certification- Powered-lift draft. **https://www.faa.gov/aircraft/draft_docs/ac_21_17-4**

In the planning phase, types of inclement weather or interference with AAM operations should be reviewed. The severity of a hazard related to specific weather conditions may depend on the operational specifications of the eVTOL vehicles. However, the FAA has deemed the forms of interference to aircraft as incompatible land uses.

In the design phase, preliminary site assessments should evaluate metrics of weather that could impact operations, such as average and maximum wind speeds, precipitation, air temperature, and others. Similarly, incompatible land uses that produce interference to operations, such as light interfering with the visual operations of the vehicle, electronics that interfere with navigational or remote operating systems[25] or thermal exhaust plumes that pose visual interference should all be strategically avoided.

In the implementation phase, the final location of a vertiport should consider the timing and location of inclement weather threats, as well as the proximity to incompatible land uses. The San Diego region is home to many different microclimates, from coastal to desert to forested foothills. Each individual vertiport will have to evaluate the potential impact of airborne dust, humidity, and heat, as well as climate hazards such as wildfires, smoke, drought, and flooding.

<u>Inclement Weather and Interference Guidance</u>

FAA AC 150/5190-4B *Airport Land Use Compatibility Planning*: Provides details on atmospheric and radio interference.

National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information – Climate Data Online: Provides existing and historical weather data for a specific location.

Existing and Future Zoning Maps: Provides insight into what areas may have incompatible land uses that could cause forms of interference.

FAA/RD-84/25 Evaluating Wind Flow Around Buildings on Heliport Placement, National Technical Information Service (NTIS) accession number AD-A153512

FAA/RD-92/15 Potential Hazards of Magnetic Resonance Imagers to Emergency Medical Service Helicopter Services, National Technical Information Service (NTIS) accession number AD-A278877

Emergency Response

In the planning phase of developing an emergency response plan for a vertiport, a thorough understanding of the capacities and constraints of the local first responders should be recognized. Some of these details can be obtained in local emergency plans and the emergency requirements set forth in all Federal Aviation Regulations (FAR) Part 139 airports.[26]

[25] For vertiports on top or adjacent to hospitals or other medical facilities, the presence of a magnetic resonance imaging (MRI) machine may interfere with navigational equipment. Large ventilator motors, elevator motors, and other devices that consume large amounts of energy may also produce electromagnetic effects.

[26] PART 139 – Certification of Airports. Retrieved online: https://www.ecfr.gov/current/title-14/chapter-I/subchapter-G/part-139

In the design phase, any existing emergency plan details that apply to the operation of a vertiport should be identified and reviewed. At an airport, aircraft rescue and firefighting (ARFF) index requirements and response times are determined by the aircraft that operate there. With the addition of AAM operations and facilities, newly determined standards set by the FAA must be achieved.

In the implementation phase, new policies and procedures specific to AAM operations and vertiports should be added to local and airport emergency plans. Full coordination with local governments, police and fire departments, hospitals, and any other applicable safety service providers should be made to ensure all services correspond. Training(s) on new procedures relative to the specifics of the AAM operations and facilities should also be implemented.

Emergency Response Guidance

Existing airport emergency plans: Required of Part 139 Airports.

FA AC 150/5200-31C - Airport Emergency Plan (Consolidated AC includes Change 2)

ARFF, Emergency Medical Technician (EMT), and police response times

14 CFR 139.315 Aircraft rescue and firefighting: Index determination.

2.3 Intergovernmental Coordination

The third component in the development of a successful vertiport is intergovernmental coordination.

The operation of an aircraft facility requires various permits from local, state, and federal authorities. These include permits for the construction and operation of the vertiport, the operation of the eVTOL aircraft, and the handling of hazardous materials.

In general, the permitting processes involve the submission of necessary applications, required documentation, and compliance with any inspections or audits. It is the responsibility of the facility manager to ensure that all necessary permits are obtained and kept up to date. The facility must also comply with any conditions or requirements stipulated in the permits. Non-compliance with permit conditions can result in penalties, including fines, suspension of operations, or revocation of permits.

All vertiport facilities are required to obtain permits through the FAA, the state-specific Department of Transportation (DOT), and the local municipality, as well as prove compliance with the surrounding Airport Land Use Compatibility Plan (ALUCP) described in this section.[27]

The guiding intergovernmental coordination questions below are to be considered during the planning, design, and implementation phases of development.

What federal standards and requirements are necessary for the development of the vertiport and AAM operations?

What environmental processes are required for development?

Is a vertiport included in an airport layout plan (ALP) or airport master plan (AMP)?

[27] Refer to Section 7 for case studies for aircraft facilities located within the City of San Diego and Brown Municipal Airport AIA.

- What local and regional governments would be impacted by the development of the vertiport?
- Are there local municipal codes that address vertiports and AAM operations?
- Are the vertiport and AAM operations compatible with other land uses?

FAA Standards and Requirements

The FAA is the United States' regulatory authority on civil aviation activity. This governance includes the construction and operation of airports and heliports, thus, any changes to an airport to enable a vertiport to be constructed or AAM operations on a non-airport site would require FAA coordination.

Land Use Compatibility and Noise

Certain characteristics of a site may inherently deem it incompatible for aeronautical activities, or it is generally not recommended to build an airport or airspace over some of which are described in Section 2.2: Safety. Specific land use compatibility policies for the San Diego Region are described in Section 2.3: Intergovernmental Coordination and Section 2.7: Case Study Example.

In the planning stages, FAA resources on compatible land uses should be reviewed to build an understanding of potential hazards that could be barriers to AAM implementation. Proponents should evaluate the site against the core characteristics of compatibility: aviation noise, airspace, visual or atmospheric interference, wildlife, protection of people and property, and development density.

FAA ACs and regulatory guidance may be valuable for understanding provisions of airport-compatible land uses throughout the planning, design, and implementation phases. However, the FAA has a limited regulatory role in land use planning, and more local, regional, state, local, and airport provisions (detailed further in this chapter) will take precedence for decision making. See the resources below and Section 2.2: AAM Safety for more context.

FAA Land Use Compatibility Resources:

- ***FAA AC 150/5190-4B, Land Use Compatibility:*** Chapter 2. Land Use Compatibility Concerns describes six core characteristics to evaluate when assessing airport-compatible land uses.[28]
- ***14 CFR Part 150- Airport Noise Compatibility Planning:*** This part prescribes the procedures, standards, and methodology governing the development, submission, and review of airport noise exposure maps and airport noise compatibility programs, including the process for evaluating and approving or disapproving those programs.[29]
- ***ACRP Report 15, Aircraft Noise: A Toolkit for Managing Community Expectations:*** Examines practices that characterize an effective

[28] FAA AC 150/5190-4B, Land Use Compatibility. https://www.faa.gov/documentLibrary/media/Advisory_Circular/150_5190_4b_Land_Use_Compatibility.pdf

[29] 14 CFR Part 150- Airport Noise Compatibility Planning. https://www.ecfr.gov/current/title-14/part-150

communications program and provides basic information about noise and its abatement to assist in responding to public inquiries.[30]

14 CFR Part 77, Safe, Efficient Use and Preservation of Navigable Airspace: Establishes standards for determining and defining objects that may pose potential obstructions to air navigation.[31]

FAA Notice Criteria Tool: Allows users (airport sponsor, developer, and local municipality) to input location and dimensional information about a proposed development to determine if they are required to file notice with FAA.[32]

ACRP Report 108, Guidebook for Energy Facilities Compatibility with Airports and Airspace: Includes research findings on visual, atmospheric, and electronic interference. Electronic interference is a compatible land use consideration and includes high-energy use, production, or transmission facilities, or installations on an institutional, commercial, or industrial property that may affect navigational aids (NAVAIDs).[33]

FAA AC 150/5200-33C, Hazardous Wildlife Attractants on or Near Airports: Provides guidance on certain land uses that have the potential to attract hazardous wildlife on or near public-use airports.[34]

Day-Night Average Sound Level (DNL). FAA has adopted DNL 65 decibels (dBA) as the threshold of significant noise exposure, below which residential land uses are compatible.[35] While DNL is the primary metric FAA uses to determine noise impacts, FAA accepts the Community Noise Equivalent Level (CNEL) in California, as California adopted the use of CNEL before FAA adopted DNL. While CNEL, like DNL, adds a ten times weighting (equivalent to a 10 dBA "penalty") to each aircraft operation between 10:00 p.m. and 7:00 a.m., CNEL also adds a three times weighting (equivalent to a 4.77 dBA penalty) for each aircraft operation during evening hours (7:00 p.m. to 10:00 p.m.)

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[30] ACRP Report 15, Aircraft Noise: A Toolkit for Managing Community Expectations. https://nap.nationalacademies.org/catalog/14338/aircraft-noise-a-toolkit-for-managing-community-expectations

[31] 14 CFR Part 77. https://www.ecfr.gov/current/title-14/part-77

[32] FAA Notice Criteria Tool. https://oeaaa.faa.gov/oeaaa/external/gisTools/gisAction.jsp?action=showNoNoticeRequiredToolForm

[33] ACRP Report 108, Guidebook for Energy Facilities Compatibility with Airports and Airspace. https://crp.trb.org/acrpwebresource4/acrp-report-108-guidebook-for-energy-facilities-compatibility-with-airports-and-airspace/

[34] FAA AC 150/5200-33C, Hazardous Wildlife Attractants on or Near Airports. https://www.faa.gov/airports/resources/advisory_circulars/index.cfm/go/document.current/documentNumber/150_5200-33

[35] FAA Community Response to Noise: https://www.faa.gov/regulations_policies/policy_guidance/noise/community

FAA Airspace Determination

In the early planning phase, prior to filing any official forms for airspace determination, it is highly recommended that vertiport proponents coordinate with the FAA, local airports, and other impacted agencies and communities. Proponents may use the FAA Notice Criteria Tool to evaluate if the proposed site location and characteristics obstruct Part 77 imaginary surfaces or potentially impact frequencies, both of which may impact safe and efficient use of airspace. If the site does infringe on Part 77 surfaces, it may require further aeronautical studies and coordination with the FAA. Other incompatible land uses described in Section 2.3: Intergovernmental Coordination should be evaluated before submitting permits to the FAA.

To prepare for the permit submittal described below, proponents should gather information for the planned vertiport as supporting materials. See Section 2.7: Case Study for the materials that must be submitted with the application.

In the design phase, vertiport proponents should gather materials and studies required for airspace determination by the FAA. In order to activate a new public or private vertiport that is **not on airport property or a non-federally obligated airport**, the FAA requires proponents to submit FAA Form 7480-1, *Notice for Construction, Alteration and Deactivation of Airports* at least 90 days in advance of the start of construction, alteration, activation, or change of status.[36] This form triggers an aeronautical study by the FAA with three potential outcomes: no objection, no objection with conditions, or objectionable.

If the vertiport is **on a federally obligated airport**, the vertiport infrastructure and equipment must be depicted on the Airport Layout Plan (ALP), and a Form 7460-1 must be submitted for FAA airspace determination before development and operation.[37] The FAA's Office of Airports (ARP) will also review the ALP under the National Environmental Policy Act (NEPA) and may respond in three ways:

1. Conditional ALP approval- not yet completed environmental review, or not authorized to build until after the ARP completes an environmental analysis.
2. Unconditional ALP approval- ARP completed environmental review, and building may begin.
3. "Mixed" ALP approval- the FAA approves part of a project and conditionally approves long-term development, "not yet ripe" for decision.

Note that approval of an ALP also indicates that the FAA finds the proposed development to be safe and efficient.

[36] The FAA highly recommends engagement with the applicable regional/district office more than 90 days in advance.

Form 7480-1 is required by Title 14 Code of Federal Regulations Part 157, https://www.ecfr.gov/current/title-14/part-157.

[37] FAA Form 7460-1 must be submitted at least 45 days prior to construction. However, it is recommended to coordinate with airports and FAA airport district offices (ADOs) prior to submittal and allow extra time for an extensive airspace review.

During the review process, both on- and off-airport development may require additional correspondence with the FAA, additional information requests, public comments, and more. Findings may require updates to plans and designs, additional processes such as environmental assessments, or the denial of airspace permits due to unsafe or inefficient conditions.

Once approved by the FAA, vertiports **not on airport property or on a non-federally obligated airport** will receive a blank 5010-3 (for public-use landing areas) or 5010-5 (for private-use landing areas), required to activate a new airport landing area. During the implementation phases, the form will need to be completed and submitted to ensure the accuracy of airport details and include it in the airport master record. The FAA or state airport inspector will then inspect the site for accuracy with the submitted 5010 form and revise and resubmit, as needed. FAA's Airport Engineering Division (AAS-100) inspects the form for accuracy, assigns the vertiport a site number, and forwards the information to the Air Traffic Organization (ATO) for entry into the National Airspace System (NAS) with a permanent location identifier.

Off-Airport Resources:

FAA Notice Criteria Tool: Allows users (airport sponsor, developer, and local municipality) to input location and dimensional information about a proposed development to determine if they are required to file notice with FAA.

14 CFR Part 157, Notice of Construction, Alteration, Activation, and Deactivation of Airports: Describes what projects require notice and defines important terms.[38]

FAA EB #105: Provides interim design standards for vertiports.

FAA Form 7480-1: Form for airspace determination off-federally obligated airports.

FAA Form 5010-3: Form to activate a new public-use landing area.[39]

FAA Form 5010-5: Form to activate a new private-use landing area. [40]

FAA AC 150/5200-35A, Submitting the Airport Master Record in Order to Activate a New Airport: Guidance on activating a new landing area, including descriptions of FAA Forms 5010-3 and 5010-5.[41]

On-Airport Resources:

FAA Notice Criteria Tool

FAA EB #105

FAA Form 7460-1: Form required to initiate an airspace evaluation.[42]

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[38] 14 CFR Part 157, Notice of Construction, Alteration, Activation, and Deactivation of Airports. https://www.ecfr.gov/current/title-14/part-157

[39] FAA Form 5010-3. **https://www.faa.gov/documentLibrary/media/Form/faa-form-5010-3-airport-master-record-2014.pdf**

[40] FAA Form 5010-5. **https://www.faa.gov/documentLibrary/media/Form/5010-5-airport-master-record.pdf**

[41] FAA AC 150/5200-35A, Submitting The Airport Master Record in Order to Activate a New Airport. **https://www.faa.gov/documentLibrary/media/Advisory_Circular/150_5200_35a.pdf**

[42] FAA Form 7460-1 can be completed online with a free account at oeaaa.faa.gov.

FAA AC 150/5070-6B, Airport Master Plans: Chapter 10. Airport Layout Plans describe components of ALPs and documentation guidelines.[43]

FAA Order 1050.1F, Environmental Impacts: Policies and Procedures: Details policies and procedures for compliance with NEPA and implementing regulations by the Council on Environmental Quality (CEQ).[44]

FAA Order 5050.4B, NEPA Implementing Instructions for Airport Actions: Provides clear instructions to airport personnel and others on how to address NEPA and potential environmental effects from major airport actions.[45]

California PUC 21661.6, Acquisition of Land On-Airport: If land is to be acquired to expand or enlarge the airport for AAM purposes, additional approval and processes are required by the state of California.[46]

State Governance

Land Use Compatibility

Airport Land Use Compatibility

In an effort to reduce the public's exposure to excessive noise and safety hazards while supporting the orderly expansion of airports in the state of California, the state of California has established Airport Land Use Commissions (ALUCs)[47] and Airport Land Use Planning requirements for public-use airports, as described in the California Airport Land Use Planning Handbook. The type of ALUC review for the development of a heliport is dependent on the site location, either within the Airport's Influence Area (AIA)[48] or on the airport property itself.

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[43] FAA AC 150/5070-6B, Airport Master Plans. https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_150_5070-6B_with_chg_1&2.pdf

[44] Order 1050.1F - Environmental Impacts: Policies and Procedures. https://www.faa.gov/regulations_policies/orders_notices/index.cfm/go/document.current/documentNumber/1050.1

[45] Order 5050.4B - National Environmental Policy Act (NEPA) Implementing Instructions for Airport Actions. https://www.faa.gov/regulations_policies/orders_notices/index.cfm/go/document.information/documentID/14836

[46] California Public Utilities Code (PUC) 21661.6, Acquisition of Land On-Airport. https://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?lawCode=PUC&sectionNum=21661.6.

[47] Set forth in California Public Utilities Code (PUC) Division 9, Part 1, Chapter 4, Article 3.5, Sections 21670 – 21679.5.

In San Diego County, the ALUC function rest with the Board of the San Diego County Regional Airport Authority (SDCRAA).

[48] Area of Influence (AIA)- The area in which current and projected future airport-related noise, safety, airspace protection, or overflight factors/layers may significantly affect land use or necessitate restrictions on land use.

During the planning phase, the location of the vertiport site should be evaluated for status within an AIA. The particular safety zone, noise contour, airspace protection boundary, or overflight notification area subject to an ALUCP can be identified using the San Diego County Airport Authority's (SDCRAA) ALUCP Mapping Tool. With this information, proponents should review the applicable ALUCP under the AIA(s) and begin coordination (if not already started) with the particular airport(s).[49]

During the planning and design phase, materials should be prepared for any applications that are required per the applicable ALUCP. Applicants will need to check the requirements of the applicable ALUCP but should generally prepare a site plan showing the proposed vertiport facility, impacts to the surrounding areas, and potential hazards. Applicants will need to show coordination with the local municipality and discuss existing and proposed land use, environmental concerns, and identify related elevations. Applications and requirements are likely to vary for the development of off-airport, on-airport, and expanding an airport. See Section 2.7 Case Study for the required documentation and processes in the case study as an example.

Airport Land Use Compatibility Resources:

***California Airport Land Use Planning Handbook*:** This handbook provides resources and requirements of airport land use planning for public-use airports in the state of California and the designated ALUCs.[50]

***SDCRAA ALUCP Mapping Tool*:** The mapping tool allows users to look up a location to determine if and which AIA the vertiport site is within. [51]

California PUC Article 2.7 Regulation of Obstructions: Section 21655 states requirements for DOT notification for any proposed site for a state building within two miles of an airport boundary.[52]

Applicable Airport Plan Use Compatibility Policy Document: The ALUCP will contain applicability, requirements, processes, and other vital information for compliance with land use nearby or on airport property.[53]

California Coastal Act

When considering environmental impacts and site locations in the planning phases, proponents should evaluate if the site is within a Coastal Zone Boundary. If the proposed site is within a Coastal Zone Boundary, new development may be subject to considerations under the California Coastal Act (CCA) of 1976, enforced for the protection of the California Coast against environmental harm, to preserve natural and scenic resources, and to promote equal access to the public.

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[49] ALUCPs within San Diego County are available online at **https://www.san.org/Airport-Projects/Land-Use-Compatibility/ALUC-Resources**

[50] California Airport Land Use Planning Handbook. (2011). **https://dot.ca.gov/-/media/dot-media/programs/aeronautics/documents/californiaairportlanduseplanninghandbook-a11y.pdf**

[51] ALUCP Mapping Tool. **https://sdcraa-aluc.maps.arcgis.com/apps/webappviewer/index.html?id=945b3a6b12a34b158d8c9022251542e3**

[52] California Public Utilities Code Section 21001 et seq. relating to the State Aeronautics Act. (2019). **https://dot.ca.gov/-/media/dot-media/programs/aeronautics/documents/puc_ssa_r3_2019.pdf**

[53] A library of the different ALUCPs within San Diego County are available online at **https://www.san.org/Airport-Projects/Land-Use-Compatibility/ALUC-Resources**

If the development is within the boundary, during the design and implementation phases, vertiport proponents should review Article 6 of the CCA and adhere to other provisions of the CCA. If the new development is in highly scenic areas designated by state and local governments, there may be additional restrictions and protocols set by those agencies that vertiport proponents shall adhere to.

CCA Resources:

- ***California Coastal Act:*** This Act is enforced for the protection of the California Coast against environmental harm, to preserve natural and scenic resources, and to promote equal access to the public.[54]
- ***Coastal Zone Boundary Map:*** A map of the Coastal Zone Boundary is provided by the California Coastal Commission to evaluate if a site is located within the zone.[55]
- ***California PRC Division 20, Chapter 3, Article 6. Development:*** Contains considerations for development within the Coastal Zone Boundary.[56]

State Airspace Determination

Heliports are required to be reviewed and approved at the State level by the California Department of Transportation (Caltrans), Office of Airports.[57] For **off-airport vertiports**, proponents should complete the following processes and documents prior to applying for state site approval (Form DOA-0201)[58]:

- Scaled drawings of the heliport that include the design standards
- Local area map showing areas of public interest[59]
- Approval of the plan for construction by either the Board of Supervisors of the county or the City Council of the city (as appropriate) in which the heliport is to be located
- Action by the Airport Land Use Commission of the county in which the heliport is to be located
- Compliance with the California Environmental Quality Act (see Section 2.5: Environmental)
- FAA Airspace Determination from form 7480-1 (see Section 2.3: Intergovernmental Coordination)

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[54] PRC Division 20, California Coastal Act. (2024). **https://www.coastal.ca.gov/coastact.pdf**

[55] Coastal Zone Boundary Map. **https://coastal.ca.gov/maps/czb/**

[56] California Public Resources Code (PRC) Division 20, Chapter 3, Article 6. Development [30250-30255]. **https://leginfo.legislature.ca.gov/faces/codes_displayText.xhtml?lawCode=PRC&division=20.&title=&part=&chapter=3.&article=6.&op_chapter=**

[57] Pursuant to PUC 21664 and CCR 3534. Note that emergency medical services (EMS) landing sites and emergency use facilities are exempt from State Heliport Permit Requirements. See California Heliport Definitions for applicability: **https://dot.ca.gov/programs/aeronautics/heliport-permits**

[58] For a full list of materials required with Form DOA-0201, see **https://dot.ca.gov/programs/aeronautics/heliport-permits**

[59] Map must include the location of the heliport and location of schools, places of public gathering and residential areas within 1,000 feet of the center of a proposed FATO.

In order to issue a permit, the Department considers if the application complies with minimum heliport design and safety standards, has developed safe air traffic patterns, and that the advantages outweigh the disadvantages that the new heliport could impose on the environment and the surrounding area. The Department may impose reasonable permit conditions that it deems necessary and can refuse to issue a permit if permit requirements have not been met or revoke a permit if conditions for compliance are not met. If ownership, physical, or operational changes occur, a Corrected Heliport Permit-Application (DOA-0202) will need to be submitted at least 30 working days before the change.

For heliports **on-airport property**, proponents will only need to submit the scaled drawings and FAA airspace determination with Form DOA-0201 for compliance with heliport design standards.[60]

Heliport Permit Guidance:

CalTrans Heliport Permits- Outlines the applicability, processes, and regulatory framework for issuing heliport permits.[61]

Department Form DOA 0201, Heliport Site Approval Permit

Department Form DOA-0202, Corrected Heliport Permit-Application

California State Aeronautics Act: Contains state laws on the regulations of aeronautics and aeronautical facilities. Article 3. Regulation of airports [21661.5-21664] includes details on site permit requirements and emergency service flights.[62]

14 CFR Part 77, Safe, Efficient Use and Preservation of Navigable Airspace: Requirements to preserve safe and efficient navigation and describes imaginary surfaces. Federal and state requirements per California PUC.[63]

California Environmental Quality Act (CEQA): Requires government agencies to consider the environmental consequences of discretionary actions. CEQA will apply to all projects and must be completed before California's release of an amendment or permit.

FAA AC 150/5390-2D Heliport Design: Standards and regulations for heliport design. Not specific to VTOL aircraft, but referenced as interim guidance for many design elements.[64]

California Code of Regulations (CCR) Title 21, Chapter 2, Article 4, § 3551, Heliport Design Standards: State of California heliport design standards.[65]

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[60] Heliport design standards for the state of California are described in CCR Article 4 (3550, 3551, 3554), in alignment with FAA ACs and FAR Part 77.

[61] CalTrans Heliport Permits. (2024). **https://dot.ca.gov/programs/aeronautics/heliport-permits**

[62] California Public Utilities Code Section 21001 et seq. relating to the State Aeronautics Act. (2019). **https://dot.ca.gov/-/media/dot-media/programs/aeronautics/documents/puc_ssa_r3_2019.pdf**

[63] 14 CFR Part 77. **https://www.ecfr.gov/current/title-14/part-77**

[64] FAA AC 150/5390-2D Heliport Design. (2023). **https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_150_5390_2D_Heliports.pdf**

[65] CCR Title 21, Chapter 2, Article 4, § 3551. **https://www.law.cornell.edu/regulations/california/21-CCR-3551**

Local & Regional Governance

The required permits needed to construct a vertiport facility vary based on the location and, thus, the municipality that has jurisdiction in that area. Generally, a site will need to obtain a site and/or building permit and must submit design plans, associated calculations, project narrative, and ensure the vertiport is an allowable use within the designated site zoning. Depending on the municipality, a public hearing, public weigh-in, and/or neighborhood notice may be required.

In addition to the general permitting requirements, the city and local planning authorities play a crucial role in the approval process for vertiport construction. This involves a thorough review of the proposed site to ensure compliance with local zoning laws, environmental regulations, and community impact assessments. The planning authorities may require additional documentation, such as environmental impact reports, traffic studies, and noise assessments, to evaluate the potential effects of the vertiport on the surrounding area. Coordination with local emergency services, such as fire and police departments, is also essential to ensure that the vertiport meets safety and operational standards. Refer to Section 2.7: Case Study Example for an example of the processes and documentation required for vertiport permits in the City of San Diego.

Local and Regional Resources:

- **Municipality Manuals and Codes:** May include Jurisdictional Municipality's Land Development Manual, Municipal Code, Stormwater Manual, Transportation Manual, Utility Manual, and/or Project Submittal Manual; each Municipality will have manuals and codes available for reference.[66]
- ***California Building Standards Code:*** This document will provide guidance for the development of buildings/structures associated with the design of a vertiport facility.[67]

2.4 Environmental

With the rise of Urban Air Mobility (UAM) and Advanced Air Mobility (AAM), vertiport development requires a thorough understanding of federal, state, and local regulations to ensure compliant and safe operations. This section identifies anticipated National Environmental Policy Act (NEPA), California Environmental Quality Act (CEQA), and other regulatory requirements so that potential environmental impacts can be identified early and proactively mitigated.

For on-airport vertiport sites, it is anticipated that both NEPA and CEQA reviews would be required. To locate a vertiport on a public-use airport that receives federal funding, the project would have to be added to the airport's Airport Layout Plan (ALP), which would trigger NEPA compliance with the FAA as the lead federal agency. The updated ALP must include any components or infrastructure related to the vertiport, its support facilities, and associated infrastructure (e.g., charging pads, electrical grid, etc.) that are not currently shown on the airport's ALP. The level of NEPA review depends on the scale, complexity, and location of the on-airport vertiport site.

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[66] **California | Municode Library**

[67] **Codes (ca.gov)**

In California, all projects requiring discretionary governmental approval, whether public or private, are subject to CEQA. For off-airport vertiport sites, it is anticipated that only CEQA reviews would be required unless federal funding or federal approvals are involved. Federal approvals may include FAA approvals or other federal actions, such as Department of Energy grant funding, related to the project. In cases where no federal funding or federal approvals are necessary, NEPA is generally not triggered for such off-airport locations. CEQA mandates environmental reviews that address noise, air quality, traffic, and natural resources. Coordination with the California Department of Transportation (CALTRANS) is also crucial to secure site approvals and validate land use compliance.

Local permitting, particularly through Conditional Use Permits (CUPs), is a key requirement in jurisdictions such as San Diego, where vertiports are subject to intensive review under the CUP Process Five. This tiered approval process involves multiple stages of environmental review, public hearings, and community engagement, providing nearby property owners and stakeholders with an opportunity to review and respond. CUPs require detailed project documentation, including site plans, environmental assessments, and operational details, to evaluate alignment with zoning laws, land use codes, and public safety standards. Additionally, projects must meet specific building, fire, and height regulations to ensure safety in densely populated or airport-adjacent areas.

The CUP process and broader regulatory framework highlight the need for early, proactive coordination among federal, state, and local agencies, along with thorough community engagement, to develop vertiports that align with stringent operational, environmental, and public health standards.

Ideally, state-level environmental reviews under CEQA would be conducted in parallel with NEPA to ensure comprehensive environmental oversight and to minimize timelines for approval. CEQA regulations allow for the preparation of a joint CEQA/NEPA document; however, joint documents are rarely produced. The project sponsor, in consultation with the FAA, will ultimately determine the timing of the CEQA and NEPA processes and whether one must be completed entirely or partially before the other can begin. Technical studies conducted for environmental reviews would only be conducted once and would be used in both the NEPA document and the CEQA document.

Regulatory Requirements and Permitting

Vertiports will require various permits from federal, state, and local agencies. Anticipated permits include construction permits, environmental permits, and operational certifications from the FAA and other relevant authorities. All necessary permits and approvals must be obtained to ensure compliance with regulatory requirements.

Environmental reviews typically include an assessment of potential impacts across various resource categories:

Air Quality - The project must address air quality concerns, particularly particulate matter (PM) 2.5 levels. An air quality impact analysis is essential to mitigate potential emissions from construction and operational activities. This will be required under NEPA and/or CEQA.

Biological Resources – Coordination with the U.S. Fish and Wildlife Service and the California Department of Wildlife and Fisheries will be required to comply with NEPA and/or CEQA.

Environmental Justice - Extensive outreach and engagement should be conducted with local communities, particularly with high concentrations of disadvantaged communities, including minority and low-income populations. Other disadvantaged communities, such as seniors or disabled individuals, should also be identified in the project area, and special outreach activities should occur to ensure they have an opportunity to express any concerns they may have.

Noise and Noise-Compatible Land Use - The operation of eVTOL aircraft, expected to be quieter than traditional helicopters, will still require noise assessments to ensure compliance with FAA standards and minimize impacts on surrounding communities.

Land Use and Physical Environment - An evaluation of land use compatibility, zoning ordinances, and permitting requirements associated with changes in operational intensity and noise levels at a proposed site will be needed.

Stakeholder Engagement - Ongoing consultation with stakeholders, including airports, elected officials, local communities, businesses, and government agencies, is a key component of the project. Public meetings and information sessions will ensure transparency and address stakeholder concerns.

Other Environmental Considerations - Potential impacts on water resources and historic and cultural resources need to be addressed. Mitigation measures and best management practices should be implemented to protect these resources.

Federal

National Environmental Policy Act

Locating a vertiport on a federally funded airport would require a change to the ALP and would affect airspace. These changes would require FAA approval and would trigger the NEPA process. It is anticipated, under current regulations, that the level of environmental documentation would be an Environmental Assessment (EA). However, it should be noted that the FAA has been directed to "apply applicable categorical exclusions or establish new categorical exclusions with the Council on Environmental Quality for use when considering the environmental impacts of proposed vertiport projects on airports."[68] It is unknown when new categorical exclusions may be implemented by the FAA in response to the FAA Reauthorization Act of 2024 (H.B. 3935). The FAA's decision on a new categorical exclusion for vertiports is not expected until the summer of 2025. It will be up to the FAA to determine how they will apply new regulations and what activities are categorically excluded.

The FAA has 12 months to complete a final environmental document for an EA. The "NEPA clock" for an EA typically begins after the project sponsor's project description, purpose and need statement, and description of proposed action and alternatives have been reviewed and approved by the FAA. The FAA does not consider the time prior to the approval of these items part of the 12-month process. The FAA encourages project sponsors to do as much planning, community outreach/engagement, and environmental studies as early as possible to ensure the NEPA process is streamlined and efficient with a goal of avoiding surprises once the "NEPA clock" has started. By identifying potential concerns or impacts early and best management practices or mitigation measures to avoid or offset those concerns or impacts, project sponsors can streamline the environmental review process.

[68] See https://transportation.house.gov/uploadedfiles/faa_reauth_act_section_by_section.pdf

Figure 2 shows the NEPA process and anticipated timelines for each step. Generally speaking, project sponsors and applicants should expect an EA led by the FAA to take no less than 12 to 18 months to complete.

Clean Air Act

Under NEPA, federal agencies must consider the impact their actions will have on the environment compared to a No Action Alternative. According to FAA NEPA implementing guidance (FAA Order 1050.1F and Desk Reference, and FAA Order 5050.4B), impacts on air quality must be considered as part of the environmental analysis under NEPA. Potential effects of the Proposed Action are evaluated against the National Ambient Air Quality Standards (NAAQS), as promulgated by the US EPA under the federal Clean Air Act (CAA).

Federally funded and approved actions at airports are subject to the US EPA's General Conformity regulations. The General Conformity Rule defines a federal action as any activity engaged in by a department, agency, or instrumentality of the federal government or any activity that a department, agency, or instrumentality of the Federal Government supports in any way, provides financial assistance for, licenses, permits, or approves.

NEPA PROCESS TIMELINE

NOTICE TO PROCEED/ KICK OFF	REVIEW EXISTING DATA	DEVELOP PURPOSE, NEED & ALTERNATIVES	CONDUCT EXISTING CONDITIONS & IMPACT ANALYSES	PREPARE DRAFT ENVIRONMENTAL ASSESSMENT	NOTICE OF AVAILABILITY & PUBLIC REVIEW OF DRAFT ENVIRONMENTAL ASSESSMENT	PREPARE FINAL ENVIRONMENTAL ASSESSMENT	NOTICE OF AVAILABILITY OF FINAL ENVIRONMENTAL ASSESSMENT
• Task Order Award/Notice to Proceed • Kick-off meeting with project team • Kick-off meeting with FAA and project sponsor • Discuss and determine schedule and level of documentation required • Conduct site visit	• Review existing site information and previous studies • Identify gaps and updates needed • Review construction phasing, proposed implementation schedule • Review conceptual design	• Define purpose and need with supporting information • Describe Proposed Action • Define No Action • Coordinate with FAA • Submit Chapter 1 Project Description/ Purpose and Need and Chapter 2 Alternatives • Receive approved Chapters 1 and 2	• Document existing conditions • Evaluate and document potential impacts to resources • Perform field work • Consult with agencies, including USFWS, SHPO, and others as necessary • Submit Chapter 3 Affected Environment and Chapter 4 Environmental Consequences	• Issue Administrative Draft PEA for FAA review • Address FAA comments • Develop Section 508-compliant Draft PEA for public release	• Prepare and publish Notice of Availability for public review • Make document available for public review for 30 days • Develop public information meeting materials and displays • Conduct public information meeting • Compile and categorize public comments	• Address public comments received during public review period • Issue Administrative Final PEA for FAA review • Address FAA comments • Develop Section 508-compliant Final PEA for public release	• Prepare and publish Notice of Availability • FAA issues decision document
Project Start	Month 1	Months 1-2	Months 2-8	Months 9-10	Months 10-11	Months 12-13	Month 14

Planning and Preparation for NEPA
(occurs before FAA "NEPA Clock" starts)

★ *Start "NEPA Clock"*

ENVIRONMENTAL ROADMAP

State

In addition to federal requirements, the State of California has a robust environmental regulatory framework with which projects must comply. This involves compliance with California laws, as well as coordination with applicable state agencies.

California Environmental Quality Act

CEQA requires state and local agencies to review projects that are publicly sponsored, identify the potential for adverse environmental impacts, and determine whether those impacts would be significant. If the proposed vertiport is located on Airport property, the project sponsor (and lead agency under CEQA) would be the Airport Authority, responsible for determining whether CEQA would apply and conducting the environmental review. If a proposed vertiport is located off Airport property, the project sponsor (and lead agency under CEQA) would be the state or local entity issuing a permit. This may be CALTRANS or the City of San Diego.

For vertiports, a review could be triggered by construction or expansion that increases operational capacity significantly; changes that lead to increased noise, air pollution, or traffic congestion; or potential impacts on local water resources, wildlife, or vegetation.

By addressing these findings through careful planning, environmental reviews, and stakeholder engagement, the project aims to avoid and/or minimize environmental impacts while providing substantial transportation and socio-economic benefits.

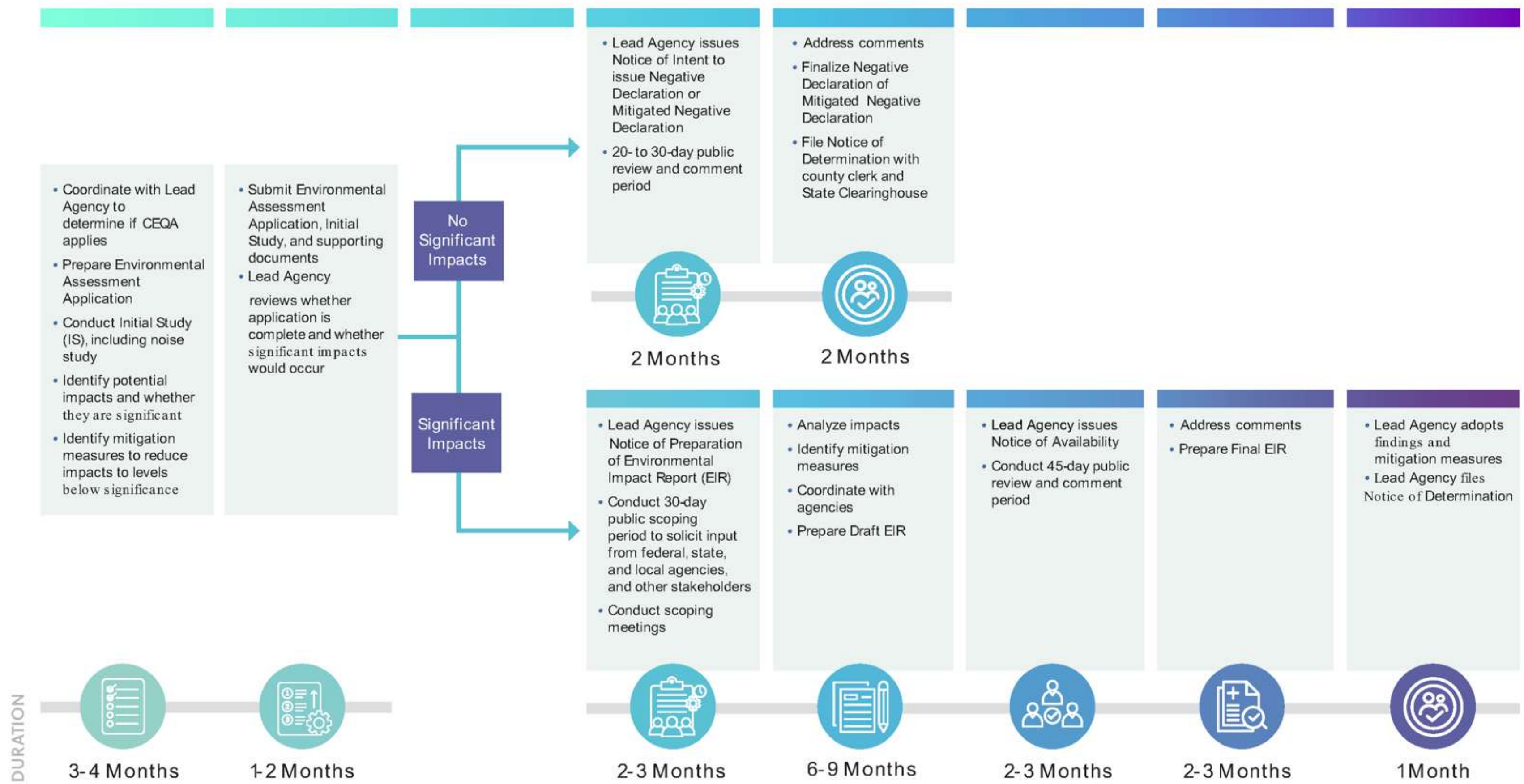
The CEQA process begins with coordination between the project sponsor and agencies to share information about the project and identify the appropriate course of action to comply with CEQA and determine the appropriate compliance steps. Typically, an Initial Study is conducted to assess potential impacts, including a Noise Study that compares projected aircraft noise to ambient levels. Other required documents include radius maps, vicinity maps, photos, and plot plans. The Initial Study, which includes the results of the technical studies performed to identify environmental resources and potential impacts, is sent to the Planner/Community Development department, which has 30 days to review the application or request more information.

If no significant impacts are found, the process proceeds with a Negative Declaration (ND) or Mitigated Negative Declaration (MND). The ND shows no significant impacts, while the MND indicates impacts can be mitigated. A Notice of Intent (NOI) initiates a 20 to 30-day public review, after which comments are addressed, and the ND or MND is finalized, leading to a Notice of Determination (NOD) with the County Clerk and State Clearinghouse, enabling project approval. The State Clearinghouse (SCH) is a division within the Governor's Office of Planning and Research (OPR) in California. It serves a critical role in the CEQA process by acting as the central point for the distribution and review of environmental documents.

If significant impacts are identified, a Draft Environmental Impact Report (DEIR) is prepared, followed by a Notice of Availability (NOA) for a 45-day public review. Comments are addressed in a Final EIR (FEIR), after which the agency certifies the FEIR, adopts mitigation measures, and files an NOD, completing the process and ensuring CEQA compliance through thorough impact evaluation and mitigation.

Figure 3 displays a typical CEQA process.

CEQA PROCESS TIMELINE



Local

In addition to state requirements, it is anticipated that full environmental due diligence will need to be coordinated with the following local entities.

City of San Diego

The project will need to comply with the City of San Diego zoning laws and land use plans. A CUP is necessary for uses that are not permitted by right in a particular zone but may be acceptable under specific conditions. The purpose is to assess each case individually to determine suitability and impose conditions to protect public health, safety, and welfare. The necessity for a CUP depends on the proposed use and its location. For uses like Airports and helicopter landing facilities, which are analogous to vertiports, a CUP is required and decided through Process Five. [69]

San Diego employs a tiered decision-making process for CUPs, ensuring that each project receives the appropriate level of review and public oversight. Process Three is the lowest level of review and involves an initial decision by a Hearing Officer, which can be appealed to the Planning Commission. In Process Four, the Planning Commission makes the decision, which may be appealed to the City Council. Finally, Process Five represents the highest level of review: the City Council makes the decision, which is final and not subject to further appeal. Airports and helicopter landing facilities, and by extension vertiports, fall under Process Five, indicating a higher level of scrutiny and public involvement. Applicants must provide detailed plans and documents, including site plans, environmental assessments, and operational details. These submissions are evaluated for completeness and compliance with the city's Land Development Code.[70]

The CUP process involves public hearings and notifications to nearby property owners and community planning groups, ensuring transparency and community engagement. For vertiport sites located on an airport, coordination with the airport and the FAA should occur before a CUP application is submitted. This is to ensure compliance with airport master plans and environmental policies.

Beyond the CUP, the project must follow San Diego building and fire safety codes, especially if structural modifications and hazardous materials are involved. There are specific height districts and safety regulations that must be adhered to, ensuring that structures comply with FAA regulations and do not interfere with other operations.

2.5 AAM Integration

The fourth component in the development of a successful vertiport is the integration of AAM into other existing systems, such as the FAA NAS, airports, multi-modal transportation systems, and other existing infrastructure.

The guiding AAM integration questions below are to be considered during the planning, design, and implementation phases of development.

How will the vertiport and AAM operations impact the NAS?

Will the airport be able to accommodate AAM operations on-site?

[69] https://docs.sandiego.gov/municode/MuniCodeChapter12/Ch12Art06Division03.pdf

[70] https://www.sandiego.gov/sites/default/files/dsdpsm_sec_04.pdf

How can AAM work with airport operations?

What updates will need to be made to existing airport planning documents?

Airport Operations Integration

AAM presents several positive opportunities for airports, including improving passenger and cargo service with short-haul flights, serving as a multi-modal hub, and expanding emergency care with efficient Medevac bases. Nonetheless, the addition of AAM vehicles in the airspace and on airport property will introduce a set of challenges to the steadily growing aviation market.

The footprint of an airport goes beyond the immediate boundary and includes imaginary surfaces in the airspace, roadways, radars and NAVAIDs, flight procedures, impacts to the surrounding areas, and more. The addition of a new type of mobility system in or around an airport could directly impact the airport's operational efficiency, safety, security, economics, and community and environmental impacts (such as noise and wildlife); therefore, early and consistent collaboration with airport authorities and the FAA is highly recommended for the success of AAM and surrounding airports.

In the planning phase, the current operations, operational capacity, and opportunities for potential airport sites should be collected and analyzed for opportunities and risks. Collaboration with airport personnel, the FAA ADO, and other impacted stakeholders should begin with planning.

The design phase will involve selecting a location after evaluating the airspace and infrastructure capabilities of potential locations and further coordination with airport stakeholders.

In the implementation phase, any applicable operational adjustments will be initiated. AAM operations may be planned to align with airport activity like arriving and departing flights.

Airport Operations Resources:

ACRP Report 243 Urban Air Mobility: An Airport Perspective: This report and the associated toolkit provide guidance on the airport's perspective, readiness, and considerations for AAM integration relevant to a variety of AAM stakeholders.[71]

FAA Airport Planning & Capacity: Provides links to guidance, tools, policy, and other resources that may be referenced to integrate a new operation.[72]

Airport Master Plans and Airport Layout Plans

AMPs and ALPs provide the long-term details of an airport's capital improvement program (CIP) for development. When the development of a vertiport is planned to be added to an airport, it must be incorporated on the ALP through an update or a Pen & Ink Change.

In the planning phase, the AMP and ALP documents should be reviewed to understand where future projects are planned and where land uses that would allow the development of a vertiport may be permitted.

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[71] ACRP Report 243 Urban Air Mobility: An Airport Perspective. **https://www.trb.org/Publications/Blurbs/182927.aspx**

[72] FAA Airport Planning & Capacity. **https://www.faa.gov/airports/planning_capacity**

In the design phase, the FAA's standards and requirements for vertiport design should help drive the development of a concept. After a thorough review, it is incorporated as a draft into the existing and proposed ALP sheets to understand how other facilities, such as support equipment, hangars, passenger or cargo processing facilities, auto parking lots, and roadways, all would interact with the rest of the airport's facilities.

In the implementation phase, the concept is submitted with all applicable ALP sheets to the FAA for review and approval.

Airport Master Plan and Airport Layout Plan Guidance

- **FAA Engineering Brief #105, *Vertiport Design***: Provides details on the design standards for vertiports.
- **FAA ARP Standard Operating Procedure (SOP) 2.00 - Standard Procedure for FAA Review and Approval of Airport Layout Plans:** Provides design standards for ALP drawings.
- **FAA ARP SOP 3.00 – SOP for FAA Review of Exhibit 'A' Airport Property Inventory Maps:** Provides standards for Exhibit A sheets.

State and Regional Transportation Plans

Existing local, regional, state, and federal transportation plans lay out the future vision of transportation networks and what goals and strategies will be prioritized.

During the planning phases, AAM stakeholders should review the transportation plans and consider how AAM can expand on existing infrastructure and plans and create alignment with the priorities of other transportation networks. AAM stakeholders should review the overarching goals, priorities, and future demand envisioned in California's Aviation System Plan (CASP) and other transportation plans to consider how an AAM service can align and integrate with the planned efforts.

In the design phase, the transportation plans can be used as a resource for integrating AAM into the state's transportation systems, plans for multimodal transportation, and a guideline for prioritizing goals such as climate, accessibility, and infrastructure.

Throughout AAM implementation, AAM stakeholders should strive to meet safety, transportation, environmental, and social goals outlined in the plans listed in this section. Many plans call out goals and strategies to reduce greenhouse gas emissions, improve connectivity, and utilize autonomous vehicles, all of which AAM aims to align with.

Aviation Transportation Guidance

- ***California's Aviation System Plan:*** California's Aviation System Plan presents a comprehensive progression for all California airports and evaluates the state of aviation and how it can contribute to the vision and goals of the California Transportation Plan. In Chapter 4, the plan also provides a high-level overview of AAM and the related infrastructure, funding, land use, and policies.[73]

Statewide Transportation Plans:

[73] California's Aviation System Plan. (2020). https://dot.ca.gov/-/media/dot-media/programs/aeronautics/documents/2020-casp-preliminary-draftdor110620.pdf

CalTrans California Transportation Plan: Discusses the CalTrans vision and goals for 2050 with the plan for achieving them. Additionally, it calls out the integration of other planning agencies, trends, and demographics associated with the state of California. The plan calls out GHG emissions reduction and the exploration of future scenarios. It proposes forward thinking with improvements to mobility, advancements in zero-emissions vehicles, technology, and supportive infrastructure, as well as autonomous vehicles.[74]

CalTrans California Freight Mobility Plan: Discusses future freight system scenarios, smart growth, and urban freight considerations, as well as projects with Zero Emission Vehicle infrastructure.[75]

CalTrans Interregional Transportation Strategic Plan: In alignment with other transportation plans, this plan provides an interregional travel policy framework related to guiding Caltrans and partner agencies during the development of comprehensive, multimodal corridor plans that lead to the identification of transformative, innovative, and cost-effective projects.[76]

San Diego County Transportation Plans:

SANDAG 2021 Regional Plan: Provides a blueprint to equip the San Diego region with a transformative transportation system, a sustainable pattern of growth and development, and innovative demand and management strategies.[77]

SANDAG Central Mobility Hub (CMH) and Connections Comprehensive Multimodal Corridor Plan: This plan builds on previous and current regional and local efforts to create a comprehensive strategy that sets a foundation for enhancing multimodal connectivity and accessibility across communities within the CMH and Connection Corridor.[78]

2.6 Infrastructure Connectivity

In addition to transportation connectivity, the infrastructure utilized by AAM will need to be developed or altered to support new or increasing electrical, landing area, and airspace requirements. The following guiding questions should be considered throughout the planning, design, and implementation phases:

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[74] CalTrans California Transportation Plan. (2021). **https://dot.ca.gov/-/media/dot-media/programs/transportation-planning/documents/ctp-2050-v3-a11y.pdf**

[75] › CalTrans California Freight Mobility Plan. (2023). **https://dot.ca.gov/-/media/dot-media/programs/transportation-planning/documents/cfmpjuly2023finala11y.pdf**

[76] › CalTrans Interregional Transportation Strategic Plan. (2021). **https://dot.ca.gov/-/media/dot-media/programs/transportation-planning/documents/system-planning/systemplanning/2021-itsp-oct21-a11y.pdf**

[77] › SANDAG 2021 Regional Plan. (2021). **https://www.sandag.org/regional-plan/2021-regional-plan/final-2021-regional-plan**

[78] SANDAG Central Mobility Hub and Connections Comprehensive Multimodal Corridor Plan. (Draft, 2023). **https://s3-us-west-2.amazonaws.com/mysocialpinpoint/uploads/redactor_assets/documents/c3a4516d090f2aa5d38d4e21da8c0c6cbf4da26677379ef58852894a58837930/77905/Draft_CMH_CMCP.pdf**

- What type of infrastructure will the vertiport be on?
- Will the infrastructure still support the needs of the community if a vertiport were here?
- Will the electric supply be able to support vehicle charging and facilities without impacting public access?
- What methods could be used to add additional power to the vertiport facility?
- How much power does the vertiport facility need today? What about in the future?
- How will energy be stored, and will there be enough to support emergencies?
- How can the infrastructure be strengthened to withstand natural disasters likely to increase from climate effects and earthquakes?

Broadband Infrastructure

Broadband Infrastructure, consisting of fiber optic connected networks and wireless access points, enables Smart City infrastructure and operations, including connected and autonomous vehicles (CAV), Internet of Things (IoT) environmental sensors, Intelligent Transportation Systems (ITS), and connectivity to the internet. Modern municipal and government operations are increasingly reliant on uninterrupted high-speed internet access for all aspects of public services, including traffic planning operations, street lighting and public safety, solid waste collection, public transit operations, and digital plan review and permitting.

Access to high-speed internet services is critical for businesses, homes, and future AAM operations. Like surface-based CAV systems (which generate terabytes of data per second), AAM is anticipated to generate tremendous amounts of data that must be collected, analyzed, and stored. Data will include flight performance metrics, localized microclimate and weather conditions, and other relevant key performance indicators. Vertiports, AAM operators, and regulatory agencies operating within the National Airspace (NAS) rely on broadband for seamless communications and to monitor safety, flight operations, and weather conditions.

Like many states, California is building out its middle-mile fiber network, which will provide high-speed internet connectivity to underserved communities, including rural areas. Improved broadband connectivity, including associated wireless access points, will benefit vertiports in rural and tribal areas, enabling real-time data collection and monitoring of AAM operations. Improved broadband connectivity will also benefit residents who lack access to high-speed internet (also known as the “digital divide”), which is increasingly necessary to fully and equitably participate in the modern economy and society.

Electrical Supply and Demand

The electrical demand to charge several eVTOLs must be accommodated by the existing grid or supplemented by other means of energy production and storage.

To allow enough time to integrate alternative or supplemental energy, an analysis of the electrical load capacity and planned electric demand should be conducted in the planning phases. The analysis of the grid's capabilities should also consider resiliency, growth, and more diverse operations in the future. Existing energy demand analyses and strategies included in this section may support the development of a load analysis. For on-airport planned vertiports, proponents should work closely with the airport to ensure adequate electrical supply can be accommodated. Planning documents such as the AMP (see Section 2.5: AAM Integration) may include future utility loads and activity forecasting for reference. Coordination with utility companies and interested local departments should also be initiated at this stage.

Supplemental electricity sources, energy storage, or microgrids should be developed in the design phase to meet energy capacity and resiliency needs, considering that a loss of power could greatly disrupt operations or lead to safety hazards. An Energy Management Plan or Energy Master Plan may be created to routinely monitor, assess, and improve on energy usage and green energy sources.

Implementation of AAM will include the construction of alternate energy infrastructure and compliance with safety measures and standards.

Electrical Supply and Demand Planning Resources:

- ***SANDAG Regional Energy Strategy***: The Regional Energy Strategy serves as a policy guide to support decision-making by SANDAG and member agencies to meet the energy needs for the growing population while maintaining and enhancing quality of life and economic stability.[79]
- ***California Energy Commission Integrated Energy Policy Report:*** This biennial report (last updated in 2023) forecasts the energy demand in the state of California, updates key issues, and strategically plans for green energy expansion.[80]
- ***National Renewable Energy Laboratory FAA Vertiport Electrical Infrastructure Study***: Contains analyses, considerations, and lessons learned concerning the electrification of a vertiport site, including estimating electrical demand, site selection, safety analysis, and other impacts to consider.[81]
- ***ACRP Report 236, Preparing Your Airport for Electric Aircraft and Hydrogen Technologies***: Provides an introduction to electric aircraft, a market assessment, a discussion of federal and state policies, and a description of potential airport impacts, and facility needs to accommodate electric aircraft.[82]

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[79] SANDAG Regional Energy Strategy. (2014). **https://www.sandag.org/-/media/SANDAG/Documents/PDF/projects-and-programs/environment/regional-energy-planning/regional-energy-strategy-2014-06-01.pdf**

[80] California Energy Commission Integrated Energy Policy Report. (2023). https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report

[81] National Renewable Energy Laboratory FAA Vertiport Electrical Infrastructure Study. (2023). **https://www.nrel.gov/docs/fy24osti/86245.pdf**

[82] ACRP Report 236, Preparing Your Airport for Electric Aircraft and Hydrogen Technologies. (2022). **https://nap.nationalacademies.org/catalog/26512/preparing-your-airport-for-electric-aircraft-and-hydrogen-technologies**

Energy Star Guidelines for Energy Management: This document is intended to provide additional information and guidance to the ENERGY STAR Guidelines for Energy Management to assist organizations in improving their energy and financial performance while distinguishing the organization as an environmental leader.[83]

Electrical Supply and Demand Safety and Implementation Resources:

IEEE 519-2014, IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems: The grid impact of high-wattage charging stations needs to be considered when designing and adopting charging stations. This standard guides the design and compliance of power systems with nonlinear loads.[84]

IEEE 1826-2020, IEEE Standard for Power Electronics Open System Interfaces in Zonal Electrical Distribution Systems Rated Above 100 kW: This standard defines how openness of system should be verified and validated through rigorous assessment mechanisms, interface control management, and proactive conformance testing to enable plug-and-play operability independently of the components' origin.[85]

2021 International Fire Code: Contains regulations to safeguard life and property from fires and explosion hazards. Topics include general precautions, emergency planning and preparedness, fire department access and water supplies, automatic sprinkler systems, fire alarm systems, special hazards, and the storage and use of hazardous materials.[86]

NFPA 110, Standard for Emergency and Standby Power Systems: To ensure the continuity of electric aircraft operations, an uninterrupted power supply is needed, thus creating a need for guidelines on emergency and backup power supply systems. [87]

NFPA 70, National Energy Code (NEC) Article 706 - Energy Storage Systems: This article applies to all energy storage systems (ESS) having a capacity greater than 3.6 MJ (1 kWh) that may be standalone or interactive with other electric power production sources. These systems are primarily intended to store and provide energy during normal operating conditions. It is a part of the National Electrical Code, the benchmark for safe electrical design, installation,

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[83] Energy Star Guidelines for Energy Management. (2021). https://www.energystar.gov/buildings/tools-and-resources/energy-star-guidelines-energy-management

[84] IEEE 519-2014, IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems. https://standards.ieee.org/standard/519-2014.html

[85] IEEE 1826-2020, IEEE Standard for Power Electronics Open System Interfaces in Zonal Electrical Distribution Systems Rated Above 100 kW. https://ieeexplore.ieee.org/document/9271958

[86] 2021 International Fire Code. https://codes.iccsafe.org/content/IFC2021P1

[87] NFPA 110, Standard for Emergency and Standby Power Systems. https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=110

and inspection to protect people and property from electrical hazards, enforced in all 50 US states.[88]

NFPA 855, Standard for the Installation of Stationary Energy Storage Systems: Covers the minimum NFPA standards established for design, installation, and maintenance of a stationary energy storage system, including battery storage systems.[89]

NFPA 70, NEC Article 625 - Electric Vehicle Charging System: Covers the electrical conductors and equipment external to an electric vehicle that connect an electric vehicle to a supply of electricity by conductive or inductive means and the installation of equipment and devices related to electric vehicle charging. It also addresses scenarios that would allow the use of load-balancing functions on electrical supply systems.[90]

NFPA 418, Standard for Heliports and Vertiports: Establishes fire safety requirements, including access points, egress routes, fixed fire protection systems, aircraft refueling equipment, rooftop hangars, portable fire extinguishers, fire alarm systems, electric aircraft safety precautions, and more.[91]

Navigational Aids and Flight Support Infrastructure

Initial AAM operations may utilize existing infrastructure and resources for navigational or other flight support infrastructure by leveraging existing NAS, Air Traffic Service (ATS), flight equipment, and support entities. In the midterm, with updated regulatory framework and procedures, AAM will rely on infrastructure and support services for flight support, navigation, and weather-related information, some of which may be located off-site from the airport or vertiport. The onset of remotely piloted and autonomous AAM flight in future mature stages will likely require alternative or additional flight support equipment.

Planning will involve the identification of AAM operators, PSUs, SDSPs, and other actors that will be involved in traffic management in the NAS. AAM stakeholders should review the existing regulatory framework to determine what equipment and service providers will be needed to fulfill requirements and enhance situational awareness. The types of approaches into the vertiport should be determined, considering the types of operations the vertiport intends to accommodate.

The design of vertiports, routes, and placement of navigational aids and flight support equipment will need to comply with the latest regulatory standards and consider the operation type, O&D vertiports or vertistops, and operating climate. Designs should be modular and redundant to accommodate for future aircraft and emergency situations.

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[88] NFPA 70, Article 706 - Energy Storage Systems. **https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=70**

[89] NFPA 855, Standard for the Installation of Stationary Energy Storage Systems. **https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=855**

[90] NFPA 70, NEC Article 625 - Electric Vehicle Charging System. **https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=70**

[91] NFPA 418, Standard for Heliports and Vertiports. **https://submittalsarchive.nfpa.org/TerraViewWeb/ViewerPage.jsp?id=418-2021.ditamap&pubStatus=FDR**

For implementation, flight operations procedures should be developed and reviewed by responsible parties. Procedures for data exchange, services, and other details should be created in coordination between AAM operators and support entities like PSUs, the FAA, and public safety officials. In the future, AAM communications systems related to navigation aids may be integrated into traffic incident management protocols to provide faster and more efficient response times.

Navigational Aids and Flight Support Resources:

Urban Air Mobility Concept of Operations (ConOps): This living document describes operations with an onboard PIC operating within the cooperative environment. It also explains airspace and operational concepts, including corridors, operational intent, providers of service, and supplemental data service providers.[92]

Unmanned Aircraft System Traffic Management ConOps v.2: Created for UAS concepts but often applicable to AAM, this document describes the essential conceptual and operational elements associated with UAS Traffic Management (UTM) operations that will serve to inform the development of solutions across the many actors and stakeholders involved in implementing UTM.[93]

FAA AC 150/5390-2D Heliport Design: Standards and regulations for heliport design. Not specific for VTOL aircraft, but referenced as interim guidance for many design elements. Chapter 6. Instrument Operations provides standards for instrument approach procedures and guidance for instrument approach equipment.[94]

ASTM F3548-21, Standard Specification for UAS Traffic Management (UTM) UAS Service Supplier Interoperability: This specification addresses the performance and interoperability requirements, including associated application programming interfaces (APIs), for a set of UTM roles performed by UAS Service Suppliers (USSs) in support of UAS operations.[95]

FAA AC 150/5220-16E, Automated Weather Observing Systems (AWOS) for Non-Federal Applications: Contains site location and implementation criteria that must be met before the installed system can be commissioned and become an approved source of aviation weather information and maintenance and annual inspection criteria for anyone proposing to design,

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[92] FAA. 2023. Urban Air Mobility Concept of Operations Version 2. https://www.faa.gov/sites/faa.gov/files/Urban%20Air%20Mobility%20%28UAM%29%20Concept%20of%20Operations%202.0_0.pdf

[93] Concept of Operations v2.0 Unmanned Aircraft System Traffic Management Traffic Management. 2023. https://www.faa.gov/sites/faa.gov/files/2022-08/UTM_ConOps_v2.pdf

[94] FAA AC 150/5390-2D Heliport Design. (2023). https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_150_5390_2D_Heliports.pdf

[95] Standard Specification For UAS Traffic Management (UTM) UAS Service Supplier (USS) Interoperability. https://webstore.ansi.org/standards/astm/astmf354821

manufacture, procure, install, activate or maintain non-Federal AWOS for aviation purposes.[96]

FAA Order 6560.20, Sitting Criteria for Automated Weather Observing Systems[97]

FAA Order 8260.3F, United States Standard for Terminal Instrument Procedures (TERPS): Prescribes standardized methods for designing and evaluating instrument flight procedures (IFPs), predicated on normal aircraft operations and performance, to be used by all personnel responsible for the preparation, approval, and promulgation of IFPs.[98]

Emergency Services

Some planning, design, and implementation exercises may differ for emergency services. Emergency services may include permanent facilities for medical, law enforcement, fire rescue, or other public services, or the designation of temporary vertiports for disaster response.

In the planning stages, it should be determined if the vertiport meets the criteria for emergency services that may qualify it for special exemptions or trigger additional processes for local, state, and federal compliance.

In the design stage, the applicable federal, state, and local requirements are incorporated into the designs.

In implementation, the applicable permits should be prepared to ensure the vertiport may operate for emergency services and have priority when needed.

Emergency Services Resources:

FAA AC 150/5390-2D Heliport Design, Appendix A. Emergency Helicopter Landing Facilities (EHLF): Guide for preplanning and developing emergency landing areas that comprise rooftop emergency facilities and medical emergency sites and are not for routine helicopter operations.[99]

California PUC Article 3 Section 21662.4, Emergency Flights for Medical Purposes: Defines emergency flights and exemptions for law enforcement, firefighting, military, or other persons who provide emergency flights for medical purposes from local ordinances adopted by a city, county, or city and county, whether general law or chartered, that restrict flight departures and arrivals to particular hours of the day or night, that restrict the departure or

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[96] FAA AC 150/5220-16E, Automated Weather Observing Systems (AWOS) for Non-Federal Applications. (2017). https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_150_5220-16E_w-chg1.pdf

[97] › FAA Order 6560.20, Sitting Criteria for Automated Weather Observing Systems. https://www.faa.gov/regulations_policies/orders_notices/index.cfm/go/document.information/documentID/1029667

[98] FAA Order 8260.3F, United States Standard for Terminal Instrument Procedures (TERPS). 2023. https://www.faa.gov/documentLibrary/media/Order/Order_8260.3F.pdf

[99] FAA AC 150/5390-2D Heliport Design. (2023). https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_150_5390_2D_Heliports.pdf

arrival of aircraft based upon the aircraft's noise level, or that restrict the operation of certain types of aircraft. [100]

Unmanned Aircraft System Traffic Management ConOps v.2: Describes the concept of UAS Volume Reservations (UVRs) to clear airspace for priority operations and a case study on the use of UVRs in a medical emergency (Scenario V2-2).[101]

NASA Electric Vertical Takeoff and Landing Aircraft Technology for Public Services – A White Paper: Presents case studies and concepts for AAM in emergency and public services with benefits, opportunities, challenges, and future efforts needed to realize the concepts.[102]

2.7 Case Study Example

Introduction

The purpose of this case study example is to outline the regulatory process necessary to permit a vertiport in San Diego. This process includes regulatory review and approval by local, state, and federal government agencies. Brown Field Municipal Airport, owned and operated by the City of San Diego, was selected for this exercise. Brown Field Municipal is classified by the FAA as a reliever airport for San Diego International Airport and serves general aviation aircraft that might otherwise use a congested air carrier airport.[103] The types of general aviation aircraft that operate at Brown Field Municipal include private, corporate, charter, air ambulance, law enforcement, fire rescue, flight training, cargo, skydiving, banner towing, and airships.

Local Codes, Planning, and Zoning for the City of San Diego

The following information outlines the permitting and development process for Heliports (and presumably vertiports) within the City of San Diego city limits per the San Diego Municipal Code.

Article 8: Airports, Division 2: San Diego Helicopter Rules and Regulations of the San Diego Municipal Code provides the definition of heliport and associated activities, as well as the process to apply for license and regulations for operations.[104]

Once a location has been selected, determine the site's zoning. Heliport landing facilities are permitted within the following zoning districts:

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[100] California Public Utilities Code Section 21001 et seq. relating to the State Aeronautics Act. (2019). https://dot.ca.gov/-/media/dot-media/programs/aeronautics/documents/puc_ssa_r3_2019.pdf

[101] Concept of Operations v2.0 Unmanned Aircraft System Traffic Management Traffic Management. 2023. https://www.faa.gov/sites/faa.gov/files/2022-08/UTM_ConOps_v2.pdf

[102] NASA Electric Vertical Takeoff and Landing (eVTOL) Aircraft Technology for Public Services – A White Paper. https://ntrs.nasa.gov/api/citations/20205000636/downloads/2021-08-20-eVTOL-White-Paper-Final_V48.pdf

[103] https://www.sandiego.gov/airports/brown

[104] Article 8: Airports, Division 2: San Diego Helicopter Rules and Regulations https://docs.sandiego.gov/municode/MuniCodeChapter06/Ch06Art08Division02.pdf

- Open Space Base Zone – OF (Open Space-Floodplain) Zones with a Conditional Use Permit but not allowed in a Coastal Overlay Zone (regulations apply from chapter 14 article 1) Art 01 Div 02
- Agriculture Base Zone – AR (Agricultural Residential) with a Conditional Use Permit Art 01 Div 03
- Commercial Base Zone – CR (Commercial-Regional), CO (Commercial-Office), CV (Commercial-Visitor) with a Conditional Use Permit but not allowed in a Coastal Overlay Zone, CC (Commercial-Community) Art 01 Div 05
- Industrial Base Zone – IP (Industrial-Park), IL (Industrial-Light), IH (Industrial-Heavy), IS (Industrial-Small Scale), and IBT (Industrial-Business and Trade) with a Conditional Use Permit Art 01 Div 06
- Mixed-Use Base Zone – Employment Mixed-Use (EMX) with a Conditional Use Permit Art 01 Div 07
- Sensitive Coastal Overlay Zone - See the environmentally sensitive lands regulations in Section 143.0110, required permit/decision process Section 143.0110 Art 02 Div 06
- Transit Area Overlay Zone - See the parking regulations in Section 142.0530, no permit required Art 02 Div 10
- Urban Village Overlay Zone - See Sections 132.1103-132.1110, Site Development Permit/ Process Three Art 02 Div 11
- Mission Trails Design District - Refer to the Mission Trails Design District Design Manual, Site Development Permit/ Process Three Art 02 Div 12
- Clairemont Mesa Height Limit Overlay Zone - See Sections 132.1305-132.1306 Site Development Permit/ Process Five Art 02 Div 13
- Community Plan Implementation Overlay Zone - Refer to the applicable community plan, Site Development Permit/ Process Three Art 02 Div 14
- Airport Land Use Compatibility Overlay Zone - Neighborhood Development Permit/ Process Two or Site Development Permit/ Process Three or Process Five Art 02 Div 15

Sites located within the Airport Land Use Compatibility Overlay Zone are designated as either Review Area 1 or Review Area 2. For the purposes of this Case Study, it is assumed the vertiport location is within the Brown Field Municipal Airport's property boundary and is thus categorized as Review Area 1.

The city classifies Heliports as one of the following:

- Class I Private, Class II Public (small) that of which accommodates helicopters up to 6,000 lbs. gross weight, or Class II Public (large) that of which accommodates helicopters in excess of 6,000 lbs.
- Three subclasses – Subclass A minimum support facility w/ no building, maintenance, or fueling, Subclass B limited supports facility w/ no fuel and no maintenance, Subclass C complete supports facilities including maintenance and fueling.

Annual license fees are paid to the city:

$100.00 for a permanent public heliport

-$10.00 for a temporary public heliport with a duration of more than 10 days, $5.00 for a duration of less than 10 days

$10.00 for a private heliport

Every application to construct and/or operate a permanent heliport must be submitted in writing to the City Manager and include the following:

Name and address of applicant

Copy of completed application to the California Department of Aeronautics for State approval

Copy of completed application to FAA for approval, for the first application in each calendar year, a certificate of insurance, providing a public liability and property damage consistent with the requirements of the California Public Utility Commission for helicopter operations

A Conditional Use Permit issued by the City Planning Commission in accordance with the provisions of the Municipal Code, Chapter 10, Article 1, Division 5.

The following conditions must be met before receiving a license to operate:

Takeoff and landing area must be enclosed by a fence or barrier not less than 3'.

Touchdown area must be in the center of the takeoff and landing area.

Obstruction clearance surface shall be as required by the FAA.

Each takeoff and landing area shall have two obstruction clearance surfaces at least 90 degrees apart, one of which is into the prevailing wind.

Wind indicating device(s) shall be provided and always maintained.

Takeoff and landing areas be provided with adequate lighting if used for night or all-weather operations.

The landing area shall be marked per FAA requirements.

Surfacing of the landing facility shall be such as to minimize the blowing of any dust, dirt, or other objectionable material onto neighboring property.

Hours of operation are limited to the periods between sunup and sundown daily unless properly lighted and specifically approved for night operation.

The Planning Commission may impose additional conditions as they see fit for public health and safety, requiring a Conditional Use Permit.

Adequate portable fire extinguishers shall be provided as determined by the City Fire Marshal.

Before denying, suspending, or revoking a license issued pursuant to this division, the City Manager shall call a hearing as provided in this division. Prior to hearing, the City Manager shall cause a written notice of hearing specifying the time and place of hearing and the reason for such suspension or revocation to be served personally or by mail upon the license holder. At the conclusion of the hearing, the City Manager shall make an order. Such an order can (a) dismiss the charges; (b) suspend or revoke the license, or (c) affix such other conditional and probationary orders as may be proper for the enforcement of this article.

Airport Land Use Compatibility

For this exercise, the Brown Field Municipal Airport Land Use Compatibility Plan was studied, and the review process is outlined below.

The Brown Field Municipal Airport Land Use Compatibility Plan was written and adopted to ensure compatibility between the airport and the surrounding land uses. The plan aims to allow for the growth of the airport and surrounding areas while safeguarding the surrounding public. The Compatibility Plan's jurisdiction aligns with the Airport's Influence Area (AIA). The responsibility to follow the Compatibility Plan falls on the Airport Land Use Commission (ALUC). In San Diego County, the ALUC's function rests with the Board of the San Diego County Regional Airport Authority (SDCRAA).

The type of ALUC review for the development of a heliport is dependent on the site location, either within the AIA or on the airport property itself.

Heliports within the AIA

All proposed heliports within the Brown Field Municipal AIA must be reviewed by the ALUC for consistency with the Compatibility Plan before local agency approval. ALUC review can be done before, after, or concurrently with the local agency review, as long as the review is completed before the local agency's final action.

The following items must be included in the application package:

- Property location information.
- Location map showing the distance between the proposed project and the airport (max size 24x36 inches).
- A description of the existing use, including current general plan and zoning designations, height of structures, maximum intensity limits, floor area ratio, and other applicable information.
- A description of the proposed use and the type of land use action being sought from the local agency.
- Site plan showing ground elevation, location of structures, open space, and water bodies as well as the mean sea level and above ground level elevations of structure and treetops.
- Identification of any features that would increase the attraction of birds or cause other wildlife hazards to aircraft operations on the Airport or in its environment.
- Identification of any characteristics that could create electrical interference, confusing or bright lights, glare, smoke, or other electrical or visual hazards to aircraft flight.
- Any draft or final environmental document (initial study, negative declaration, mitigated negative declaration, environmental assessment, environmental impact statement, or environmental impact report) that has been prepared for the project.
- Any staff reports regarding the project that may have been presented to local agency decision-makers.

Any project submittal information and final airspace determination that has been obtained from the FAA in accordance with Part 77.

Review fee.

ALUC will review for consistency with the Compatibility Plan. If a project is deemed conditionally consistent with the Compatibility Plan, ALUC will lay out a list of required conditions and/or modification requirements for the proposed project.

ALUC may require public noticing and consider public input before determining final action on a proposed project. If the project scope changes substantially during the local agency review, the project must be resubmitted for ALUC consistency determination.

ALUC has 60 days to review proposed projects with complete applications. The review cycle will not start until an application is deemed complete and includes all the necessary information. ALUC has 30 calendar days for completeness review.

Airport Expansion Review

ALUC review is also required in cases where the Airport Master Plan is being modified or if an airport expansion is proposed. Airport expansion is defined to include the construction of a new runway, the extension or realignment of an existing runway, and the acquisition of runway protection zones or the acquisition of any interest in land for the purposes identified above.

ALUC's review for an airport expansion project will assess noise, safety, airspace protection, and overflight impacts of airport activity to surrounding properties along with compatibility with the Airport Master Plan. ALUC has 60 days to review the proposed project.

Submittals must include the following:

Site plan showing the property boundaries, helicopter takeoff and landing areas, helipad protection zones, and helicopter approach/departure flight routes.

A map of the proposed airspace surfaces as defined by Part 77, if the proposal would result in changes to these surfaces.

Activity forecasts, including the number of operations by each type of aircraft proposed to use the facility, the percentage of day versus night operations, and the distribution of takeoffs and landings.

Existing and proposed flight track locations, current and projected noise contours, and other supplementary noise impact data that may be relevant.

An exhibit showing existing and planned land uses in the areas affected by aircraft activity associated with the implementation of the proposed project.

Environmental report (initial study, negative declaration, mitigated negative declaration, environmental assessment, draft environmental impact report, draft environmental impact statement, etc.).

Identification and proposed mitigation of impacts on surrounding land uses.

Review fee.

Vertiport Permitting

In addition to the City of San Diego permitting process described in **Article 8: Airports, Division 2: San Diego Helicopter Rules and Regulations** of the San Diego Municipal Code, applicants must complete the following:

FAA Approval

The FAA requires public and private airports and heliports to submit a FAA Form 7480-1, *Notice for Construction, Alteration and Deactivation of Airports,* with the goal of receiving a permit determination.

The FAA states that the following types of projects require the submittal of an FAA Form 7480-1:

1. Construct or otherwise establish a new airport or activate an airport.
2. Construct, alter, realign, or activate any runway or other aircraft landing or takeoff area of an airport.
3. Construct, alter, realign, or activate a taxiway associated with a landing or takeoff area on a public-use airport.
4. Deactivate, discontinue using, or abandon an airport or any landing or takeoff area of an airport for a period of one year or more.
5. Deactivate, abandon, or discontinue using a taxiway associated with a landing or takeoff area on a public-use airport.
6. Change the status of an airport from private use (use by the owner or use by the owner and other person authorized by the owner) to an airport open to the public of from public-use to another status.
7. Change status from IFR (Instrument Flight Rules) to VFR or from VFR to IFR.
8. Establish or change any traffic pattern or traffic pattern altitude, or direction. (FAA Form 7480-1, Notice for Construction, Alteration, and Deactivation of Airports)

The proposed heliport/vertiport would be considered as the construction of a new private helipad (identified in criteria #1 above) and must undergo the FAA permit filing process.

The following process will need to be completed:

1. Develop Supporting Documentation for FAA Form 7480-1 – Develop the supporting documentation, including the FAA 7480-1 form, figures, and site plan to submit to the FAA for review.
2. File FAA Form 7480-1 with the FAA – Upon review and approval from the Owner, submit the FAA Form 7480-1 submittal package to the FAA for review via an online application.
3. FAA Review of Form 7480-1 – FAA review of the Form 7480-1 package is estimated to take approximately 30 working days, although review times may vary based on FAA workload. FAA review consists of a site plan/preliminary design review, as well as a detailed airspace review. Typically, the FAA performs a site visit with the Project Team to discuss any potential hazards and to see the preliminary site location. Due to extenuating circumstances from COVID-

19, the FAA is not performing initial site visits at this time. The FAA staff will perform a “desk review” of the proposed landing area and design parameters. A site visit will be performed at the closeout of the project.

4. FAA to Issue Final Permit Determination – After thorough review of the FAA Form 7480-1 submittal package, the FAA will issue a Notice of Heliport Airspace Analysis Determination, Establish Private Use Heliport, **Conditional No Objection** for the project site. The determination will outline criteria that will need to be met for the helipad to be registered with the FAA for operation post-construction.

There is no fee associated with this permit process.

CEQA Review

The project would require discretionary governmental approval and is, therefore, subject to CEQA. The CEQA process begins with coordination between the project sponsor and agencies to share information about the project and identify the appropriate course of action to comply with CEQA and determine the appropriate compliance steps. Typically, an Initial Study is conducted to assess potential impacts, including a Noise Study that compares projected aircraft noise to ambient levels. Other required documents include radius maps, vicinity maps, photos, and plot plans. The Initial Study, which includes the results of the technical studies performed to identify environmental resources and potential impacts, is sent to the Planner/Community Development department, which has 30 days to review the application or request more information.

If no significant impacts are found, the process proceeds with a Negative Declaration (ND) or Mitigated Negative Declaration (MND). The ND shows no significant impacts, while the MND indicates impacts can be mitigated. A Notice of Intent (NOI) initiates a 20 to 30-day public review, after which comments are addressed, and the ND or MND is finalized, leading to a Notice of Determination (NOD) with the County Clerk and State Clearinghouse, enabling project approval. The State Clearinghouse (SCH) is a division within the Governor's Office of Planning and Research (OPR) in California. It serves a critical role in the CEQA process by acting as the central point for the distribution and review of environmental documents.

If significant impacts are identified, a Draft Environmental Impact Report (DEIR) is prepared, followed by a Notice of Availability (NOA) for a 45-day public review. Comments are addressed in a Final EIR (FEIR), after which the agency certifies the FEIR, adopts mitigation measures, and files an NOD, completing the process and ensuring CEQA compliance through thorough impact evaluation and mitigation.

State Approval

Heliports are required to be reviewed and approved at the State level by the California Department of Transportation (Caltrans), Office of Airports.

The following items are required for permit approval:

1. Two copies of scaled drawings of the airport and adjoining areas, which include heliport design standards.
2. Topographic map that shows the location of the approach surfaces relative to the heliport.

3. Local area map or drawing depicting the heliport and the location of schools, places of public gathering, and residential areas within 1,000 feet of the center of a proposed FATO.
4. Pursuant to PUC 21661.5, documentation of approval of the plan for construction by either the Board of Supervisors of the county or the City Council of the city (as appropriate) in which the heliport is to be located. Note that PUC 21661.5(b) allows delegation of this responsibility to the county or city planning agency, if properly delegated.
5. Documentation of action by the Airport Land Use Commission of the county in which the heliport is to be located.
6. Documentation of compliance with the California Environmental Quality Act
7. Documentation showing ownership of the heliport. The owner is the person with the authority to possess the facility, either as the outright legal owner or through a lease of at least one year. Grant Deeds, Tax Bills, and Lease Documents are examples of potentially suitable proof of ownership documents. Submissions should also include a plat map showing the location of the parcel(s).
8. FAA Airspace Determination regarding the heliport. The proponent must complete and submit FAA Form 7480-1, Notice of Landing Area Proposal, to the FAA.
9. Items that the Department considers prior to heliport permit issuance:
10. The site meets or exceeds the minimum heliport standards specified by the Department in its rules and regulations (the Department may modify its minimum heliport standards if satisfied that the heliport will conform to minimum standards of safety)
11. Safe air traffic patterns have been established for the proposed heliport and all existing airports/heliports and approved airport/heliport sites in its vicinity.
12. Safe "zones of approach" for the heliport have been engineered in conformity with the provisions of PUC 21403 (compliance with FAR Part 77).
13. The advantages to the public in selection of the site of a proposed new heliport (or heliport expansion) outweigh the disadvantages to the environment. Environmental considerations include but are not limited to noise, air pollution, and the burden upon the surrounding area caused by the heliport (or heliport expansion), including but not limited to, surface traffic and expense.

3 | Case Studies and Analysis

Introduction

The primary objective of the case study was to explore the feasibility and practicality of integrating AAM infrastructure in the San Diego region, with an emphasis on air taxi, cargo, and medivac use cases. Rather than recommending specific sites, this case study and the analysis aim to provide a replicable assessment methodology for AAM infrastructure site selection, informing planners and regional authorities of a structured approach to evaluating potential locations based on available data, for example, socioeconomics, transportation, and land use.

This case study aimed to create a comprehensive methodology by leveraging the unique requirements of air taxi, cargo, and medivac use cases. The main reason for considering these three use cases was that each use case brings specific operational requirements and, specifically, transportation or socio-economic considerations. By leveraging these case studies, the analysis aims to provide a potential assessment methodology that can be used to determine selection criteria that account for factors such as proximity to urban and logistical centers, airspace, transportation nodes, airspace restrictions, and connectivity for site selection for AAM infrastructure.

Methodology

The methodology employed for developing the case study analysis and assessing potential sites relied on a data-driven approach, using Smart Atlas, a geospatial analysis tool. In Smart Atlas, all relevant data layers were integrated to provide a multi-layered perspective to evaluate each location's suitability for its respective use cases. The core aim of this approach was to systematically identify sites that align with operational needs while ensuring equitable and efficient integration into the San Diego region.

The methodology involved sequential steps, beginning with identifying specific use cases and progressing through detailed assessments of data layers specific to each use case and site-specific justification. Each step was meticulously designed to ensure that the selected sites were operationally viable, logistically feasible, and could potentially support the communities they would serve.

The first step in developing the methodology for assessing potential sites for AAM infrastructure was to determine which data needs to be considered, and to be integrated with the Smart Atlas tool. Each data layer played a critical role in evaluating the feasibility and viability of AAM infrastructure for each use case. After careful review of available data, a total of 30 data layers were identified and included in the analysis. The data layers below provide an overview of the type of data that was considered in the analysis. The complete list of all the data layers is provided in Appendix B.

- **Zoning and Land Use**: This layer provided insights into local land use regulations, including zoning restrictions and classifications. Zoning data was used to eliminate locations that were incompatible with the intended AAM operations, such as residential areas, while identifying commercial and industrial zones suitable for air taxis or cargo infrastructure development.

- **Airports and Heliports**: Existing aviation infrastructure was mapped to assess potential origin points for AAM operations. General aviation airports and heliports offered pre-existing infrastructure that could be leveraged to establish hubs for operations like air taxis or medivac services.
- **Airspace Constraints**: This layer outlined restricted, controlled, or congested airspace, ensuring selected sites complied with Federal Aviation Administration (FAA) airspace regulations. Avoiding restricted zones minimized the risk of operational disruptions and enhanced safety.
- **Justice40 Data**: Socioeconomic data was incorporated to assess the potential impact on disadvantaged communities. This layer supported equitable site selection, ensuring AAM operations would not disproportionately burden vulnerable populations while maximizing access to underserved regions.

Step 1: Identification of Use Case

The first step in the process was identifying and defining the specific use case for which sites would be selected. This provided a clear framework for subsequent steps, ensuring that data collection and analysis were relevant and targeted. The defined use cases included:

- **Air Taxis**: Prioritized passenger accessibility, focusing on urban centers, downtown districts, or areas with significant commercial activity to maximize demand and connectivity with existing transportation systems.
- **Cargo Delivery**: Focused on industrial zones, warehouses, and distribution centers to streamline logistics and minimize transit times between hubs and delivery points.
- **Medivac Services**: Required proximity to hospitals and healthcare facilities to facilitate rapid response times and efficient integration with emergency services.

Step 2: Applying Smart Atlas Layers

Smart Atlas was used to integrate and prioritize data layers relevant to each use case, ensuring a focused and efficient analysis. For example, sites to support air taxi missions will require access points near urban/suburban centers to downtown or to major transportation nodes (e.g., airports) to maximize accessibility and multimodal integration for commuters and travelers. Second, the cargo use case necessitates close integration with logistical hubs and warehouses, and the medivac use case demands locations with relatively quick access to hospitals and emergency facilities.

1. **Establishing Relevant Data Layers**: Each use case required specific data layers to guide site evaluation. For example:
    - Air taxis emphasized commercial zoning, population density, and proximity to transportation hubs.
    - Cargo delivery relied on industrial zoning, proximity to warehouses, and accessibility.
    - Medivac services required data on hospital locations, traffic patterns, and rapid response routes.

2. **Setting up Parameters for Each Use Case**:

   - Each use case was assigned specific data layers to reflect that each use case will require different data considerations from a planning perspective. A complete list of layers that were considered for each use is provided in Table 4 below.

Table 4

Cargo	Medivac	Air Taxi
National security UAS flight restrictions	Heliport – Hospital	Transit priority area
Land use – Warehousing	30-minute drone and drive time analysis	Mobility and flexible fleets
Zoning codes – Commercial, industrial, and mixed	Zoning codes – Commercial, industrial, and mixed	Heliport
Commercial airport	2035 network volumes	California rail network
Airspace class	Airspace class	Airspace class
Noise contours	California Justice40	Noise contour
California rail network		Zoning codes – Industrial, commercial, and mixed
Ports		San Diego VMT maps
California Justice40		California Justice40

   - After establishing the data layers for each use, a one-time qualitative analysis was conducted to determine the priority level of each data layer for its respective use case when planning for an AAM infrastructure site. The priority levels were set for low, medium, and high. The reader should note that the assignment of the priority levels was based on educated assumptions, based on available information about factors that can influence AAM infrastructure site selection.
   - The purpose of this prioritization was to make recommendations as a part of the implementation strategy based on available data and establish pros and cons, trade-offs of this methodology.

Step 3: Determine Origin and Destination Points

Using Smart Atlas, origin and destination points were identified based on the specific requirements of each use case. The analysis combined data-driven insights with qualitative considerations to ensure the selection of practical and impactful routes. The following details provide a more in-depth account of this process, informed by the SANDAG AAM Case Study.

Cargo Delivery Use Case

1. **Proposed Route: Brown Field Airport to Viejas Reservation**
   - **Origination**: Brown Field Airport was identified as a strategic starting point due to its existing infrastructure and proximity to logistics hubs. This site offers the advantage of existing aeronautical infrastructure and congested urban zones, facilitating uninterrupted cargo operations.
   - **Destination**: Viejas Reservation was chosen as a destination, highlighting the potential of AAM to connect rural, remote, or underserved areas. This route demonstrates a potential use case of addressing logistical gaps between urban and rural regions.
   - **Key Considerations**:
     - **Advantages**: Low population density along the route minimizes community disruption. Additionally, the lack of complex airspace constraints enhances operational efficiency.
     - **Avoidance Zones**: Urban areas such as Alpine, Santee, Mira Mesa, and El Cajon were excluded due to higher population densities.

Medivac Use Case

1. **Primary Route: UCSD Healthcare Facilities**
   - **Origination**: Multiple hospitals within the UCSD healthcare system, such as the UC Jacobs Medical Center and affiliates like the Burn Unit and Rady Children's Hospital, were identified as key points for medivac services.
   - **Destination Options**:
     - **Veterans Hospital and Navy Hospital**: These facilities were considered to support accessibility and ensure potentially efficient transitions between aerial and ground medical services.
2. **Key Considerations**:
   - **Accessibility**: Proximity to major healthcare facility networks and existing helipads ensures rapid access in case of an emergency.

Air Taxi Use Case

1. **Proposed Routes**: High-demand urban and suburban regions, where transportation options are currently limited, were prioritized. It should be noted that the San Diego International Airport was used as an example solely for the intent and purposes of the case study and the analysis.
   - **Origination**: San Diego International Airport (SAN) was selected as a central hub for air taxi services due to its established role as a regional aviation hub.
   - **Destinations**:
     - **Solana Beach, Del Mar, Encinitas, and Carlsbad**: These suburban locations were identified as high-need areas due to limited ground transportation options connecting them to SAN.

- **Key Considerations**:
  - **Advantages**: These routes address a critical transportation gap, particularly for commuters or travelers in areas underserved by public transit.

Step 4: Regulatory Requirements

A detailed review of local regulatory requirements was conducted for each potential site to ensure compliance with land use and airspace laws. This step involved:

1. **Zoning Laws**: Each site's zoning classification was cross-referenced with its intended use to confirm compatibility. For instance, commercial zones were prioritized for air taxis, while industrial zones were favored for cargo use cases.
2. **Airspace Constraints**: Each site's proximity to restricted or controlled airspace was assessed to ensure compliance with FAA regulations and avoid flight path conflicts.

Step 5: Smart Atlas Analysis Process

The following process was utilized in Smart Atlas using the identified and prioritized layers for each use case.

1. **Define boundary layers**: Boundary layers were set up for each use case based on an overview of the available data and review of the need for each use case across the San Diego region.
2. **Weighing data layers**: Next, all the data layers were weighed based on their priority levels determined in Step 2. Each data layer was assigned with a numerical rating of 3 = high, 2 = medium, and 1 = low. Negative values were used to indicate restrictions or constraints for a specific data layer, for example, prohibited airspace.
3. **Assign ratings**: Using the field calculator tool in Smart Atlas, weight for each data layer was added for each use case. This allows quantifying the layer's contribution in terms of the impact in the overall analysis.
4. **Merge layers**: After all the layers were weighted, the Union tool was utilized to merge all data layers into one cohesive layer for each use case. This step consolidated layers while retaining their individual attributes.
5. **Sum weight**: Next, a calculation was done for each use case by summing the weight values from all the layers to ensure equal consideration.
6. **Visualization**: The symbology for the merged layers was updated with graduated colors based on the sum weight field, which allowed for an efficient way to visualize areas with varying suitability levels for each use case.

Step 6: Site Justification

For each shortlisted site, a one-time qualitative analysis was conducted to evaluate its overall viability. This analysis considered:

1. **Community Impact**: Potential effects on nearby residents were assessed, including noise pollution, land zoning, and socio-economic benefits. Justice40 data was instrumental in identifying sites that could enhance equity and accessibility.

2. **Accessibility**: Each site's connectivity to existing road and air networks was analyzed to ensure efficient operations. Ground accessibility was particularly important for use cases like medivac services, which require seamless integration between ground ambulances and aerial transport.
3. **Multi-Modal Integration**: The selected sites were evaluated for their potential to integrate with existing transportation systems, such as rail networks, enhancing their value within the broader mobility ecosystem.

Use Case Analysis

Smart Atlas was employed to map out relevant data layers critical to the cargo delivery use case. Layers such as industrial zoning, proximity to logistics hubs, airspace restrictions, and ground accessibility were visualized to identify regions in San Diego.

Cargo Delivery Use Case Findings

Smart Atlas was employed to map out relevant data layers critical to the cargo delivery use case. Layers such as industrial zoning, proximity to logistics hubs, airspace restrictions, and ground accessibility were visualized to identify feasible sites. Based on the prioritized data layers, the list below provides an overview of the rationale for each layer's implementation.

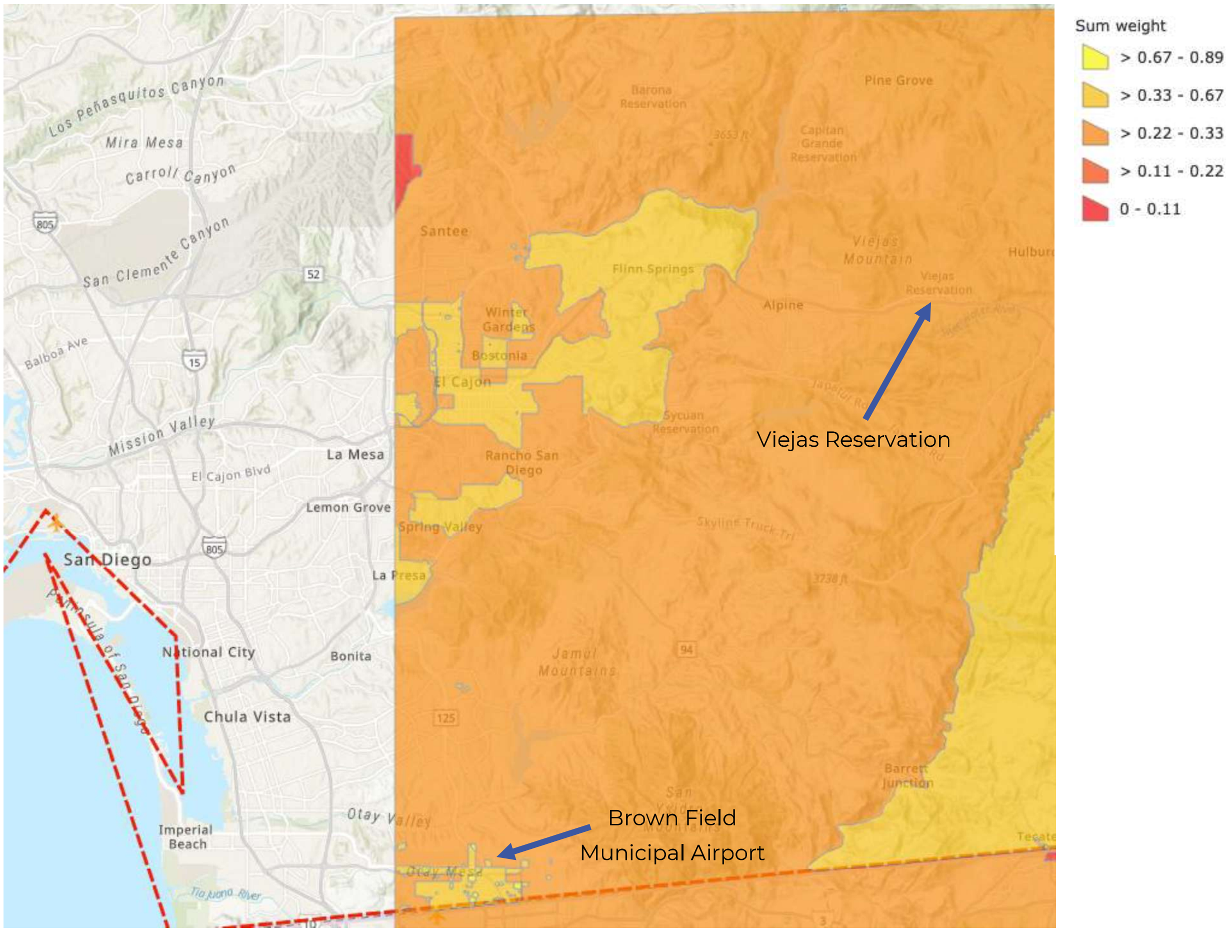
- **Industrial Zoning**: Highlighted regions with warehousing and manufacturing areas to ensure proximity to existing supply chains.
- **Airspace Constraints**: Avoided heavily regulated or congested airspace to reduce operational barriers.
- **Ground Connectivity**: Evaluated regions near highways or other transportation networks for seamless ground-to-air logistics transitions.

Based on the analysis, the table below shows a list of potential regions that show suitability for an AAM infrastructure, considering the available data and assumptions used in the analysis.

Table 5

Location	Description
Brown Field Airport	Proximity to existing warehouses and infrastructure
Viejas Reservation	Demonstrates the potential to increase connectivity to tribal regions to support increased regional connectivity
National City	Proximity to port and rail network to enable multi-modal connectivity

Figure 4



Medivac Use Case Findings

Smart Atlas mapped key healthcare facilities and their surrounding infrastructure, focusing on helipad locations, proximity to road networks, and accessibility. Based on the prioritized data layers, the list below provides an overview of the rationale for each layer's implementation.

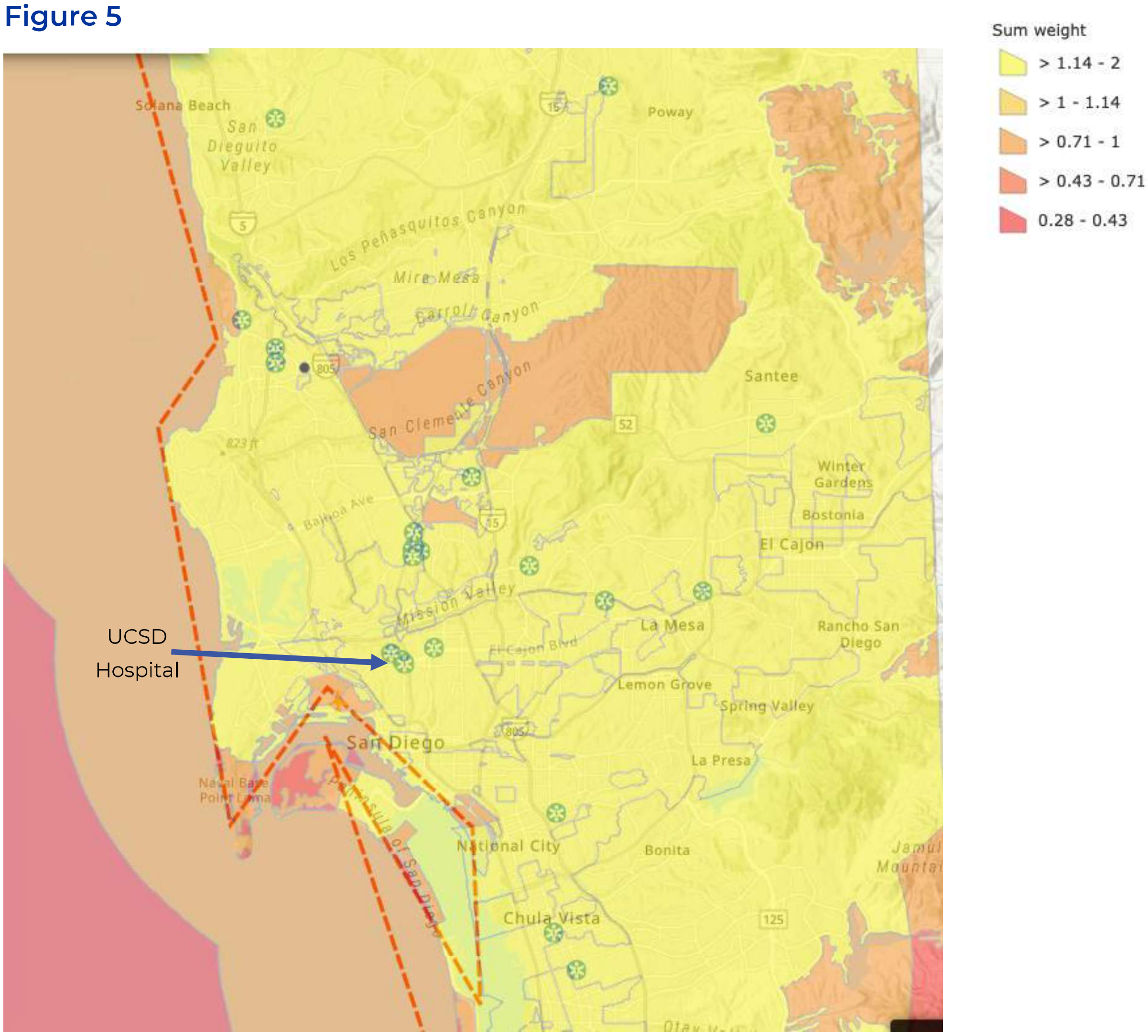
- **Hospital Locations**: Identified primary healthcare destinations, including UCSD affiliates and specialized units. Including hospitals with helipads.
- **Emergency Accessibility**: Evaluated proximity to major roadways and emergency response centers.
- **Socioeconomic Data**: Considered underserved regions to support better emergency care access.
- **Transportation**: Conducted a 30-minute drone and drive time analysis to highlight the reach of the medivac across the San Diego region.

Based on the analysis, the list of potential regions is shown in Figure 5, with Table 6 providing a brief description of each potential site.

Table 6

Location	Description
UCSD Hospital and affiliates (Burn unit)	Proximity to existing helipad
Rady's Children Hospital	
Veteran's and Navy Hospital	Support connectivity

Figure 5



Air Taxi Use Case Findings

Smart Atlas was used to identify suburban and urban locations for air taxi services, focusing on underserved areas with limited ground transportation options and affluent regions likely to generate demand. Based on the prioritized data layers, the list below provides an overview of the rationale for each layer's implementation.

- **Population Density**: Highlighted suburban regions with the potential to improve and increase connectivity.

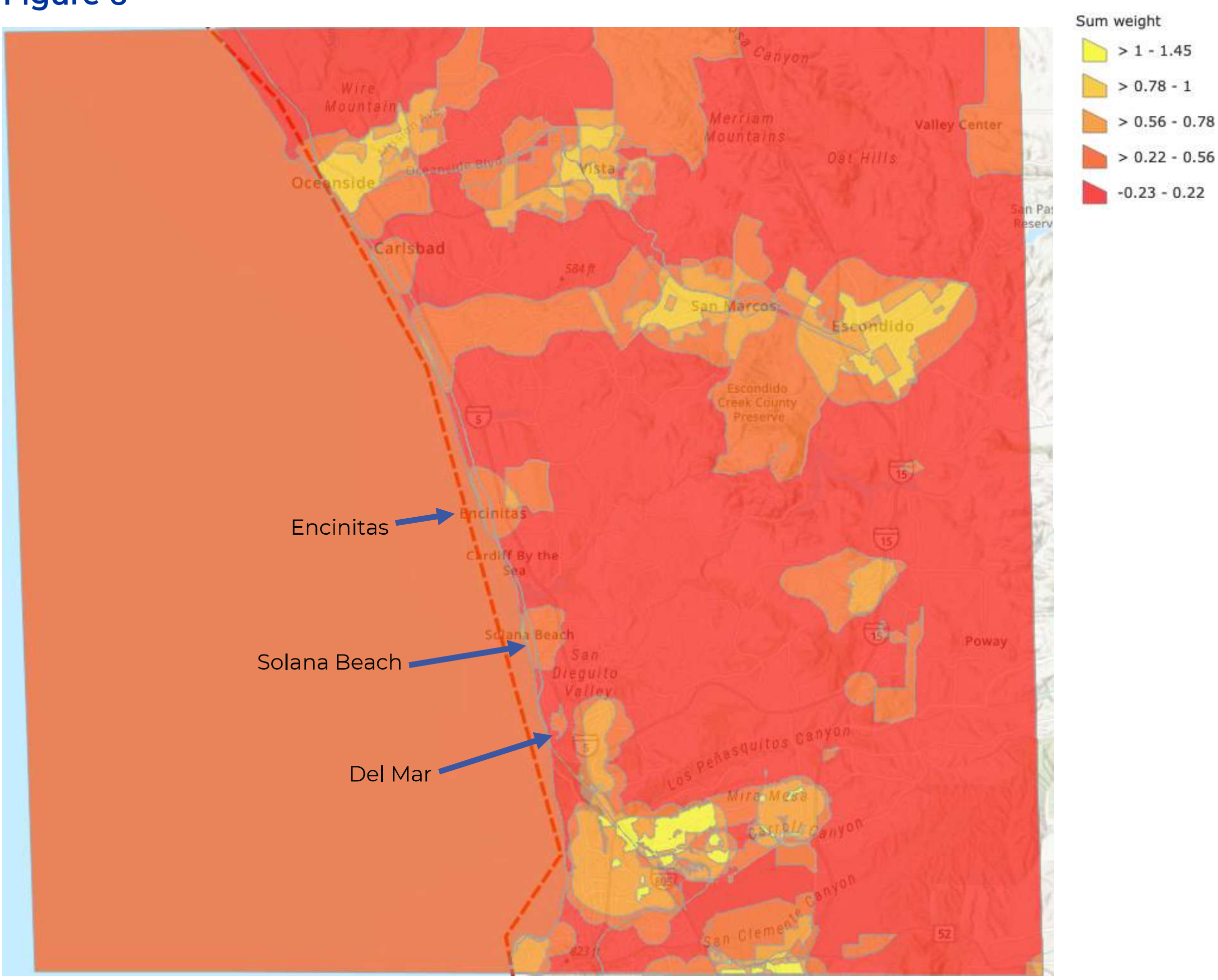
- **Zoning Data**: Identified commercial and residential zones likely to benefit from air taxi infrastructure.
- **Transit Gaps**: Mapped regions with limited public transit connectivity to transportation hubs.

Based on the analysis, the following regions in the San Diego region were identified as potential recommendations for AAM infrastructure, particularly for the air taxi use case.

Table 7

Location Region	Description
Solana Beach	Suburban locations with limited transportation options for commuting to and from the airport.
Del Mar	
Encinitas	
San Diego International Airport	Selected for the sole purpose of this case study

Figure 6



Conclusions

This analysis employed a data-driven methodology using Smart Atlas to recommend an assessment methodology for determining suitable sites for AAM infrastructure by integrating geospatial data layers, such as land zoning, airspace constraints, and accessibility. The proposed methodology utilizes an approach that provides transparency and objectivity, balancing operational needs and unique data considerations required to analyze specific use cases under AAM. The proposed methodology offers several benefits, including prioritizing data unique to each use case, customization of the data layers based on assumptions, and scenario-based planning focused on accessibility and equity. However, the process also has certain disadvantages, such as subjectivity in assigning weights and the assumptions made in data prioritization. Similarly, trade-offs, such as potential bias in data prioritization and the risk of oversimplifying qualitative factors, like community acceptance or regional feasibility based on a different use case, to accommodate AAM infrastructure, could result in a different outcome for suitable sites in the San Diego region.

For planners and planning authorities, the findings underscore the importance of stakeholder engagement to address community concerns and foster collaboration with regulatory bodies. Incorporating socio-economic and environmental data can support equitable and sustainable site selection while balancing zoning, land use, transportation, and airspace requirements, ensuring compliance and feasibility. While GIS-based methods streamline site selection, planners must remain aware of the trade-offs, ensuring decisions align with both operational goals and broader societal needs. A balanced approach combining data-driven insights and stakeholder collaboration is essential for successful AAM implementation.

4 | Infrastructure Requirements

The primary purpose of this advanced air mobility (AAM) infrastructure report is to provide a holistic overview of the infrastructure considerations that need to be understood for establishing vertiports and other associated components to integrate AAM operations into the member communities of the San Diego Association of Governments (SANDAG). The information and standards for AAM infrastructure provided in this document are aimed at informing the SANDAG stakeholders and community of the anticipated infrastructure requirements to best integrate AAM into the regional landscape. While the standards provided in this document are not exhaustive of all applicable standards that might apply to a vertiport or a specific component, for example, electric chargers, the report does provide a detailed discussion of all the critical AAM infrastructure and their general standards. In addition, while reading this report, the reader should keep in consideration that the AAM infrastructure, vertiport components, and the standards covered in this report are based on existing Federal Aviation Administration (FAA) regulations for heliport designs, industry and academic research, and interim vertiport guidelines presented in the FAA Engineering Brief 105. Any future regulatory guidelines the FAA provides may supersede the standards provided in this document. Nevertheless, this document should serve as a helpful resource for the reader to understand what a vertiport is, what its components are, and their potential sizing requirements.

This report is divided into six sections:

4.1: eVTOL Use Cases and Maturity Timeline | Vehicle variations, use cases, and vehicle evolution

4.2: San Diego County Overview | Understanding Regional Capacity Today

4.3: Infrastructure Considerations for AAM | AAM Infrastructure Requirements

4.4: Vertiport Design Standard | Design Guidelines and Regulatory Requirements

4.5: Prototype Minimum Standard | Establishing benchmarks for initial implementation

4.1 eVTOL Use Cases and Maturity Timeline

eVTOL Use Cases

AAM offers innovative solutions for passenger transport, addressing the challenges of urban congestion and providing faster, more efficient travel options. Key passenger use cases include:

Figure 7: Advanced Air Mobility Use Cases

On-demand Air Taxi	Airport Shuttle	Regional	Corporate / Business	Sightseeing	VIP services
Mobility service to transport passenger from point-to-point location within mega-regions / combined metro areas; includes both commute and recreational travel	Transport services from urban locations to nearby airports operating on a fixed route and schedule	Inter-city transport services for short distance trips that are not viable for regular aviation travel Operate on fixed routes and schedules with range between 50-350km initially	Shuttle service to ferry employees to and from workplace; could include commute between multiple plant / office locations in proximity , including off-shore vessels	Aerial tourism service to provide sightseeing offering bird's eye view of natural and urban landscape to tourists	Official ferry services for officials, diplomats, celebrities, prisoners, and other particular cases

Source: Aviation 2030[105]

1. **Passenger Transportation**[106]

   a. **On-demand Air Taxi:** This service provides point-to-point transportation within mega-regions or combined metropolitan areas, catering to both commuters and recreational travelers. It offers a flexible and time-saving alternative to traditional ground transportation.

   b. **Airport Shuttle:** AAM can serve as an airport shuttle, connecting urban areas with nearby airports. These shuttles operate on fixed routes and schedules, facilitating a seamless transition from urban locations to airport terminals and vice versa.

   c. **Corporate and Business Travel:** AAM can offer shuttle services for corporate employees, providing convenient transport between workplaces, multiple office locations, or even offshore vessels. This use case enhances efficiency and reduces travel time for business purposes.

   d. **Sightseeing:** Aerial tourism is another promising use case, offering tourists a unique bird's-eye view of natural and urban landscapes. AAM can provide memorable sightseeing experiences, attracting visitors to various tourist destinations.

   e. **Regional Air Travel:** For short-distance inter-city trips that are not feasible for regular aviation, AAM can offer a viable alternative. These services operate on fixed routes and schedules, initially covering 50-350 km (approximately 31 – 217 miles).

2. **Cargo Transportation**[107]

AAM can also support innovative solutions for cargo transport, catering to both small and large cargo needs:

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[105] Aviation, 2030, https://assets.kpmg.com/content/dam/kpmg/ie/pdf/2022/07/ie-advanced-air-mobility-revolution.pdf

[106] UAM Market Study. https://ntrs.nasa.gov/api/citations/20190001472/downloads/20190001472.pdf

a. **Small Cargo:** This involves transporting goods like medicine or parcels within urban areas, often serving as the 'last mile' delivery solution. The agility and speed of AAM make it ideal for urgent and time-sensitive deliveries.

b. **Large Cargo:** For heavier cargo, typically ranging from over 20 lbs. (10 kg) to under 4400 lbs. (2,000 kg), AAM offers efficient transport options in urban settings. This can include transporting supplies to various business locations or aiding in logistics operations.

3. Public Services[107]

AAM can play a crucial role in emergency services by providing rapid response capabilities:

a. **Logistics of Natural Disasters and Humanitarian Crises**: Providing rapid delivery of essential supplies, medical aid, and personnel to areas affected by natural disasters or humanitarian emergencies.

b. **Medical Evacuation (Medevac)**[108]: Offering quick and efficient transportation of patients from accident sites or remote locations to medical facilities.

c. **Law Enforcement and Public Safety:** Supporting law enforcement activities, including situational awareness, search and rescue, and rapid response to incidents or priority calls.

4. Military and Defense[107]

AAM can support transporting military personnel and supplies in the defense sector, providing a versatile and rapid deployment solution. The flexibility and speed of AAM vehicles make them suitable for various military operations, including humanitarian aid and disaster response in challenging terrains.

5. VIP Services[109]

AAM can offer exclusive services for high-profile individuals, including officials, diplomats, and celebrities. These services provide secure and private transportation, catering to the unique needs of VIP passengers.

AAM Maturity Timeline

The maturity timeline of eVTOL operations AAM involves a progressive evolution characterized by key indicators. Initially, UAM operations start with a low operational tempo, utilizing existing Air Traffic Services (ATS) rules and regulations.[110]

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[107] NASA Electrical Vertical Take0off and Landing (eVTOL Aircraft Technology for Public Services – A White Paper, https://ntrs.nasa.gov/api/citations/20205000636/downloads/2021-08-20-eVTOL-White-Paper-Final_V48.pdf

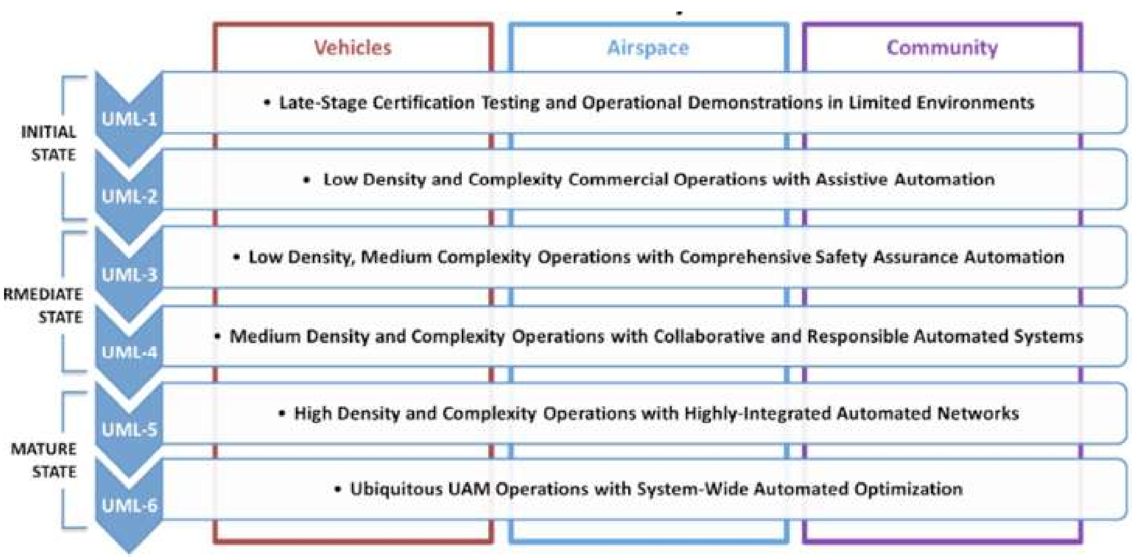
[108] Advanced Air Mobility Missions for Public Good, https://ntrs.nasa.gov/api/citations/20230012505/downloads/NASA-CR-20230012505.pdf

[109] UAM Market Study, https://ntrs.nasa.gov/api/citations/20190001472/downloads/20190001472.pdf

[110] AAM Implementation Plan, https://www.faa.gov/sites/faa.gov/files/AAM-I28-Implementation-Plan.pdf

This phase is marked by minimal infrastructure and procedural changes, with eVTOL aircraft primarily piloted by onboard pilots under traditional Visual Flight Rules (VFR) or Instrument Flight Rules (IFR). As operations progress to the midterm stage, the tempo increases, necessitating regulatory adaptations and establishing UAM Corridors—specific airspace structures designed to manage and streamline UAM traffic. During this phase, introducing Community of Practice (COPs) standards helps define operational norms and expectations, and remote piloting becomes more common alongside onboard pilots. In the mature state, UAM operations reach high densities and frequencies, supported by a complex network of UAM Corridors and extensive automation advancements, including Human-Over-the-Loop (HOVTL) capabilities. This phase requires comprehensive regulatory frameworks and more sophisticated COPs to manage the increased operational demands and ensure safety and efficiency in the UAM ecosystem.[111] As these operations mature in scale, regional governing authorities must be prepared to integrate this mode of transportation within the broader transportation network of the region to supplement connectivity, equity, and access for their communities. An early understanding of how these technologies will mature will ensure that it is efficiently integrated into regional planning, supporting a more resilient, multi-modal transportation ecosystem.

Figure 8: Advanced Air Mobility Maturity Levels



Source: NASA[112]

[111] Urban Air Mobility Concept of Operations https://www.faa.gov/sites/faa.gov/files/Urban%20Air%20Mobility%20%28UAM%29%20Concept%20of%20Operations%202.0_0.pdf

[112] Description of the NASA Urban Air Mobility Maturity Level (UML) Scale, https://ntrs.nasa.gov/api/citations/20205010189/downloads/UML%20Paper%20SciTech%202021.pdf

4.2 San Diego County Overview

San Diego County hosts a variety of airports, serving both commercial and general aviation needs. The most notable is **San Diego International Airport (SAN)**, the primary commercial airport and among the busiest single-runway airports in the world. It offers extensive domestic and international flights and is a crucial gateway for tourism and business in the region.

In addition to San Diego International, the county has several other public and private airports, including:

- Bob Maxwell Memorial Airport
- Borrego Valley Airport
- Brown Field Municipal Airport
- Fallbrook Community Airpark
- Gillespie Field
- Jacumba Airport
- Montgomery-Gibbs Executive Airport
- McClellan-Palomar Airport (CRQ)
- Ocotillo Airport
- Ramona Airport

San Diego International Airport (SAN) operates nearly 500 flights daily, offering over 60 nonstop destinations throughout the US and internationally, including Asia, Europe, Mexico, and Canada. In 2019, before the pandemic, the airport reached a record of over 25 million passengers, with the majority (over 24 million) being domestic travelers. The largest growth in seat capacity was seen in the West Coast markets.[113]

San Diego serves as a case study due to its status as an FAA-defined large hub in a competitive region with multiple airports. Nearby competitors include Los Angeles International Airport (LAX), which handled over 88 million passengers in 2019; John Wayne Airport (SNA) in Orange County, CA, with nearly 11 million passengers; and Ontario International Airport (ONT) in San Bernardino County, which saw over 5.5 million passengers in 2019.[113]

San Diego County also features a network of heliports that support medical, law enforcement, and corporate helicopter operations. Key heliports are located at:

- Grossmont Hospital HP
- Palomar Medical Center HP
- Palomar Medical Center HP Downtown
- Pomerado Hospital HP

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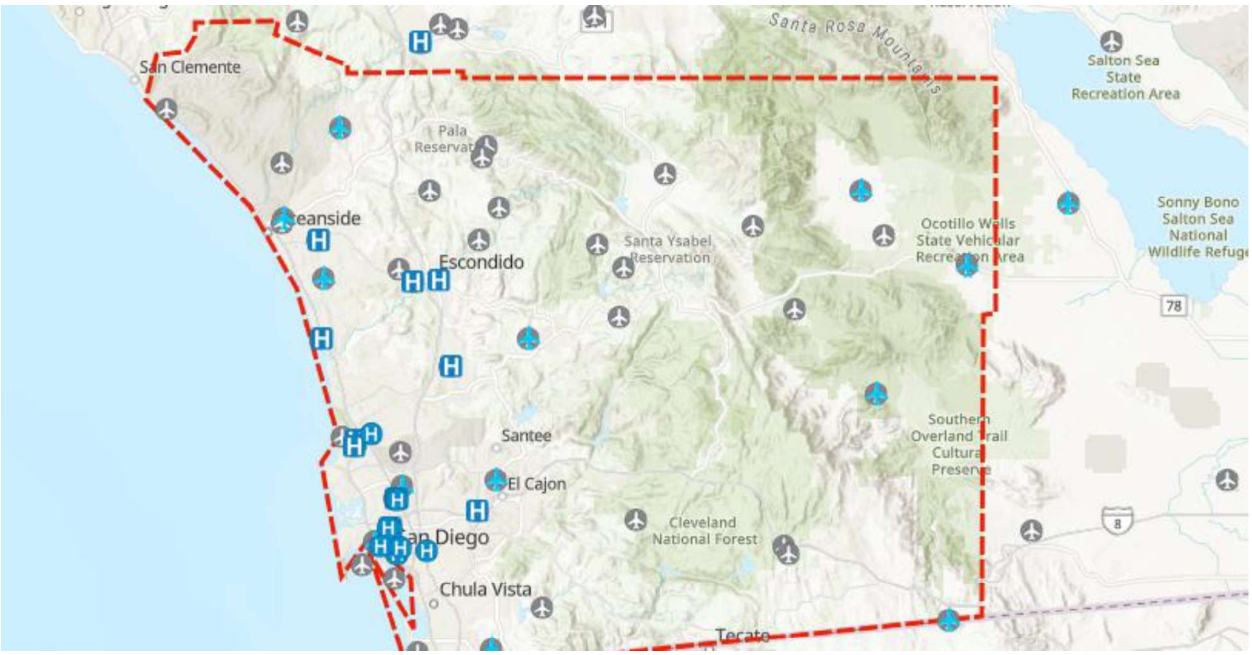
[113] San Diego Case Study, https://crp.trb.org/acrpwebresource12/wp-content/uploads/sites/25/2021/08/SAN-Case-Study-Full-Report.pdf

- Rady Children's Hospital-San Diego HP
- Scripps Memorial Hospital Encinitas HP
- Scripps Memorial Hospital HP
- Scripps Mercy Hospital HP
- Sharp Memorial Hospital HP
- Tri-City Medical Center HP
- UC San Diego Medical Center HP
- UCSD Jacobs Medical Center HP

Figure 9: Airports and Heliports in San Diego County



Source: Smart Atlas

San Diego County hosts the largest concentration of military presence worldwide, serving as the headquarters for 16 stations of the U.S. Navy, U.S. Marine Corps, and U.S. Coast Guard. Recently, San Diego has emerged as a hub for healthcare, mobile telecommunications, and biotechnology, leading innovations in technology-driven health solutions, such as wireless health. The region is also a significant center for research and development in the U.S., home to numerous research institutions. With 98% of the firms being small businesses, local enterprises contribute to 68% of San Diego's economy.[114]

[114] San Diego, Case Study https://crp.trb.org/acrpwebresource12/wp-content/uploads/sites/25/2021/08/SAN-Case-Study-Full-Report.pdf

Passenger traffic at San Diego International Airport (SAN) has been on a steady rise since 2010, reaching a peak of over 25 million passengers in 2019. The airport has seen a compound average growth rate of 3 percent in passenger traffic since 2008. Following a recovery from the global economic downturn in 2008, the growth rate over the last five years has increased to 6 percent.

The number of nonstop destinations served by SAN, as well as flights to major markets, expanded from 2008 to 2019. In 2008, the airport provided service to 50 destinations, which grew to 60 destinations by 2019, marking a 20 percent increase over 11 years. While domestic destinations remained the majority, their growth was only 8 percent during this period.

At SAN, six domestic airlines operate out of Terminal 1, while Terminal 2 hosts 11 domestic and international carriers. Southwest Airlines was the largest carrier at SAN in 2019, accounting for nearly 38 percent of onboard passengers. Alaska Airlines followed with 14 percent, and Delta Air Lines, United Airlines, and American Airlines each had around 12 percent. In 2019, the airport's scheduled seats reached nearly 31 million, with an estimated load factor of 82.8 percent. These airlines have established partnerships with leading eVTOL aircraft manufacturers to support their existing domestic and regional routes.

4.3 Infrastructure Considerations for AAM

Infrastructure at airports plays a crucial role in ensuring the safe movement of aircraft and the protection of the aircraft, people, and cargo they transport. AAM operations are poised to become increasingly prevalent, and airports need awareness of the infrastructure considerations that need to be addressed clearly. Recognizing this, the FAA is proactively taking steps to provide more comprehensive guidance and support for integrating AAM operations.

Numerous infrastructure considerations must be considered when integrating AAM operations into an airport, including charging and maintenance facilities, airport ground control and air traffic control systems, and airport security measures. A comprehensive approach to these infrastructure needs will be essential to integrate AAM operations effectively across both airports and emerging vertiport facilities.

The FAA's recognition of the need for improved guidance and support around AAM operations, as well as the many infrastructure considerations that must be taken into account, highlights the importance of preparing airports and developing dedicated facilities, such as vertiports, for integrating AAM operations. By prioritizing these considerations, regional planning authorities can ensure that they are able to integrate AAM operations safely and effectively and support the continued growth of this exciting and innovative industry.

While vertiports will be an essential component of ground infrastructure to support AAM operations, it is crucial to understand vertiports and their components. In general terms, a vertiport is a designated area for the take-off, landing, and maintenance of eVTOL and other AAM aircraft, equipped with facilities for passenger boarding (gates), vehicle charging, and maintenance services. It is essential to keep in consideration that all these components that will be required to support AAM operations need to be factored in when developing standards for a vertiport.[115,116]

Types of Vertiport

Based on the existing literature and ConOps, a ground-based infrastructure for AAM operations can be broken down into three major types[117]:

1. Vertipad or vertistation: The vertipad is the smallest of the three categories. It will typically comprise one take-off and landing site with an additional space for one or two eVTOL aircraft. A vertipad will also be equipped with either existing or retrofitted associated buildings and facilities. Keeping in consideration the footprint of a vertipad, this ground-based infrastructure would be ideal for an AAM infrastructure set up in an off-airport environment.

Figure 10: Vertistation

Source: National Academy of Sciences[118]

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[115] Designing a Scalable Vertiport, Lilium, https://lilium.com/newsroom-detail/designing-a-scalable-vertiport

[116] World Economic Forum, https://www.weforum.org/agenda/2023/02/aviation-vertiports-vtol-transport/

[117] Urban Air Mobility An Airport Perspective, https://nap.nationalacademies.org/catalog/26899/urban-air-mobility-an-airport-perspective

[118] Urban Air Mobility An Airport Perspective, https://nap.nationalacademies.org/catalog/26899/urban-air-mobility-an-airport-perspective

2. Vertiport or vertibase: The vertibases are medium-sized structures that will be either newly built or retrofitted existing facilities, such as hangars [on the airside] or parking garages [on the landside]. A vertibase will most likely staff a basic maintenance crew, including ground personnel for the aircraft. Charging stations will also be provided, depending on the availability of enough electrical capacity.

Figure 11: Vertiport

Source: National Academy of Sciences[118]

3. Vertihub: Vertihub will be the largest ground-based structure. Similar to an airport, these facilities will be a stand-alone building that will be able to accommodate approximately ten take-off and landing facilities, plus additional space for parking and maintenance.

   Vertihub will be equipped with passenger and baggage processing, retail space, and other services for passengers. Due to their capability of supporting multiple eVTOL operations, vertihub requirements can be included as part of facility requirements for long-term forecasts, as the tempo of AAM operations will increase.

Figure 12: Vertihub

Source: National Academy of Sciences[119]

Each of the mentioned infrastructures will require a different footprint and available land, as well as an evaluation of local policy and regulation regarding vertiport site selection and development. Table 8 provides an overview of the minimum footprint each will require to develop, in addition to the cost and services they will potentially offer.

Table 8: Type of AAM Infrastructure[119]

	Vertipad	Vertiport/base	Vertihub
Minimum Footprint	100 x 60 ft.	250 x 100 ft.	400 x 200 ft.
FATO/TLOF	1	1 – 2	2+
eVTOL Stands	1 – 2	2 – 10	10+
MRO Capabilities	Not available onsite	Limited capability	MRO capability
Capital Expenditure	$200,000 - $400,000	$500,000 - $800,00	$6 - $7 million
Operating Expense	$600,00 - $900,000	$3 - $5 million	$15 - $17 million

[119] Urban Air Mobility An Airport Perspective, https://nap.nationalacademies.org/catalog/26899/urban-air-mobility-an-airport-perspective

Vertiport Topology

Due to the emerging nature of AAM, limited information is available that focuses on exploring vertiport design standards, with the latest being vertiport design standards established by the FAA in Engineering Brief 105, Vertiport Design. In the absence of AAM infrastructure standards, existing heliport design standards can be used as a proxy to define surface features (for example, topology), spacing constraints, and other associated component sizing standards as prescribed for general aviation VFR heliports in AC 150/5390-2C and Airport Design AC 150/5300-13B.

In addition to identifying the spacing feature, it is also crucial to determine the general layout of placing a vertipad at an airport. One of the first steps the Hovecon team undertook was to identify the different topologies of placing a vertiport at a site. Since the standards for vertiport topology have still not been established in the industry, the Hovecon team, based on the analysis of the current heliport topology as a proxy, proposes the below-provided configuration of vertiport topology. Based on the provided topology configuration, the airport and city planners can further assess placing AAM-based ground infrastructure based on airside and landside facility assessment at their airport and in a metropolitan area, based on available land and need.

Linear Topology

In the linear topology, the touchdown and liftoff area (TLOF) is laid in a linear fashion, as shown in the figure below. Based on the available land, multiple TLOF pads will be placed next to one another. In linear topology, there will be no dedicated gates or staging areas available in the hangar or on the tarmac. It is the simplest of the designs, where each TLOF pad can take the role of a gate. The linear topology is most useful when the aircraft turnaround times are short and the available footprint is limited.

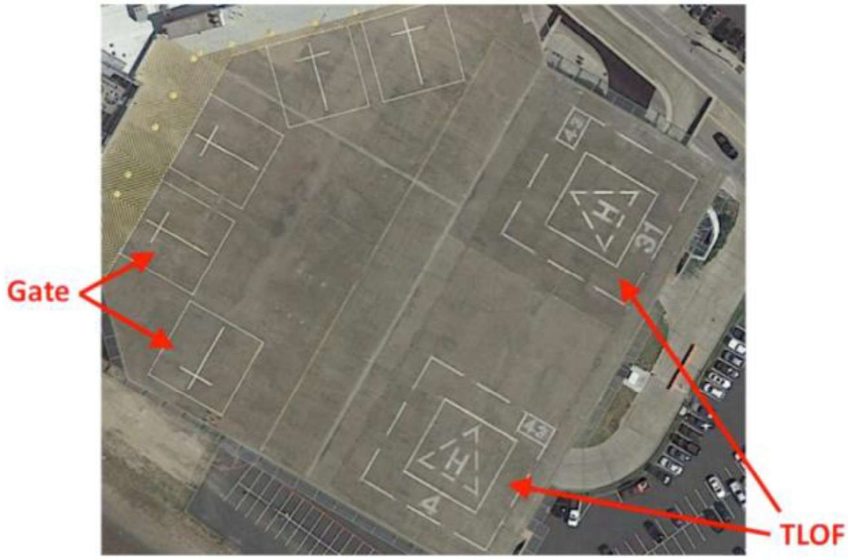
Figure 13: Linear Topology

Source: Google Maps

Satellite Topology

In the satellite topology, as shown in the figure below, one or more TLOF pads are associated with gates that are circumferentially placed around them. Depending on the number of TLOF pads present, they may or may not have independent approach and departure paths for AAM aircraft. The satellite topology is one of the most compact layouts. This layout configuration is most suitable when the available footprint is limited, and further land acquisition of land near an airport is not possible.

Figure 14: Satellite Topology

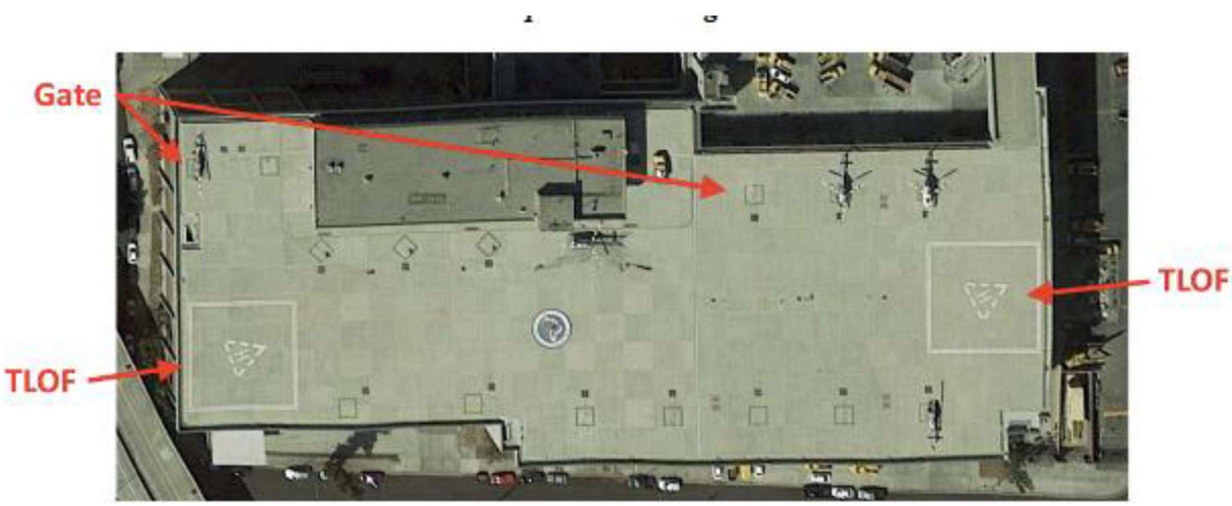


Source: Google Maps

Pier Topology

In the pier topology, one or more TLOF pads are placed to feed aircraft into a long corridor of gates, as shown in the figure. This topology is beneficial for facilities that expect to have longer vehicle turnaround times or desire to stage multiple aircraft onsite. This topology separates the TLOF from the gates, terminal, and staging area. An advantage of this configuration is that, due to the separation between the TLOF and gate, the take-off and landing angles, i.e., the approach and departure path for eVTOL, can be multi-directional, which can accommodate higher tempo operations, resulting in greater gate utilization and passenger process capacity.

Figure 15: Pier Topology



Source: Los Angeles Heliport, Google Maps

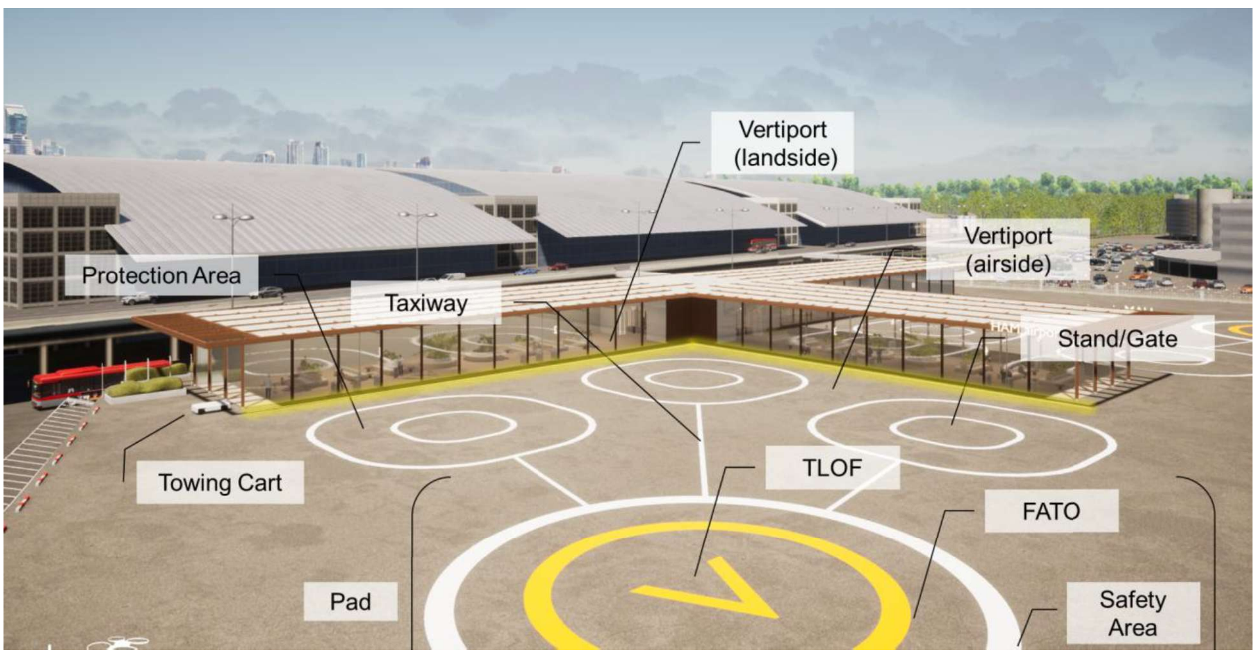
Standard Specification for Vertiport Design

Before AAM facilities are integrated into the infrastructure planning process, both the airport and city planners need to be well-versed in any new terminology associated with electric aircraft characteristics and any associated ground infrastructures. Based on the available information, the following terms need to be defined and considered in the AAM infrastructure planning process.

- *Controlling Dimensions (CD)*: The greatest distance between the two outermost opposite points on an aircraft as measured along either the horizontal or longitudinal axis (that is, wingtip to wingtip, rotor tip to rotor tip, rotor tip to wingtip, fuselage to rotor tip, fuselage to fuselage, etc.)
- *Design Aircraft*: A single or composite, that is, multiple, aircraft that reflects the maximum weight, maximum contact load/minimum contact area, controlling dimension, undercarriage dimensions, and pilot's eye height of all aircraft expected to operate at the vertiport.
- *Dynamic load*: For airport planning and design purposes, the dynamic load can be assumed to be at 150 percent of the maximum take-off weight of the design aircraft applied through the main undercarriage on a wheel-equipped or aft contact areas of skid-equipped aircraft.
- *Elevated vertiport*: A vertiport located on a raised structure on land, such as a multi-level parking garage.
- *Electric vehicle power transfer system*: A means of replenishing an aircraft's electrical energy reserves. This includes portable and stationary charging systems that are designed to be connected to an aircraft, as well as battery-swapping programs.
- *Energy storage system (ESS)*: Complete energy storage device consisting of one or more energy storage cells arranged into one or more packs, with ancillary subsystems for physical support and enclosure, thermal management, and electronic control.
- *Touchdown and liftoff area (TLOF)*: A load-bearing surface area normally centered in its own FATO, on which the aircraft may touchdown or liftoff.
- *Final approach and Take-off Area (FATO)*: A defined area over which the aircraft completes the final phase of the approach to a hover or a landing and from which the aircraft initiates take-off that has an unobstructed perimeter area that allows for safe maneuvering of the design aircraft in all modes of operation.
- *Ground taxi*: The surface movement of a wheeled VTOL under its power with wheels touching the ground.
- *Ground towing*: The movement of an aircraft while in contact with the ground with the assistance of a ground handling device, where the aircraft is not producing thrust or lift.
- *Hover taxi*: The movement of a wheeled or skid-equipped aircraft above the surface, typically used to move short distances from one point to another. For planning purposes, a hover taxi is usually considered for skid-equipped eVTOL aircraft.
- *Parking positions*: A designated location at an airport, especially at a vertiport, for transient aircraft to be positioned utilizing ground or hover taxi for the purpose of loading and unloading cargo or passengers, charging, fueling, or short-duration maintenance.
- *Predesigned emergency landing area (PELA)*: A location identified as a potential emergency landing site for an aircraft in distress to land when continued flight is unadvisable due to an off-nominal situation concerning maintenance, weather, or an in-flight emergency.

- *Safety area*: A defined, unobstructed area surrounding the FATO of a vertiport designed to allow for any accidental divergence of an aircraft from the FATO perimeter.
- *Safety net*: A physical and structurally supported safety device surrounding any landing/take-off surface, parking areas, taxiway, walkway, access point, passenger area, and crew area that is elevated greater than 30 inches.
- *Static load*: For design purposes, the design of static load is equal to the aircraft's maximum take-off weight applied through the total contact area of the wheels or skids.
- *Taxiway*: Defined unobstructed clear path established for air and ground taxiing, or both aircraft from one part to another.
- *Transitional surface*: These surfaces extend outward and upward from the lateral boundaries of the primary surface and from the approach surfaces at a slope of 2:1 for a distance of 250 ft measured horizontally from the centerline of the primary and approach surfaces.
- *Vertiport elevation*: The highest point of a vertiport's FATO measured in feet from the mean sea level (MSL).

Figure 16: Vertiport Components[120]



Vertiport Requirements

To integrate AAM facilities into the planning process, the following general requirements need to be met.

[120] Urban Air Mobility: Systematic Review of Scientific Publications and Regulations for Vertiport Design and Operations. https://www.mdpi.com/2504-446X/6/7/179

General

- A vertiport site, both on an airport premise or in a metropolitan area, needs to ensure safe approaches and departures of all aircraft that it is designed to support.
- A vertiport shall have a dedicated Emergency Action Plan (EAP) in place. The EAP should be updated regularly to reflect changes and be tested and practiced annually.
- Each vertiport facility shall always have a functioning wind cone in place to provide an alternative means of communicating real-time active winds to the pilot.
    - The wind cone should be placed near the FATO and be clearly identifiable by crewed aircraft pilots during approach, departure, and ground operations.
    - The wind cone shall be located outside the safety area, so it does not penetrate the approach, departure, and transitional surface.
- Vertiport intended for night operations: the wind cone, marking, and signs shall be illuminated internally or externally to ensure it is clearly visible to pilots and ground personnel.

Charger Requirement (Fixed-Based Chargers, Mobile, and Battery Swap)

- The charging requirements for AAM aircraft are a key consideration for AAM infrastructure. AAM aircraft will require a reliable and efficient charging solution that can be quickly and easily accessed. This could include fixed-based chargers, mobile chargers, or battery swap stations. Fixed-based chargers can be installed in dedicated locations and provide a consistent and reliable source of power for aircraft. Mobile chargers offer greater flexibility, allowing aircraft to be charged at different locations around the airport or a modified heliport. Battery swap stations allow for a quick change of battery without the need for charging, which can be especially important for cargo operations. It is important to consider that mobile and battery swap charger applications will require dedicated on-premises storage facilities.

Deicing Infrastructure

- Deicing infrastructure is essential to ensure the safe and efficient operation of AAM aircraft during winter conditions. AAM aircraft will require dedicated deicing bays with access to deicing fluids and equipment, and clear procedures for deicing aircraft. The deicing infrastructure should be designed to minimize the impact on other airport operations and be located close to the aircraft parking areas.

Access to Aircraft Movement Areas, Dedicated Parking Gates

- AAM aircraft will require dedicated access to aircraft movement areas, including parking gates, taxiways, and runways. This will ensure that AAM aircraft can safely and efficiently access the aircraft movement areas without interfering with other airport operations. The dedicated parking gates should be designed to minimize the impact on other airport operations, have access to terminal or cargo facilities, and provide a safe and secure location for eVTOL aircraft movement.

Hangars, MROs for Storage and Maintenance

- Hangars and Maintenance, Repair, and Overhaul (MRO) facilities are essential for the safe and efficient storage and maintenance of AAM aircraft. Hangars should be designed to accommodate the unique characteristics of AAM aircraft, including their size and shape, and should provide a secure and controlled environment for storage.

- MRO facilities should be located close to the hangars to minimize the need for aircraft to be moved and designed to accommodate AAM aircraft's maintenance requirements.

Environmental Impact & Noise Evaluation

- The environmental impact and noise generated by AAM aircraft is an important consideration for airport infrastructure. AAM aircraft will require dedicated noise and emission evaluation procedures to minimize their impact on the surrounding community and environment. This will include regular monitoring and reporting of noise levels and measures to minimize the impact of aircraft operations. Additionally, the disposal of aircraft batteries will also need to be considered to minimize the environmental impact of these operations.

AAM Operators and Airport Requirements

Approach and Departure Paths

- One of the critical requirements for AAM operations at an airport is the approach and departure paths. AAM operators must have a clear and defined path to and from the airport to ensure safe and efficient operations. The FAA is responsible for determining the approach and departure paths, taking into consideration the safety and efficiency of all aircraft. AAM operators must work closely with the FAA to ensure that the approach and departure paths align with their aircraft's operational requirements and capabilities.
- In terms of airspace integration, according to the FAA AAM Implementation plan, initial AAM operations will be limited to specific, scheduled routes in urban areas. In the near term, AAM operations will leverage existing ATM systems and the procedures for flying in a controlled and uncontrolled airspace. AAM aircraft will use the controlled airspace and operate mainly under visual flight rules (VFR) below 4,000 feet.[121]

Two-way Radio Communications

- Effective two-way radio communication is another essential requirement for AAM operations at an airport. AAM operators must have reliable and clear communication with the airport ground control, the FAA, and other relevant authorities. This enables the operator to receive real-time information about the status of the airport, aircraft movements, and other critical information. The AAM operator must also have the capability to communicate with its aircraft in flight, ensuring that it can provide real-time instructions and updates.

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[121] FAA, https://www.faa.gov/sites/faa.gov/files/AAM-I28-Implementation-Plan.pdf

ADS-B

- Automatic Dependent Surveillance-Broadcast (ADS-B) is a crucial requirement for AAM operations at an airport. ADS-B is a surveillance technology that enables aircraft to be tracked in real time, providing critical information to the FAA, the airport ground control, and other relevant authorities. AAM operators must ensure that their aircraft are equipped with ADS-B technology and are compliant with the FAA regulations. This technology provides critical information on the aircraft's location, altitude, and speed, ensuring that the FAA and airport ground control clearly understand aircraft movements.

Providers of Service for UAM (PSU)

- The Providers of Service for Urban Air Mobility (PSU) are responsible for ensuring that AAM operations at the airport are safe and efficient. The PSU provides essential services such as air traffic control, ground control, and flight planning. The PSU must work closely with the AAM operator and the FAA to ensure that the necessary infrastructure and procedures are in place to support AAM operations at the airport. The PSU must also ensure that the AAM operator is compliant with all relevant regulations and standards, including those related to air traffic control, airworthiness, and aircraft maintenance.

Workforce Requirement and Training

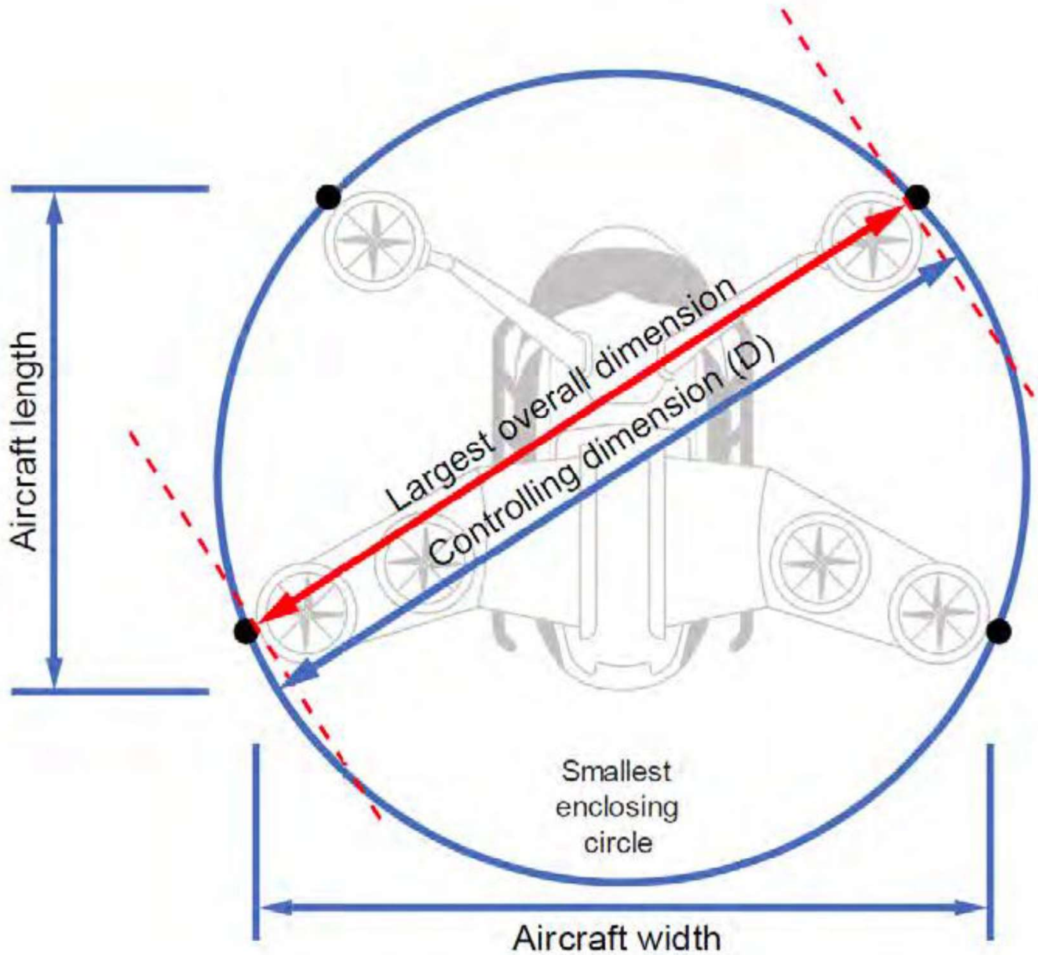
- The airport infrastructure and services required for AAM operations are complex and involve various aspects, including the workforce. Ground personnel play a critical role in ensuring the seamless and safe operation of AAM flights. In particular, the training and qualifications of ground personnel for passenger experience, electric battery charging, and battery swapping are key considerations for ensuring the success of AAM operations at an airport.
- Ground personnel for passenger experience are responsible for ensuring a smooth and comfortable experience for AAM passengers, from check-in and baggage handling to security and boarding. This requires personnel to be well-trained in customer service as well as in the procedures for ensuring the safety and security of AAM passengers and their belongings.
- Electric battery charging and battery swapping require personnel to be trained in the safe handling of high-power electrical systems. This includes understanding the electrical charging and battery management systems used by AAM aircraft, as well as the procedures for safely disconnecting and reconnecting batteries. Ground personnel must also be knowledgeable about the charging and battery swap infrastructure at the airport and have the necessary tools and equipment to perform these tasks efficiently.

4.4 Vertiport Design Standards

One of the critical parts of a vertiport is the vertipad. A vertipad is a ground-based feature that consists of the TLOF, FATO, and safety area. In the airport planning process, regardless of the number of vertipads that are intended to be included in the AAM facility, each vertipad needs to meet the minimum dimensions of TLOF, FATO, and safety areas.

In September 2022, the FAA released an Engineering Brief (EB), which provides interim guidance for the design of vertiports for eVTOL aircraft. The dimensions of the vertiport FATO, TLOF, and safety area are based on the controlling dimension (CD) of the design of the eVTOL aircraft, which is defined for each vertiport facility, as shown in the figure below.

Figure 17: AAM Aircraft Dimensions



Source: FAA Engineering Brief 105

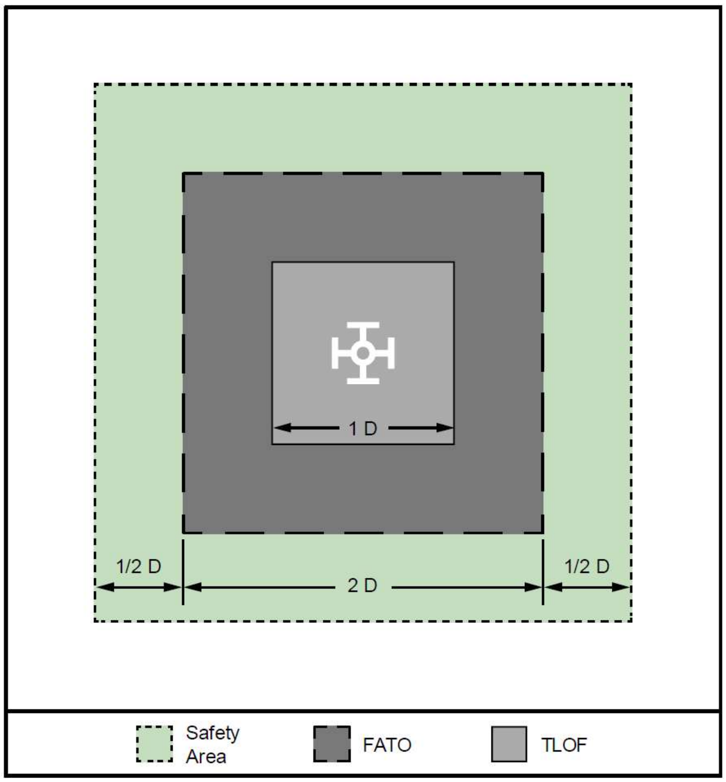
The table below provides the minimum dimensions of the take-off and landing area based on the controlling dimension of an eVTOL aircraft. One factor the airport planner needs to consider is that the current dimensional requirements are based on a generic VTOL aircraft. As more empirically validated performance data becomes available, these dimensions must be adjusted accordingly. Infrastructure planners must consider future changes to these dimensions based on eVTOL aircraft development.

Table 9: Vertiport Component Dimensions

Element	Dimension
TLOF	1D (for both circular & square shaped TLOF)
FATO	2D
Safety Area	3D (½D added to edge FATO)

Source: FAA Engineering Brief

Figure 18: Vertiport Components Minimum Dimension



Source: FAA Engineering Brief 105

TLOF Guidance

As defined in the previous section, TLOF is a load-bearing paved area centered in the FATO, on which the eVTOL aircraft will perform a touchdown or liftoff. According to the FAA Engineering Brief, the following guidelines will apply to TLOF:

- Can be placed at ground level or on elevated structures.
- On level terrain or a level structure.
- It is clear of penetrations and obstructions to the approach/departure and transitional surfaces.
- Support the maximum take-off weight of the aircraft that will be using TLOF.
- The placement of TLOF should account for rotor/propeller downwash in a load-bearing capacity.

- It is centered within its own FATO.
- The TLOF should have the same shape as the FATO and the safety area.

FATO Guidance

FATO is a defined area over which the VTOL aircraft completes the final phase of the approach to a hover or a landing and from which the aircraft initiates take-off. According to the FAA Engineering Brief, the following guidelines will apply to the FATO:

- Located at ground level or on elevated structures.
- Clear with no penetrations or obstructions except for navigational aids that are fixed-by-function.
- Support the weight of the VTOL aircraft and any ground support vehicle.
- Should have the load-bearing capacity of the rotor/propeller downwash load.
- Centered within its own Safety Area.
- Design the distance between the TLOF, FATO, and Safety Area perimeters to be equidistant regardless of the shape of the TLOF.
- The FATO surface prevents loose stones and any other flying debris caused by the rotor/propeller downwash or outwash.
- For FATO placed on an elevated surface or a rooftop, the following should be considered in the planning process:
    - The FATO and TLOF elevations are at or above the elevation of the adjacent Safety Areas.
    - The FATO is above the level of any obstacle in the Safety Area that cannot be removed.
    - Does not use permanent railing or fences that would be a safety hazard during aircraft operations.
    - Optionally, one can use safety nets that meet state and local regulations and are at least 5 feet wide.

Safety Area Guidance

The Safety Area is a defined area surrounding the FATO intended to reduce the risk of damage to the aircraft unintentionally diverging from the FATO. According to the Engineering Brief, the following guidelines apply to the safety area:

- It should be located at ground level, on elevated structures, at rooftop level, and can extend over water or in clear airspace.
- Clear with no penetration or obstructions except for navigational aids that are fixed-by-function.
- For the Safety Area placed on an elevated TLOF, no fixed objects within the Safety Area project above the FATO except those fixed-by-function, which must be on frangible mounts.
- The distance between the TLOF, FATO, and Safety Area perimeters to be equidistant regardless of the shape of the TLOF.
- The Safety Area should prevent loose stones and any other flying debris caused by downwash or outwash.

VFR Approach/Departure Guidance

The Visual Flight Rules (VFR) approach/departure path refers to the VTOL aircraft's flight track when landing at or taking off from a vertiport. The guidelines for these paths are as follows:

Alignment with Wind Direction:

a. Preferably, approach/departure paths should align with the predominant wind direction to minimize downwind operations and limit crosswind maneuvers.

Multiple Paths:

b. It is advisable to provide more than one approach/departure path, ideally oriented as close to reciprocal magnetic headings as possible (e.g., 180 degrees and 360 degrees) to offer flexibility in different wind conditions.

Additional Paths:

c. Additional paths should be based on an analysis of prevailing winds and, if applicable, should be separated from the primary path by at least 135 degrees.

Obstacle-Free Surfaces:

d. All approach and departure surfaces must be free of obstructions to ensure safe flight operations.

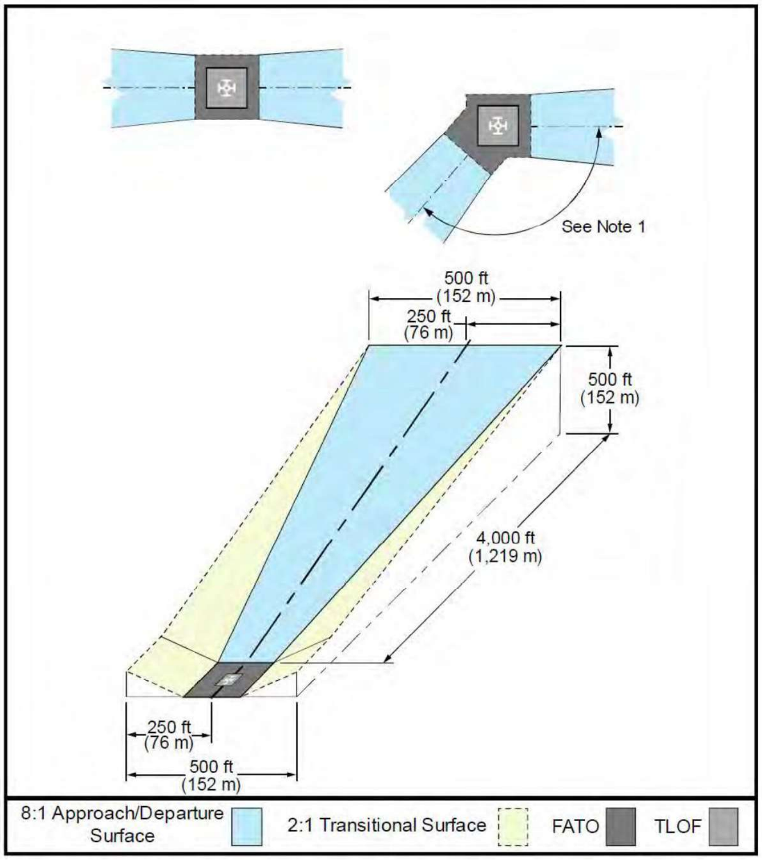
Approach/Departure Angles:

e. The approach/departure paths should provide an 8:1 ratio of horizontal to vertical units, ensuring the aircraft's gradual ascent and descent angle.

Independence from Runway Operations:

f. Whenever possible, vertiport approach/departure path design should be independent of the paths used for active runways, particularly if separate areas are designated for VTOL take-offs and landings. This separation enhances safety by preventing interference between different types of aircraft operations.

Figure 19: Vertiport Approach and Departure Paths



Source: FAA Engineering Brief 105

On-Airport Vertiport

Initial AAM operations will leverage existing ground-based infrastructure to support early AAM flights. While supporting AAM operations, several original equipment manufacturers (OEMs) and operators are actively developing vertiports in airports, focusing on utilizing existing on-airport helicopter landing facilities. According to the FAA Engineering Brief, all federally sponsored and obligated airport sponsors are required to ensure the safety, efficiency, and utility of the airport and its facilities.

On-Airport Location of TLOF

The TLOF should be placed in a location where it can be used for its intended operations, i.e., passenger or cargo operations. For passenger operations, the TLOF should be placed in such a way that it provides ready access to the airport terminal with applicable security measures in place or to the VTOL user's origin or destination. If needed, locate the TLOF away from but with access to fixed-wing aircraft movement areas, including runways, taxiways, and other areas of an airport that are used for taxiing, take-off, and landing of aircraft, exclusive of loading ramps and aircraft parking areas.

On-Airport Location of FATO

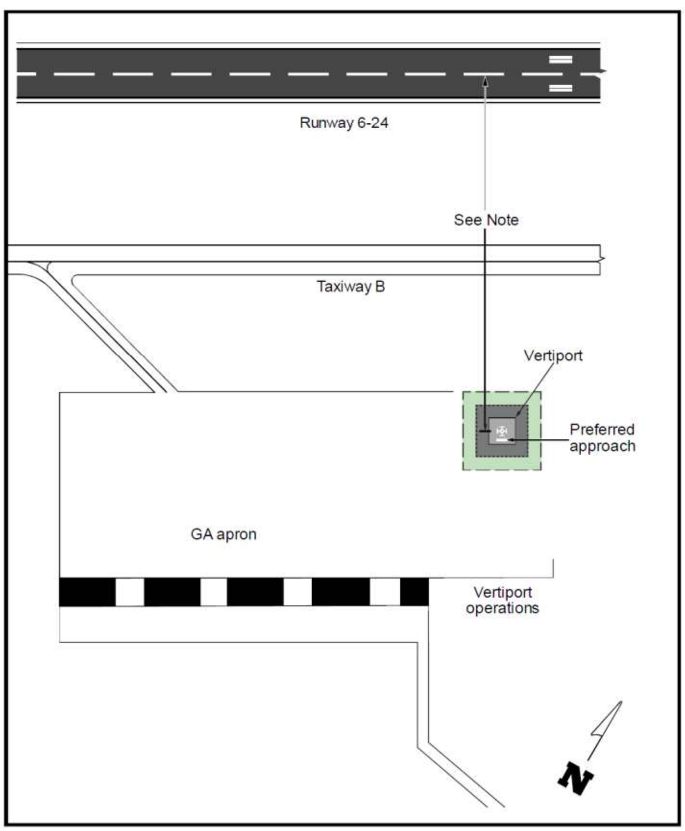
When considering adding a vertiport to the airport master planning process, the FAA Engineering Brief proposes standards of the distance between the centerline of an approach to a runway and the centerline of an approach to a vertiport's FATO for multiple, same-direction VFR operations. The table provided below provides the standards established by the FAA based on the maximum take-off weight of a VTOL aircraft.

Table 10: On-Airport FATO Requirements

Reference VTOL aircraft MTOW	Airplane Size	Distance from Vertiport FATO Center to Runway Centerline
12,500 pounds (5,670 kg) or less	Small Airplane (12,500 pounds (5,670 kg) or less)	300 feet (91 meters)
12,500 pounds (5,760 kg) or less	Large Airplane (12,500-300,000 pounds (5,670-136,079 kg)	500 feet (152 meters)
12,500 pounds (5,760 kg) or less	Heavy Airplane (Over 300,000 pounds (136,079 kg)	700 feet (213 meters)

Source: FAA Engineering Brief 105

Figure 20: On-Airport Vertiport Requirements



Source: FAA Engineering Brief 105

Vertiport Components

Taxiway

The FAA defines two types of taxiways for eVTOL aircraft. The first type is a "ground" taxiway, where aircraft with wheels either move independently or are towed along a hardened surface. The second type, known as a "hover" taxiway or "air" taxiway, is used by hover-capable eVTOL aircraft that move above the ground with a recommended hover height of 1 to 5 feet and a ground speed under 20 knots.

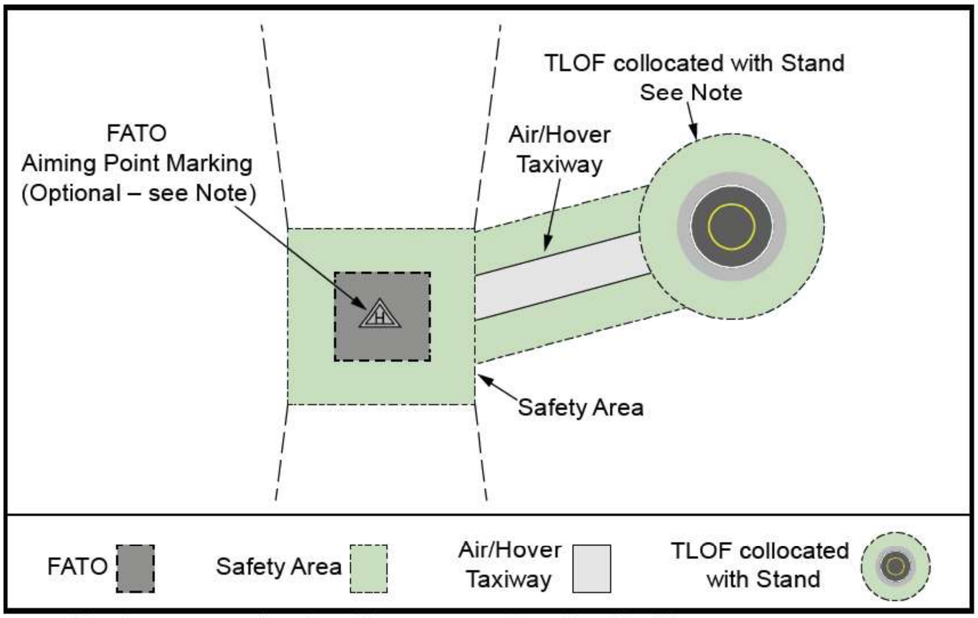
A "taxi route" comprises the taxiway and the necessary clearances on both sides. Hover taxiing has been found to expose passengers to stronger rotor wash and consume more energy, which is particularly challenging for electric aircraft. Consequently, ground taxiing is recommended for vertiports with high throughput and public operations. While the FAA Vertiport Engineering Brief does not provide interim guidance for taxiway design and standards, the Hovecon team utilized the AC 150/5300-13, Airport Design, taxiway guidelines for Group 1 Aircraft and AC150-5390-2D Helicopter to inform the provisional standards for both hover and ground taxi. The taxiway guidelines can be broken down into two broad categories: Hover taxi and ground taxi. The reader should keep in mind that these standards are being suggested as a proxy and are subject to change as the industry matures and more vertiport-focused standards for vertiport taxiways are provided by the FAA.

Hover Taxiway Standard

Several of the existing eVTOL aircraft under development are equipped with wheels or skids. Considering these two design configurations, the taxiway and taxi route guidelines for an eVTOL aircraft that is equipped with either skids or wheels should be a function of the eVTOL taxiway size, route marking, and type of operations. Based on the FAA recommendations, the minimum requirements for the hover taxi will dictate the taxiway and taxi route width. According to the FAA, the following guidelines should be considered:

- When the fleet comprises a combination of large ground taxiing eVTOL aircraft and smaller air taxiing eVTOL aircraft, the larger aircraft may dictate the taxiway/taxi route widths.
- If a wheel-equipped eVTOL aircraft uses the taxiway with wheels not touching the surface, design the facility with hover taxiway widths rather than ground taxiway widths.
- Where the visibility of the centerline marking cannot always be guaranteed, such as locations where snow or dust commonly obscure the centerline marking and it is not practical to remove it, determine the minimum taxiway/taxi route dimensions as if there were no centerline marking.
- Where the TLOF is located outside of the FATO, and aircraft access the TLOF after approaching and hovering at FATO, provide an air taxiway between the FATO and TLOF.
- The total taxiway width for a hover taxi should be a minimum of 1.67 x CD and 1.25 x CD for ground taxi of the largest eVTOL aircraft.

Figure 21: Hover Taxi Area



Source: AC 150/5390-2D, Heliport Design

Gate

Due to the operational characteristics of an eVTOL aircraft, three types of gates can be utilized at an airport or a vertiport. As per the FAA, general requirements dictate that vertiport gates must be sized to provide a minimum obstruction-free area for maneuvering and parking at designated air or landside locations. Based on the eVTOL aircraft, type of operation, and needs of the vertiport site, three types of gates can be placed at a vertiport.

- Turn-around gate
- Taxi-through gate
- Back-out gate

For all gate types, the size of the largest eVTOL aircraft that will use the vertiport will dictate the sizing of the vertiport gates. Generally, the gate that will be used to park an eVTOL aircraft should be a minimum of 0.83 x CD of the largest eVTOL aircraft.

For "turn-around" and “Back-Out” gate positions, the parking position should be located to ensure a minimum safe distance between the eVTOL aircraft's CD and any object, building, or safety area. This distance should be at least 10 feet (3 meters) for ground taxi operations and 0.28 x CD of the largest eVTOL, but not less than 10 feet (3 meters) for hover taxi operations.

For "taxi-through" gate positions, the eVTOL should be positioned such that the outermost rotor circle is at least 10 feet (3 meters) away from any object, building, or safety area during ground taxi operations. The minimum clearance should be 0.28 x CD of the largest eVTOL for hover taxi operations, but not less than 10 ft (3 meters). For ground taxis, this distance should be 10 feet (3 meters)

Additionally, parking positions should be arranged to maintain a minimum distance between the outermost rotor arc and the edge of any taxi route. The standard distance for this is 1/2 CD, but it should not be less than 30 feet (9.1 meters).

Parking positions should be sized according to the eVTOL's dimensions, with clearances tailored to the type of taxi operations (ground or hover). The most demanding operational requirements should guide the design. Typically, parking needs for skid-equipped eVTOLs are more demanding, but if a large, wheeled eVTOL is the largest aircraft expected to use the vertiport, the design should accommodate its needs. A second factor to consider is that wheel-equipped eVTOL requires a larger turning radius than hover taxi operations. This disparity should be accounted for when designing turnaround and back-out gates.

All parking positions should be capable of accommodating the largest eVTOL operating at the facility. If multiple parking positions are available, they can be of various sizes, with at least one capable of handling the largest eVTOL. Other positions can be tailored to smaller eVTOLs based on the operator's eVTOL aircraft fleet.

Parking

When anticipating more than one eVTOL aircraft at a vertiport simultaneously, it is essential to design the facilities with designated areas for parking. The size of these areas depends on the number and dimensions of the specific eVTOL aircraft to be accommodated. Not all parking positions need to accommodate the largest design aircraft, but each should be built to handle the size and weight of the expected eVTOLs.

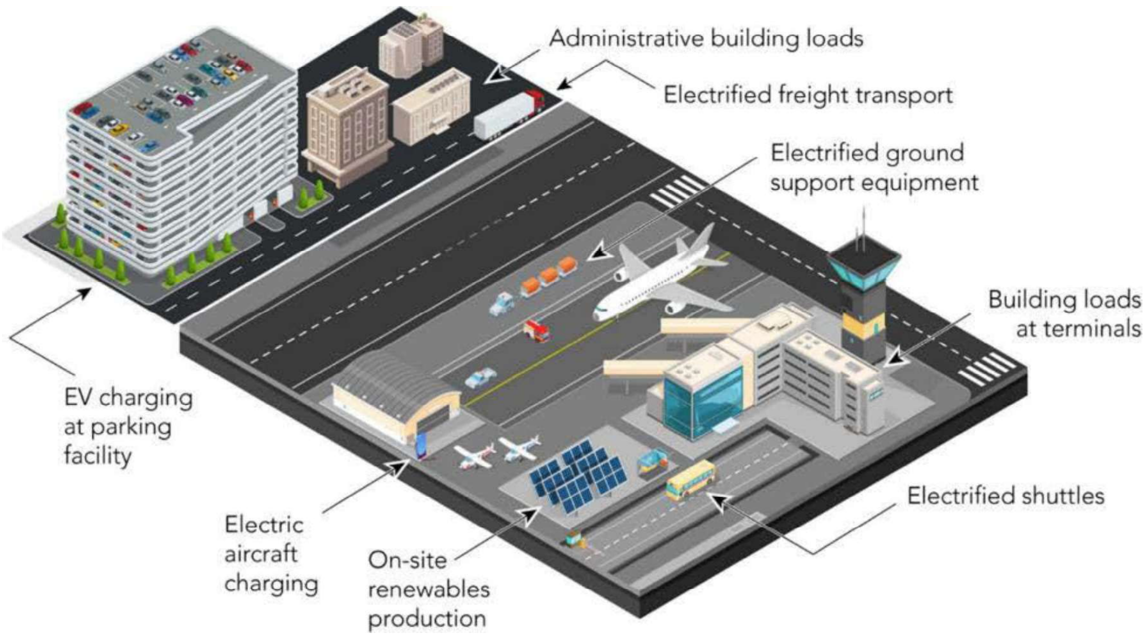
Key considerations for designing eVTOL parking positions include:

- **Separation Between Positions and Taxi Routes:**
    - Use the design aircraft to determine the separation distances between parking positions and taxi routes. For parking positions intended for different sizes of eVTOLs, the separation should be based on the larger eVTOL aircraft.
- **Support for Static Loads:**
    - eVTOL aircraft will be considerably heavy, due to the use of large batteries. Specific consideration needs to be placed on constructing parking positions to support the static loads of the eVTOLs that will use them.
- **Design of Parking Areas:**
    - Parking areas can be designed as one large, paved apron or individual paved positions.
- **Ground and Hover Taxi Turns:**
    - For eVTOL aircraft, consider the larger area required for ground taxi turns compared to hover taxi turns. This consideration is crucial when designing taxi intersections and parking positions.
- **Avoid Areas Around Propellers or Rotors:**
    - Ensure that the orientation of parked eVTOLs keeps the "avoid areas" around propellers or rotors clear of passenger walkways for safety reasons.

Electrification

Another critical component of a vertiport will be the charger required to support eVTOL charging needs. It is important to consider that with the advent of eVTOL aircraft, electrical charging loads will be added to airports and vertiports along with building loads and other areas of the premises that operate on electricity, such as lighting systems, HVAC, peak demand, grid capacity, storage, etc.

Figure 22: Airport Electricity Needs



Source: Federal Aviation Administration Vertiport Electrical Infrastructure Study[122]

Considering the continuous development of eVTOL aircraft, battery technology, and charger requirements, the following standards might apply:

- Power Requirements:
  - eVTOL aircraft manufacturers report peak Direct Current (DC) charging loads ranging from 300 kW to 1 MW. Vertiports should plan for at least 1 MW capacity, potentially scaling higher to accommodate future needs.
- Charging Infrastructure:
  - Stationary Chargers: Should be placed near the vertiport landing area or a designated charging area. The placement will depend on the aircraft's configuration, including direct taxiing or moving the aircraft using ground handling equipment.
- Utility Coordination:
  - Early engagement with utility providers is crucial for identifying suitable sites and managing costs related to electrical upgrades. Distance from existing power sources can significantly affect installation costs.

[122] FAA Vertiport Electrical Infrastructure Study, https://www.nrel.gov/docs/fy24osti/86245.pdf

- Operational Considerations:
  - Vertiports must consider the peak operating hours and ensure that the charging infrastructure can handle peak demand. For locations with heavy traffic, clustering of multiple charging stations and demand-side management may be necessary to manage the load without causing degradation in power quality.
- Environmental and Structural Considerations:
  - The feasibility of installing heavy mobile chargers or fixed infrastructure must be assessed for rooftop vertiports. Structural support and accessibility for maintenance are critical factors.
- Safety and Compliance:
  - Charging infrastructure must comply with all relevant safety standards, including but not limited to[123]:
    - **2021 International Fire Code (IFC):** Focuses on general safety precautions, emergency preparedness, and handling hazardous materials for alternative energy systems.
    - **NFPA 110 - Standard for Emergency and Standby Power Systems:** Provides guidelines for ensuring continuous power supply, crucial for maintaining uninterrupted electric aircraft operations.
    - **NFPA 70, NEC Article 625 - Electric Vehicle Charging System:** Details the requirements for electric vehicle charging infrastructure, including electrical conductors, equipment installation, and load balancing.
    - **NFPA 70, Article 706 - Energy Storage Systems:** Applies to energy storage systems (ESS) with capacities over 1 kWh, focusing on storage and energy provision during regular operations.
    - **NFPA 400 - Hazardous Materials Code:** Specifies the standards for storing and handling hazardous materials like lithium batteries.
    - **NFPA 418 - Standard for Heliports:** Establishes fire safety standards for heliports and rooftop hangars, with future updates to include electric mobility considerations.
    - **NFPA 855 - Standard for the Installation of Stationary Energy Storage Systems:** Provides guidelines for the design, installation, and maintenance of stationary energy storage systems, including battery systems.

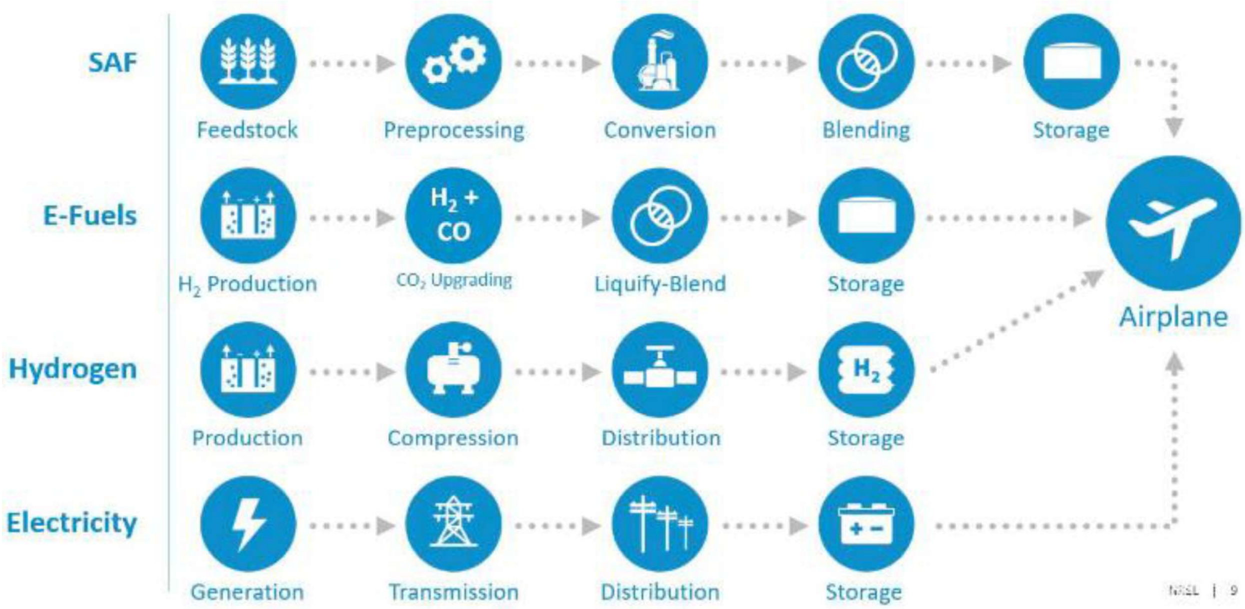
Sustainable Aviation Fuel and Hydrogen

In addition to electrification, the aviation industry, in line with the goal of decarbonization, is also looking into using alternative fuels, for example, sustainable aviation fuel (SAF) and hydrogen, for commercial air travel. Many airports and air carriers have committed to decarbonization and transformation of their operations as they prepare to serve a more diverse aircraft portfolio within their fleet.

[123] FAA Engineering Brief 105, https://www.faa.gov/sites/faa.gov/files/eb-105-vertiports.pdf

As technology evolves and aviation propulsion systems diversify, the complexity and interdependencies required to safely transport passengers and goods across various transportation modes will continue to rise. This growing complexity, coupled with aviation's stringent safety standards and global reach, is further amplified by the ongoing transformation of the aviation market. One of the principal considerations from an infrastructure planning perspective will be to address the supply chain and inclusion of stakeholders who were previously not involved in the planning process.

Figure 23: Supply Chain for SAF and Alternate Propulsion Fuels



Transporting and storing SAF and hydrogen will require careful consideration and will need to meet the regulations established by the local, state, or federal authorities. Currently, Several federal environmental laws, including the Clean Air Act, Clean Water Act, Resource Conservation and Recovery Act, Comprehensive Environmental Response, Compensation, and Liability Act, Toxic Substances Control Act, and Safe Drinking Water Act, govern activities and fuel structures at airports.[124] The Environmental Protection Agency (EPA) administers these laws, where state and tribal governments can apply to take on primary oversight and enforcement responsibilities, ensuring that federal standards are met while allowing for local control.

Fuels are stored in various airport structures, including aboveground storage tanks (ASTs), field-constructed tanks (FCTs), airport fuel hydrant systems (AHSs), connected pipelines, and fuel transport trucks. Traditionally, these structures have stored fossil fuels; however, some airports and airlines have started using SAF. SAF adheres to the same American Society for Testing and Materials (ASTM) fuel quality standard as Jet A, so compatibility issues are not anticipated.[124]

[124] U.S. Airport Infrastructure and Sustainable Aviation Fuel, https://afdc.energy.gov/files/u/publication/U.S.-airport-infrastructure-and-sustainable-aviation-fuel.pdf

Hydrogen storage poses a major technological challenge for the advancement and broad adoption of fuel cell technologies in aviation. Hydrogen offers the highest energy per mass of any fuel, but its low density at ambient temperatures leads to a lower energy per unit volume. This necessitates the development of advanced storage methods with the potential for higher energy density.[125] Hydrogen can be stored either as a gas or a liquid. When stored as a gas, it typically requires high-pressure tanks with pressures ranging from 350 to 700 bar (5,000 to 10,000 psi). To store hydrogen as a liquid, it must be kept at cryogenic temperatures due to its boiling point of −252.8°C at atmospheric pressure. Alternatively, hydrogen can be stored on solid surfaces through adsorption or within solid materials through absorption.[126]

Additional standards and requirements may be applicable for storing hydrogen, depending on the location and the capacity available at the vertiport.[127] The reader is encouraged to refer to the Occupational Safety and Health Standards for Hydrogen provided by the Occupational Safety and Health Administration (OSHA).

Security Parameter

For vertiports located within secured airport areas, the Transportation Security Administration (TSA) may require passenger screening if it hasn't been conducted at the VTOL passengers' departure point. Airports may need to provide designated screening areas or procedures before passengers enter secured zones.[128] Multiple VTOL parking positions or terminal locations should also be established to accommodate passenger screening and cargo handling needs.

General guidance for safety and security includes:

c. Access Control and Safety Barriers:

    a. Ground-Level Vertiports: A safety barrier, such as a fence or wall, should be installed around the VTOL aircraft operational areas. This barrier should be positioned outside the Safety Area and below the 8:1 slope of the approach/departure surface.

    b. Approach/Departure Path Barriers: If necessary, barriers should be placed outside the perimeter of the Safety Area and below the elevation of the approach/departure and transitional surfaces, as outlined in the standards.

    c. Barrier Height: The barriers should be high enough to deter unauthorized access but not so high as to pose a hazard to aircraft operations.

d. Security Measures:

    a. Control access to airside areas with adequate security measures, as recommended or required by the TSA.

    b. Passengers and baggage arriving from an unregulated vertiport must be screened before entering a Sterile Area.

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[125] Hydrogen Storage, https://www.hydrogen.energy.gov/program-areas/storage

[126] Hydrogen Physical Storage, https://www.energy.gov/eere/fuelcells/hydrogen-storage

[127] Occupational Safety and Health Standards – Hydrogen, https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.103

[128] Security Considerations for AAM, https://www.sskies.org/images/uploads/subpage/PARAS_0041.AAMOperations_.FinalReport_.pdf

e. Install cautionary signage, such as a vertiport caution sign, at all access points to alert and inform individuals of operational areas and potential hazards.

4.5 Prototypical Minimum Standards

Based on the guidance provided in the FAA Engineering Brief 105, this section will give an overview of the minimum standards for a vertiport and all its associated components. Based on the vertiport component sizing requirements outlined in the FAA Engineering Brief, the first step is to determine the CD of an applicable eVTOL aircraft. For the purpose of this document, the Beta Technologies eVTOL aircraft will be used as the reference aircraft. The Beta Technologies eVTOL aircraft is a Lift+Cruise aircraft with a CD of 50 ft. For the reader's reference, a detailed list of existing eVTOL aircraft designs with their associated CD is provided in Appendix C. Additionally, the reader should also note that the provided standards are based on existing requirements and standards. These requirements will change based on future regulatory requirements as they are developed in the future.

Vertipad Standard

For this document, a vertipad will consist of a minimum of a FATO, TLOF, and safety area. The minimum sizing requirement for a vertipad to accommodate a Beta Technologies eVTOL aircraft is provided in Table 11.

Table 11: FATO, TLOF, and Safety Area Dimension

Vertipad (Square and Circular)	FAA Engineering Brief	Dimension
TLOF	1D	50 feet
FATO	2D	100 feet
Total Safety Area	3D	150 feet

Taxiway Standard

Per the FAA requirement, the interim taxiway standard for a vertiport should follow the taxiway design guideline for General aviation, transport, and helicopter heliport taxiways in AC 150/5390-2D, Heliport Design.

Table 12: Vertiport Taxiway Width

Taxiway type[129]	Total Taxiway Width
Ground Taxi	62.50 feet
Hover Taxi	83.50 feet

[129] Heliport Design, https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_150_5390_2D_Heliports.pdf

Gate/Parking Position Standard

The gate size will depend on the eVTOL aircraft it will accommodate. Based on the minimum requirements provided by the FAA, the minimum standard for the Beta Technologies eVTOL aircraft is provided in Table 13.

Table 13: Vertiport Gate Requirement

Gate type[130]	Dimension
Taxi Through Gate	42 feet
Back-out Gate	42 feet
Turn Around Gate	42 feet

Markings and Lighting

1. General Lighting:
    a. In-pavement Lighting: Recommended over elevated lighting to minimize obstructions and interference.
2. Type of Lights:
    a. TLOF and FATO Lighting: Use FAA-type L-861H omnidirectional perimeter light fixtures, which support multiple approach directions. These lights should have a chromaticity that meets the "aviation green" standard as per SAE AS 25050 for incandescent lights, with specific standards for LED lights detailed in EB 67.
    b. Lighting Intensity and Placement: Lights should be strategically placed to outline the edges of the TLOF and FATO, ensuring they are visible from various approach angles. The intensity must be sufficient to be seen in poor visibility but not so bright as to cause glare or interfere with the pilot's vision.
3. Floodlights:
    a. Installation: Floodlights should be positioned to avoid casting shadows in operational areas or creating glare that could interfere with the pilot's vision. Floodlights should be capable of being turned off remotely by the pilot or air traffic control to prevent disruption during critical phases of flight.
4. Identification Beacon:
    a. Specifications: The beacon must flash in a distinct pattern (white/yellow/green) at a rate of 30 to 45 flashes per minute, making it recognizable from various distances and angles.
5. Wind Cone:
    a. Purpose: To provide pilots with real-time wind direction and speed information.

[130] Heliport Design, https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_150_5390_2D_Heliports.pdf

b. Specifications: The wind cone should conform to the FAA AC 150/5345-27 and be illuminated for visibility during night operations. It must be visible from at least 500 feet away and from the TLOF to ensure that pilots can assess wind conditions accurately.

6. Marking Requirements
    a. General Markings:
        a. Materials: Markings should be applied using durable paint or preformed materials that can withstand environmental conditions. Reflective paint and retroreflective markers can enhance visibility, but should be used cautiously to avoid confusing reflections or glare.
    b. TLOF Perimeter Marking: A 12-inch-wide solid white line outlines the TLOF, providing a clear boundary for pilots during landing and take-off.
7. Identification Symbol:
    a. Purpose: Identifies the location as a vertiport, marks the TLOF, and provides visual cues to the pilot.
    b. Marking Guidance: Vertiport facilities should use the "H" symbol to identify the location as a vertiport.
        a. Locate the "H" in the center of the TLOF and orient on the axis of the primary preferred approach/departure path.
        b. Place a one-foot-wide bar 2 feet below the "H", the width of the "H", when it is necessary to distinguish the preferred approach/departure direction.
        c. A "VTL" marking must be used to indicate a vertiport. Text height is a minimum of 3 feet and a maximum of 5 feet.
8. Placement and Size: It should be centered within the TLOF and large enough to be visible from the air at a distance, providing a clear visual reference point for landing.

5 | AAM Implementation Considerations for San Diego

5.1 Summary Overview

Purpose of the Implementation Strategy

The Regulatory Framework and this initial Implementation Strategy are a roadmap for the AAM planning process, intended to assist decision-makers and planners among the member communities of the San Diego Association of Governments (SANDAG) with preparing and implementing plans for AAM facilities and operations. In addition, SANDAG stakeholders and community members may also find this informative for understanding AAM and the planning processes applicable to their local municipalities. While this regulatory framework does not include every process, regulation, or consideration that could be encountered, and some of the material may become superseded by future regulatory guidance or AAM industry advancements, developers, operators, municipalities, and citizens may find this guide a helpful resource to understand the nature of AAM operations, AAM facilities, and the regulations applicable to AAM planning, development, and implementation.

Overview of the AAM ecosystem in San Diego

San Diego has been at the forefront of integrating Advanced Air Mobility (AAM) technologies, leveraging initiatives like the FAA's Unmanned Aircraft Systems (UAS) Integration Pilot Program (IPP), the Chula Vista Police Department's Drone as First Responder (DFR) program, and the San Diego Association of Governments' (SANDAG) development of an AAM policy framework and implementation strategy.

FAA UAS Integration Pilot Program (IPP) and Related Accomplishments

In 2018, the City of San Diego was selected as one of ten participants in the FAA's UAS IPP, which aims to explore the safe integration of drones into the national airspace. San Diego's participation led to several pioneering achievements:

- **Public Safety Operations**: The Chula Vista Police Department (CVPD) became the first public safety organization in the nation to receive a Beyond Visual Line of Sight (BVLOS) Certificate of Authorization. This enabled the CVPD to deploy drones rapidly to incident scenes, providing real-time video feeds to command centers and enhancing situational awareness for first responders.
- **Medical Deliveries**: In collaboration with partners like Matternet and UPS Flight Forward, drones were used to transport medical specimens between healthcare facilities, improving delivery speed and reliability.
- **Commercial Deliveries**: Partnerships with companies such as Uber Elevate facilitated the testing of food and beverage deliveries via drones in urban environments, showcasing the potential for commercial drone applications.

Chula Vista Drone as First Responder (DFR) Program

The CVPD's DFR program has been a standout success in integrating drone technology into daily public safety operations:

- **Operational Achievements**: As of the program's reporting, drones responded to over 4,300 calls, assisted in 558 arrests, and were the first to arrive on scene nearly 2,000 times, with an average response time of approximately 224 seconds. Notably, in over 1,000 instances, the deployment of drones prevented the need to dispatch traditional patrol units, optimizing resource allocation and reducing potential confrontations.
- **Regulatory Milestones**: The program achieved several firsts, including the Tactical BVLOS waiver, allowing officers to operate drones beyond their visual line of sight within specific parameters, and the 2-to-1 Operations authorization, enabling a single operator to control two drones simultaneously, thereby expanding coverage and efficiency.

SANDAG's AAM Policy Framework and Implementation Strategy

Recognizing the transformative potential of AAM, SANDAG, in partnership with the San Diego County Regional Airport Authority, initiated efforts to develop a comprehensive policy framework and implementation strategy:

- **Strategic Objectives**: The initiative aims to establish a unified vision for AAM technologies, identify opportunities to complement ground transportation demands, and integrate AAM into the regional transportation system. This includes forming a collaborative forum for discussion and information-sharing to guide the development of the AAM policy framework and implementation strategy for local jurisdictions.
- **Stakeholder Engagement**: SANDAG has convened the AAM Collaborative, bringing together public and private stakeholders to discuss the complexities of incorporating AAM into the region. This collaborative effort seeks to align future AAM opportunities with community needs and goals, addressing factors such as regulatory landscapes, permitting processes, and infrastructure requirements.

Through these coordinated efforts, San Diego continues to position itself as an active participant in the adoption and integration of advanced air mobility solutions, enhancing public safety, healthcare logistics, commercial services, and regional transportation planning.

Key stakeholders (government, private sector, academia, community)

San Diego's advanced mobility integration efforts involve a diverse array of stakeholders collaborating to implement and promote innovative transportation solutions. Key participants include:

San Diego Association of Governments (SANDAG)

SANDAG leads regional planning and has been instrumental in developing strategies for Advanced Air Mobility (AAM). They have partnered with various organizations to create an AAM implementation strategy, aiming to integrate these technologies into the regional transportation system.

Local/Regional Government Agencies

- **City of San Diego**: As a participant in the FAA's Unmanned Aircraft Systems Integration Pilot Program, the city has been active in exploring drone applications for public safety and other services. The City of San Diego provides guidance as a Project Development Team (PDT) member and is owner of various aviation assets throughout San Deigo.

- **San Diego County Regional Airport Authority (SDCRAA)**: As a project partner, the SDCRAA oversees the San Diego International Airport (SAN) and is the region's Airport Land Use Compatibility authority. SAN worked closely with SANDAG and Caltrans to ensure the strategy was aligned with our regional aviation goals and provide integral expertise, support, and direction.

Federal and State Agencies

- **Federal Aviation Administration (FAA)**: The FAA provides federal regulatory oversight and has previously selected San Diego for pilot programs to integrate uncrewed aircraft systems into the national airspace.
- **California Department of Transportation (Caltrans)**: Caltrans, a project partner and Grantor, collaborates on infrastructure projects and regulatory frameworks to support advanced mobility initiatives.

Industry Partners

SANDAG and the AAM team worked alongside industry leaders to provide expert insights that informed various components of this effort. From Collaborative meetings to one-on-one sessions, industry leaders joined our regional discussions to provide context around interoperability, anticipated support infrastructure, and how to bridge the public-private sector gap. Industry professionals ranged from Original Equipment Manufacturers (OEMs) to meteorological experts, digital support infrastructure suppliers, and beyond.

Academic and Research Institutions

Local universities and research centers contribute to technological advancements and policy development, supporting the integration of advanced mobility solutions throughout the country. San Diego is home to over seven universities that have some variation of drone/UAS curriculum, including universities with dedicated drone labs, such as San Diego State University's (SDSU) Center for Unmanned Systems Technologies, and the University of San Diego's (UCSD) DroneLab – Qualcomm Institute.

Community and Advocacy Groups

Organizations focused on public engagement ensure that advanced mobility projects address community needs and promote equitable access to new transportation technologies.

These stakeholders collectively drive San Diego's efforts to integrate advanced mobility solutions, aiming to enhance transportation efficiency, safety, and sustainability in the region. Groups such as the Association for Uncrewed Vehicle Systems International (AUVSI) with national chapters that provide a localized UAS advocacy community also seeking the seamless, safe integration of AAM technology.

5.2 Vision and Goals

San Diego's long-term vision for Advanced Air Mobility (AAM) is to integrate innovative aerial transportation solutions into the broader aviation and surface transportation network, enhancing mobility, reducing congestion, and promoting sustainability. This vision focuses on creating a seamless, multimodal transportation ecosystem where AAM services complement existing infrastructure, improve accessibility, and support economic growth.

Key Elements of the Long-Term AAM Vision

1. Integrated, Multimodal Transportation System

- **AAM as a First-, Middle- and Last-Mile Solution**: Urban Air Mobility (UAM) and Regional Air Mobility (RAM) services, such as eVTOL (electric vertical takeoff and landing) aircraft, will connect passengers to transit hubs, airports, and key business districts, reducing reliance on personal vehicles.
- **Seamless Interoperability**: AAM infrastructure, such as vertiports, will be strategically placed near key transit nodes, such as airports, transit and logistics centers, and major employment hubs.

2. Smart Infrastructure & Urban Planning

- Development of AAM Vertiports: Identifying and zoning areas for public and private vertiports, ensuring compatibility with land use and environmental regulations.
- Smart Skies & Urban Air Traffic Management (UTM): Establishing a regional air traffic management system to coordinate drone and eVTOL operations, integrating with the FAA's evolving NextGen ATM system.

3. Public Safety, Equity, and Accessibility

- Emergency Response & Public Services: Expand Drone as First Responder (DFR) programs and use AAM for medical deliveries, disaster relief, and law enforcement.
- Community-Centered Approach: Ensure that AAM is accessible, equitable, and provides benefits to all residents, including underserved communities.

4. Economic Development & Workforce Readiness

- Innovation Hub for AAM: Position region as a leader in AAM development, fostering collaborations with universities, tech firms, and startups due to favorable, predictable climate and bi-national position.
- Job Creation: Establish training programs for AAM pilots, maintenance technicians, and support personnel to build a skilled workforce for future transportation technologies.

5. Sustainability & Climate Goals

- Zero-Emission Air Mobility: Prioritizing the deployment of electric and hydrogen-powered VTOLs and supporting the expansion of clean energy infrastructure around vertiports.
- Reducing Ground Congestion: AAM will serve as a viable alternative to traditional ground transportation, anticipating shorter travel times and lowering greenhouse gas emissions.

6. Policy & Regulatory Leadership

- SANDAG's Role in AAM Policy Development: Continue refining a comprehensive AAM framework to ensure safe, efficient, and community-aligned integration into the transportation system and seek future public-private partnerships.

- FAA & State Partnerships: Collaborate with FAA, Caltrans, and municipal agencies to shape airspace policies, infrastructure funding, and seek future public-private partnerships.
- Develop Strong Key Objectives: Develop robust key objectives and performance metrics to maximize the long-term benefits of scaled AAM integration. (e.g., enhancing urban mobility, reducing emissions, fostering economic growth)
- Align Regional Goals: Ensure regional and jurisdictional priorities are reviewed and reflected in the development of AAM planning and policy initiatives. Seamless policy integration will require considerable coordinated effort and public alignment.

5.3 Infrastructure Development

The successful integration of AAM in the San Diego region requires a robust infrastructure framework to support safe and efficient operations. This includes vertiport and landing site development, airspace management, energy and charging solutions, and maintenance and support facilities. Infrastructure planning must align with regional transportation strategies, ensuring seamless multimodal connectivity while meeting federal, state, and local regulatory requirements.

AAM infrastructure must be strategically located to enhance accessibility, reduce congestion, and integrate with the existing transportation system. Site selection criteria, energy demands, and airspace coordination will be critical factors in determining the success of the AAM ecosystem. Furthermore, collaboration with stakeholders such as the FAA, utility providers, and transit agencies will play a key role in addressing operational challenges.

The following table outlines key considerations for infrastructure development:

Category	Details
Vertiports & Landing Sites	Establish site selection criteria prioritizing proximity to key transit hubs, business centers, and high-demand corridors.
	Align with regional land-use planning to integrate vertiports into existing infrastructure (airports, public transit stations, commercial districts).
	Implement noise and environmental impact assessments to comply with FAA and CEQA regulations.
	Ensure multi-modal connectivity, including pedestrian, electric vehicle (EV), and public transit access.
Airspace Management	Collaborate with the FAA and Air Traffic Control (ATC) to ensure safe integration of AAM operations into controlled airspace.

	Implement Unmanned Aircraft System Traffic Management (UTM) solutions to coordinate low-altitude air traffic with NextGen ATM systems.
	Define dedicated AAM corridors for passenger and cargo eVTOL operations to prevent conflicts with commercial aviation.
	Develop real-time airspace monitoring and deconfliction systems utilizing AI-driven automation.
Energy & Charging Infrastructure	Assess grid capacity to support widespread electrification of eVTOL operations, coordinating with local utilities (SDG&E).
	Explore hydrogen-powered AAM alternatives for long-range, high-capacity applications.
	Deploy rapid charging and battery-swapping infrastructure at vertiports to minimize turnaround times for eVTOLs.
	Integrate renewable energy solutions (solar, wind, microgrids) to ensure sustainability in AAM operations.
Maintenance & Support Facilities	Develop AAM service hubs to provide maintenance, inspections, and operational support for eVTOL fleets.
	Ensure compliance with FAA Part 145 repair station standards for AAM servicing.
	Plan logistical hubs for spare parts storage, remote diagnostics, and predictive maintenance technologies.
	Train a specialized workforce in AAM maintenance and operations to support long-term industry growth.

5.4 Policy & Regulatory Considerations

As local governments within the SANDAG region begin to formulate their own AAM strategies, a clear understanding of the regulatory and policy landscape is paramount. This section highlights key considerations from the earlier sections of this strategy document, providing a framework for navigating the complex web of regulations, standards, and policies that will shape AAM implementation at the local level. Successfully integrating AAM requires proactive engagement with these factors to ensure safety, compliance, and community acceptance.

Establishing a well-defined regulatory framework is crucial for the safe and efficient integration of AAM. This involves addressing various aspects, such as AAM operations, safety protocols, intergovernmental coordination, environmental concerns, and infrastructure connectivity. Considerations during the planning, design, and implementation phases of vertiport development are key to the success of AAM. Early-stage planning should focus on emergency services enhancement, public awareness and acceptance, stakeholder collaboration, and ensuring inclusive and equitable mobility. A comprehensive safety and security framework, incorporating safe vehicle design, robust infrastructure, secure operational protocols, and personal safety measures, is essential. A "Crawl-Walk-Run" methodology, aligned with FAA guidelines, can facilitate entry into service while strategically integrating advanced AAM technologies. Updating local government land development codes and addressing the electrical grid's capacity are also vital. A clear and uniform vision for integrating AAM, addressing gaps and concerns, defining stakeholder roles, and informing environmental requirements are necessary. The SANDAG AAM Collaborative has worked to finalize a project charter to level-set expectations and provide parameters for participants in the development of integration plans.

Category	Details
Federal, state, and local regulations affecting AAM operations	Successfully implementing AAM requires navigating a complex web of regulations at the federal, state, and local levels.
	* At the **federal level**, the FAA plays a central role in ensuring the safety and efficiency of civil aviation. Local governments must stay informed about FAA regulations related to airspace management, aircraft certification, and operational procedures.
	* **State governance**, particularly in California, involves adherence to Airport Land Use Compatibility Plans (ALUCPs) overseen by Airport Land Use Commissions (ALUCs). Local planners should evaluate vertiport sites for their status within an Airport Influence Area (AIA) and coordinate with relevant airports.
	* **Local regulations**, such as municipal codes and permitting processes, also significantly impact AAM development. Compliance with local zoning laws, environmental regulations, and community impact assessments is essential for vertiport construction.
Safety, security, and privacy standards	Ensuring the safety and security of AAM operations is critical for public acceptance and regulatory compliance.

	Local governments should prioritize the development of **emergency management plans** that integrate AAM operations with existing community and airport emergency response systems.
	Cybersecurity is another key consideration, requiring collaboration with providers and users of secure networks to establish robust protocols for data protection.
	Adhering to **TSA requirements** for passenger processing facilities, ticketing areas, and airport operation areas is also crucial for maintaining security.
Zoning, noise, and environmental impact considerations	Integrating AAM into the urban environment requires careful consideration of zoning regulations, noise impacts, and environmental sustainability.
	Local planners should update **land development codes** to enable efficient AAM operations through a model vertiport permitting process.
	Noise assessments are necessary to ensure compliance with FAA standards and minimize impacts on surrounding communities. Strategies for low emissions and noise abatement should be prioritized to align with environmental policies and promote community acceptance.
	Compliance with the **California Environmental Quality Act (CEQA)** is essential for assessing and mitigating potential environmental impacts, including air quality, biological resources, and water resources.
Data governance and cybersecurity measures	As AAM operations generate vast amounts of data, establishing clear data governance and cybersecurity measures is crucial for protecting privacy and ensuring system integrity.
	Local governments should collaborate with the FAA, UAS Service Suppliers (USSs), and private industry stakeholders to develop **protocols for secure and timely data requests**.
	Implementing **cybersecurity plans** with customized protocols and systems is essential for protecting vertiport facilities and AAM operations from cyber threats.

	Adopting the **National Cybersecurity Strategy** and relevant guidance materials from organizations like IATA and ICAO can help local governments establish robust cybersecurity frameworks.

5.5 Operational Challenges & Risk Mitigation

This section will address the **operational challenges and risk mitigation strategies** crucial for successfully implementing AAM in the San Diego region. This includes public acceptance and community engagement, environmental and geographic challenges, workforce development, and integration with existing transportation networks. The "Infrastructure Requirements" section provides an overview of infrastructure considerations for establishing vertiports and integrating AAM operations. The standards are based on FAA heliport regulations, industry research, and FAA Engineering Brief 105. It also identifies critical components and considerations for an AAM Regulatory Framework.

Integrating Advanced Air Mobility (AAM) into existing systems, such as the FAA's National Airspace System (NAS), airports, and multi-modal transportation networks, is crucial for vertiport development. Key questions to consider include how vertiports and AAM operations will influence the NAS, whether airports can support AAM operations, and how AAM can collaborate with current airport operations. Reviewing airport master plans, ALUCs, and Airport Layout Plans (ALPs) is vital for understanding future projects and land uses that allow vertiport development. Transportation plans at the local, regional, state, and federal levels should be assessed to determine how AAM can enhance existing infrastructure and align with transportation network priorities. This integration should also consider how AAM services can coincide with and support the objectives outlined in California's Aviation System Plan (CASP) and other transportation plans. The incorporation of AAM must consider the existing infrastructure and transportation options in San Diego County. San Diego International Airport (SAN) operates nearly 500 flights daily and serves as a key transportation hub in the region. Understanding the airport's operations, passenger numbers, and airline partnerships is essential for integrating AAM services.

Category	Description
Public Acceptance & Social Equity	**Affordability strategies** should aim to make AAM services accessible to various communities. **Public outreach programs** with transparency can educate communities about the benefits and challenges of AAM.
Environmental & Geograph Challenges	**Emergency planning** must account for weather-related disruptions and geographic constraints to ensure rapid and effective responses. AAM could be used for faster, more efficient emergency response, medical evacuations, and wildfire control.

Workforce Development	Skilled labor needs in AAM encompass pilots, maintenance personnel, air traffic controllers, and other specialized roles. **Certification pathways** must be established in accordance with FAA guidelines to ensure AAM personnel are adequately trained and qualified. Integrating AAM can foster local employment opportunities in operations, maintenance, and administrative roles.
Multi-Modal Connectivity	**Seamless multi-modal connectivity** should be ensured with last-mile connectivity solutions to link vertiports with other transport modes. **Multimodal transport strategies** should optimize the overall transportation ecosystem. The San Diego region is primarily interested in achieving regional readiness for AAM with a multi-modal approach to transportation and cross-jurisdictional collaboration for infrastructure investments.

5.6 Economic & Market Opportunities

Exploring the economic and market opportunities presented by AAM is crucial for its sustainable integration. This includes considering various business models, such as passenger transport, cargo delivery, and emergency services. Public-private partnerships (P3s) and diverse funding mechanisms can play a significant role in supporting AAM initiatives, along with incentives and subsidies for early adopters to stimulate market growth. Identifying viable markets and potential origin and destination (O&D) locations based on interest and anticipated demand is essential. Discussions with local airports, airlines, fixed-base operators (FBOs), and other tenants can provide valuable insights into connectivity and public-private partnership opportunities. Market studies with forecasted demand, growth, and types of AAM operations, along with cost-benefit analyses (CBAs) to determine profitability and ROI, are important for assessing the financial feasibility of AAM and P3s in the region. A well-defined AAM market is shaped by interest from other businesses, specific analyses, and forecasts.

Section 6 will focus on economic and market opportunities that the audience should remember and consider from the previous sections of this strategy document when building their own AAM strategy. These include business models, public-private partnerships, incentives, and the potential for growth in the local aerospace industry.

Category	Description
Business Models	AAM offers various business models, and the specific model can significantly influence infrastructure needs, operational requirements, and regulatory considerations. When defining the AAM market, a process should be used that includes market cost-benefit analysis, forecasts, market viability studies, and profitability studies.
	Some ways that AAM may be utilized include air taxi or charter, cargo, medical, passenger, personal or recreational, and military.
	The specific scenarios or examples that illustrate the use of AAM to address various transport needs can be defined as use cases.
	Understanding the specifics of intended operations is an important component in developing a successful vertiport.
Public-Private Partnerships (P3s) and Funding Mechanisms	Public-private partnerships (P3s) and various funding mechanisms will be essential for AAM. Stakeholders should consider public funding sources, private investments, and innovative financing models to support infrastructure development and operational costs.
	Discussions with business entities such as the local airport, airlines, fixed-base operators (FBO), and other tenants can provide valuable insight into interest around connectivity and other public-private partnerships.
	A sustainable business model can attract investments and maintain operational viability over the long term.
Incentives and Subsidies	Incentives and subsidies can play a crucial role in encouraging early adoption of AAM technologies and services. Policymakers can offer tax breaks, grants, and other incentives to attract AAM operators and stimulate demand.
Aerospace Industry Growth	AAM has the potential to drive significant growth in the local aerospace industry. Investment in the AAM sector can lead to the development of new technologies, the creation of high-skilled jobs, and the increased commercial viability of AAM systems.
	This opens valuable opportunities for public-private partnerships to accelerate technological development, inform regulatory frameworks, and facilitate infrastructure planning.

	Integrating AAM can foster local employment opportunities in various domains, including operations, maintenance, and administrative roles.

5.7 Phased Implementation Roadmap

Recommended Strategic Implementation Timeline - Overview

Short-Term (2025-2030)

- Pilot AAM projects, including urban air taxi routes and expanded drone delivery programs.
- Establish initial vertiport locations and regulatory framework.
- Develop partnerships with private sector AAM operators and infrastructure providers.

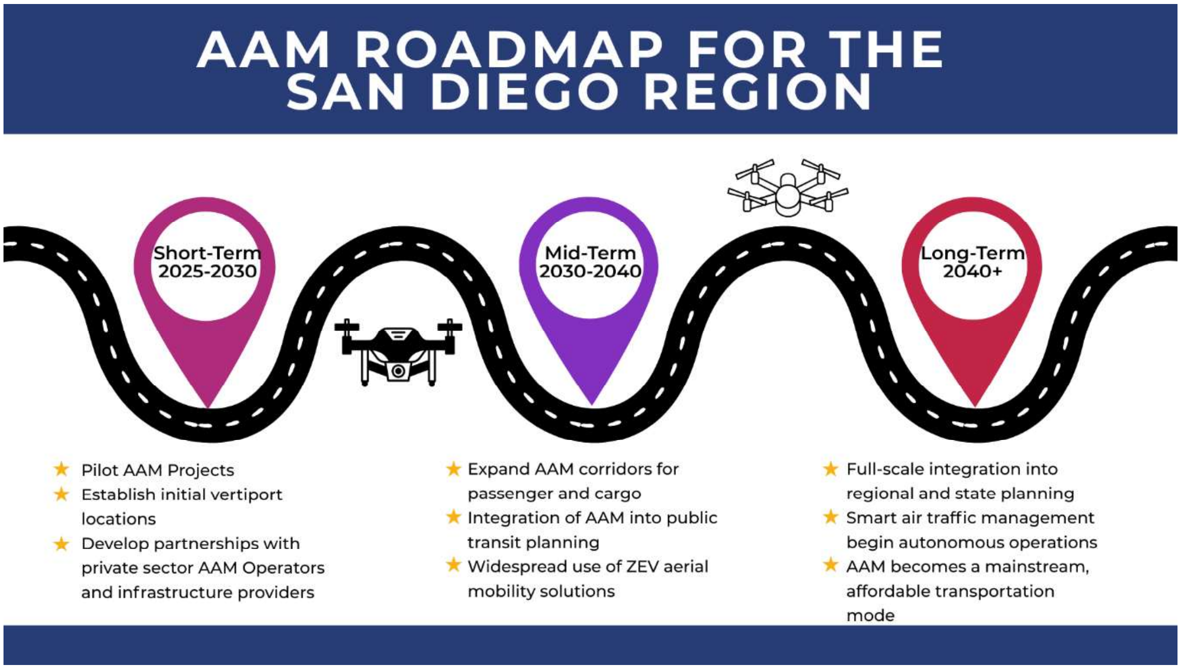
Mid-Term (2030-2040)

- Expansion of AAM corridors for passenger and cargo transport.
- Integration of AAM into public transit planning, including MTS (Metropolitan Transit System) and rail services.
- Widespread deployment of zero-emission aerial mobility solutions.

Long-Term (2040 and beyond)

- Full-scale AAM integration into regional and state transportation planning.
- Smart air traffic management systems begin autonomous operations.
- AAM becomes a mainstream, affordable transportation mode, complementing existing mobility options.

The San Diego region's long-term vision for AAM is centered on safety, efficiency, equity, and sustainability, ensuring that aerial mobility enhances, not replaces, traditional transit systems. With strategic planning, public-private partnerships, and regulatory innovation, San Diego aims to be a global leader in all forms of mobility and transportation integration.



A Strategic Implementation Plan for SANDAG and Stakeholders

This roadmap provides a structured plan for integrating Advanced Air Mobility (AAM) into the San Diego region's transportation ecosystem, aligning with key policy, infrastructure, technology, and workforce development initiatives.

Phase 1: Short-Term (2025-2030) – Foundation & Pilot Programs

Goal: Establish initial AAM operations, regulatory framework, and infrastructure planning to support early adoption.

1. Policy & Regulatory Framework (2025-2027)

- Establish an AAM Policy & Regulatory Task Force led by SANDAG, in collaboration with the FAA, Caltrans, and local municipalities.
- Develop zoning and land-use regulations for vertiports and drone corridors.
- Engage local governments and airport authorities to integrate AAM into planning documents and municipal policies.
- Work with the FAA to expand Beyond Visual Line of Sight (BVLOS) operations and Urban Air Traffic Management (UTM) systems.

2. Pilot Programs & Testing (2025-2028)

- Launch Urban Air Mobility (UAM) Pilot Projects with eVTOL partners to test passenger services between key hubs (e.g., SAN Airport, Downtown, UC San Diego, Chula Vista).
- Expand Drone as First Responder (DFR) programs for law enforcement, firefighting, and emergency medical deliveries.
- Implement cargo and medical drone delivery trials in partnership with healthcare providers and logistics firms.

3. Infrastructure Planning & Investment (2026-2030)

- Conduct feasibility studies for vertiports and multi-modal mobility hubs.

- Secure federal/state grants and private investment partnerships for vertiport development.
- Identify priority AAM corridors connecting key employment centers, transit hubs, and high-traffic regions.

4. Public Engagement & Workforce Development (2027-2030)

- Establish community advisory groups to ensure AAM integration aligns with public needs and concerns.
- Develop AAM-related workforce training programs in aviation technology, maintenance, and air traffic management in collaboration with universities and technical schools.

Phase 2: Mid-Term (2030-2040) – Expansion & Infrastructure Deployment

Goal: Expand AAM operations, integrate into transit networks, and develop sustainable aviation infrastructure.

1. Scaled AAM Operations (2030-2035)

- Expand passenger AAM services with commercial eVTOL operators, offering regular urban air taxi services between transit hubs.
- Implement dedicated AAM cargo corridors for freight and logistics providers, integrating with existing port and warehouse operations.
- Establish low-altitude airspace management (USS/Provider of Services UAM [PSU]), coordinating real-time flight operations with FAA regulations.

2. Vertiport Infrastructure & Network Growth (2032-2038)

- Construct fully operational vertiports with passenger lounges, battery-swapping stations, and multi-modal integration at key sites.
- Develop sustainable power infrastructure (solar, hydrogen, and electric charging stations) for vertiport networks.
- Expand automated air traffic control (ATC) systems to ensure safe integration with conventional air traffic.

3. Policy Standardization & Statewide Collaboration (2035-2040)

- Adopt statewide AAM policies to ensure interoperability between cities and regional air mobility systems.
- Implement equitable pricing models and public-private partnerships to keep AAM accessible.
- Strengthen environmental impact policies to align with zero-emission aviation goals.

Phase 3: Long-Term (2040 & beyond) – Full Integration & Smart Air Mobility

Goal: Establish AAM as a mainstream, widely accessible, and fully integrated component of San Diego's transportation system.

1. Fully Autonomous & On-Demand AAM Services (2040-2050)

- Deploy fully autonomous air taxi networks operating in real-time with dynamic route optimization.
- Establish a citywide drone-based delivery network for retail, emergency services, and government operations.
- Achieve affordable, equitable access to AAM services across the region, including underserved communities.

2. Integrated Regional & Statewide AAM System (2045 & beyond)

- Connect San Diego's AAM network with statewide hubs, including Los Angeles, Orange County, and the Inland Empire.
- Create a smart transportation ecosystem integrating AAM with high-speed rail, transit, and electric ground mobility.
- Utilize real-time AI-driven urban airspace management for autonomous aircraft coordination.

San Diego as a Leader in AAM

By executing this phased roadmap, San Diego, SANDAG, and its partners can position the region as a pioneer in Advanced Air Mobility. San Diego is considered an ideal market for AAM operability. With careful infrastructure planning, regulatory collaboration, and technology innovation, AAM will enhance regional mobility, reduce congestion, and promote sustainable, high-tech transportation solutions.

5.8 Monitoring & Adaptation

Establishing robust monitoring and adaptation mechanisms is essential for the long-term success and sustainability of AAM initiatives. This involves defining clear metrics for success related to safety, economic viability, and environmental impact and implementing adaptive policy mechanisms to address evolving technology and regulatory changes. Continuous feedback loops with stakeholders, including regular consultations, public forums, and transparent communication channels, are crucial for addressing community concerns, ensuring equitable outcomes, and fostering collaboration. Adaptive policies should allow for regular reviews and updates to accommodate technological advancements and regulatory changes while incorporating flexibility to address unforeseen challenges and opportunities. Continuous engagement with stakeholders promotes a community-first approach, ensuring that AAM development aligns with the needs and values of the communities it serves.

This section will focus on monitoring and adaptation that the audience should remember and consider from the previous sections of this strategy document when building their own AAM strategy. This encompasses establishing clear metrics for success, designing adaptive policy mechanisms, and implementing continuous feedback loops with stakeholders to ensure AAM initiatives remain effective, equitable, and responsive to evolving conditions. These elements are vital for the long-term success and sustainability of AAM.

Element	Description
Metrics for Success	Quantifiable metrics are needed to evaluate the success of AAM initiatives. These include safety records, economic indicators, and environmental impact assessments. Measuring safety, economic viability, and environmental impact is essential for assessing the overall success and sustainability of AAM projects.
	Safety metrics should encompass incident rates, system reliability, and adherence to safety standards.
	Economic metrics can include job creation, investment levels, and cost-benefit ratios.
	Environmental impact should be evaluated through emissions reductions, noise pollution levels, and overall ecological footprint.
Adaptive Policy Mechanisms	The rapidly evolving nature of AAM technology and regulations requires adaptive policy mechanisms. Policymakers should establish frameworks that allow for adjustments to regulations and policies based on new developments in the industry.
	Adaptive policies should allow for **regular reviews and updates** to accommodate technological advancements and regulatory changes.
	These mechanisms should also **incorporate flexibility** to address unforeseen challenges and opportunities that may arise during AAM implementation.
	Creating policies that are flexible enough to accommodate evolving technologies, and regulatory changes will be crucial for AAM's long-term viability.
Continuous Feedback Loops with Stakeholders	Maintaining continuous feedback loops with stakeholders is essential for addressing community concerns, ensuring equitable outcomes, and fostering collaboration.
	These feedback loops should involve **regular consultations**, public forums, and transparent communication channels to incorporate diverse perspectives into AAM planning and implementation.
	Feedback mechanisms can help **identify potential issues early** and facilitate timely adjustments to AAM projects, enhancing public trust and acceptance.

	Continuous engagement with stakeholders promotes a **community-first approach**, ensuring that AAM development aligns with the needs and values of the communities it serves.

Appendices

Appendix A – AAM Overview

Introduction to Advanced Air Mobility

Advanced Air Mobility (AAM) is a broad term encompassing the emerging aviation ecosystem that envisions advanced, highly automated aircraft technology to transport people and goods more efficiently and sustainably. Urban Air Mobility (UAM) and Regional Air Mobility (RAM) are two subsets of AAM that are often used interchangeably but are distinguished by their range and operating environment. AAM aircraft are most commonly conceptualized as electric vertical takeoff and landing (eVTOL) aircraft, but can also include Unmanned Aerial Systems (UAS; i.e. drones), short takeoff and landing (STOL), conventional takeoff and landing (CTOL), and vertical takeoff and landing (VTOL) aircraft utilizing hydrogen or other alternative fuels.

The aviation industry, as well as regulatory agencies, are taking a conservative approach regarding early opportunities for AAM aircraft entry into service and will build upon regulatory frameworks, procedures, and infrastructure requirements as AAM implementation and operations concepts are demonstrated in real-world situations. In the near future, the Federal Aviation Administration (FAA) envisions initial pilot project operations by 2028, and further operations will scale as the operational tempo increases.[131] The FAA AAM Implementation Plan: *Near Term (Innovate28) Focus with an Eye on the Future of AAM* (Version 1.0, July 2023) anticipates piloted operations that will transport people and cargo within the limits of aircraft and certification regulations. AAM operators are expected to comply with existing communications, navigation, and surveillance (CNS) requirements for the airspace in which they will operate, including charted routes designed for Visual Flight Rules (VFR) conditions only. In its current state, before initial operations, specific AAM procedures, requirements, and guides are being developed by governmental and industry stakeholders. In the meantime, assumptions are made by referring to existing aviation frameworks and emerging knowledge. It is unlikely that the initial attempts at integrating AAM will follow the same path as many steps in the process have yet to be defined.

Benefits of Advanced Air Mobility

AAM offers several benefits and solutions to challenges currently facing many growing cities. Some more notable advantages of AAM involve factors that positively impact the economic, environmental, and social health of an area and its residents and improve efficiency in the transportation of people, goods, and emergency services. AAM's potential benefits will vary depending on how and where utilized, but may reasonably include:

New employment and economic development opportunities;

Reduced greenhouse gas (GHG) emissions compared to traditional fossil-fuel transportation modes;

Improved transportation efficiency for people, cargo, and emergency supplies;

Reduced and more consistent travel times for AAM users while providing an alternative for users with limited ground transportation access;

[131] FAA Innovate28. https://www.faa.gov/sites/faa.gov/files/AAM-I28-Implementation-Plan.pdf

Inclusion of sophisticated safety technologies, including autonomous flight controls, redundant systems, and rigorous testing protocols;

Highly regulated, controlled, and subject to strict regulatory oversight by aviation authorities;

Shorter emergency response times for medical, public safety, and emergency services with the potential to save lives in time-critical situations;

Faster natural disaster and emergency support capabilities;

Enhanced connectivity for multi-modal or cargo transportation modes

Improved mobility options for residents and transportation system modernization for cities;

Potential expansion of mode choice between rural or suburban and urban areas; and

Possible optimization of currently underutilized infrastructure.

Potential Community Equity Impact

Despite AAM's potential advantages, initiating a novel transportation system introduces concerns for communities that will need to be diligently addressed and mitigated. AAM stakeholders, working groups, and policymakers are currently working on evaluating potential impacts and building policies and guidelines to minimize community disturbances caused by the presence of AAM. Considering and mitigating the impact AAM has on the community will be an ongoing process for AAM proponents, and meaningful public engagement both early on and throughout the planning process is critical.

Community members are often concerned about issues like visual obstructions, environmental pollution, increased noise, and maintaining privacy. People may also be concerned about the affordability, social equity, environmental justice, and economic aspects of the technology. AAM safety and security aspects can also be unsettling due to uncertainty over flight automation, novel forms of technology, cybersecurity concerns, and the proximity to the ground. Oftentimes, negative perceptions stem from uncertainty and misconceptions; therefore, educating stakeholders and the community with reputable information about AAM and its future role in the community will be a productive effort to participate in. This may be accomplished through public meetings, developing educational materials such as playbooks, collaborating with local agencies and advocacy groups, and more.

To better understand the potential impacts on communities, the SANDAG team conducted extensive stakeholder outreach and engagement with transportation agency partners, regional government partners, and industry representatives, as described in Section 1. This planning effort was necessary to conduct due diligence on localized issues and determine data sources for informed decision-making, as well as prioritization criteria to evaluate in future phases.

Community Outreach Resources:

Airport Cooperative Research Program (ACRP) Report 261, Advanced Air Mobility and Community Outreach: A Primer for Successful Stakeholder Engagement: This research report includes several strategies and considerations for engaging stakeholders during the planning, development, and implementation of AAM and includes a stakeholder engagement toolkit.

Advanced Air Mobility Use Cases

Setting the scope and intention for the development or operation of a vertiport will be essential for planning efforts and the following stages. Some ways that AAM may be utilized include:

Air Taxi or Charter – Air taxi or charter AAM uses include on-demand and/or unscheduled air service for passengers and cargo.

Cargo – Cargo AAM uses may include the delivery of parcels and packages in normal settings, as well as last mile delivery; emergency supply distribution amidst natural disasters and critical shortages; transportation of perishable goods; Just-in-Time (JIT) delivery for critical manufacturing.

Medical – Medical AAM uses may include air ambulances or emergency medical services (EMS) such as rapid responses and patient transporting, organ transporting; delivery of medical supplies, laboratory and telemedicine support.

Passenger – Passenger AAM uses may include on-demand and scheduled passenger services for point-to-point travel within cities and short-haul commutes; tourism and recreational services; accessibility from remote areas to urban areas and amenities; and business travel options.

Personal or Recreational – Personal and recreational AAM uses may include recreationally operating drones in some instances; experimental and research-based testing to upgrade and improve eVTOL technologies.

Military – Military AAM uses and requirements for operations may have special use privileges and be subject to the branch of the military that has authority.

Advanced Air Mobility Aircraft

Several AAM vehicles are being developed and tested by original equipment manufacturers (OEMs), some of whom have reached milestones for airworthiness certification by the FAA[132]. Key characteristics that distinguish AAM vehicles from one another include the takeoff characteristics, vehicle configuration, fuel type, passenger capacity, and level of autonomy. Each of these various characteristics will result in different infrastructure demands, as described further below.

Takeoff Characteristics

VTOL: Aircraft capable of taking off, hovering, and landing vertically. VTOL aircraft are anticipated to use existing helicopter infrastructure or new AAM-specific vertiport facilities. Generally, the footprint of this facility is considerably smaller than a conventional airport, and future AAM operations are envisioned atop urban parking garages and building rooftops or co-located with multimodal transit stations. Existing infrastructure readiness for this type is low (rooftops and multimodal transit stations) to medium (repurposed helicopter facilities).

STOL: Aircraft designed to take off and land in very short distances. These aircraft may use existing airport runways that are not long enough for larger conventional aircraft. Existing infrastructure readiness for this type is medium to high.

[132] FAA airworthiness certification is described further in Section 2: eVTOL Vehicle Certification.

CTOL: Fixed-wing aircraft that need a runway or body of water to land. These aircraft can use existing airport runways. Existing infrastructure readiness for this type is medium to high.

Vehicle Configuration: The position of engines and types of propulsion. Some configurations are still in conceptual phases, but a few common configurations include:

Multicopter: Uses multiple rotors for lift, as opposed to a single or double rotor on a conventional helicopter.

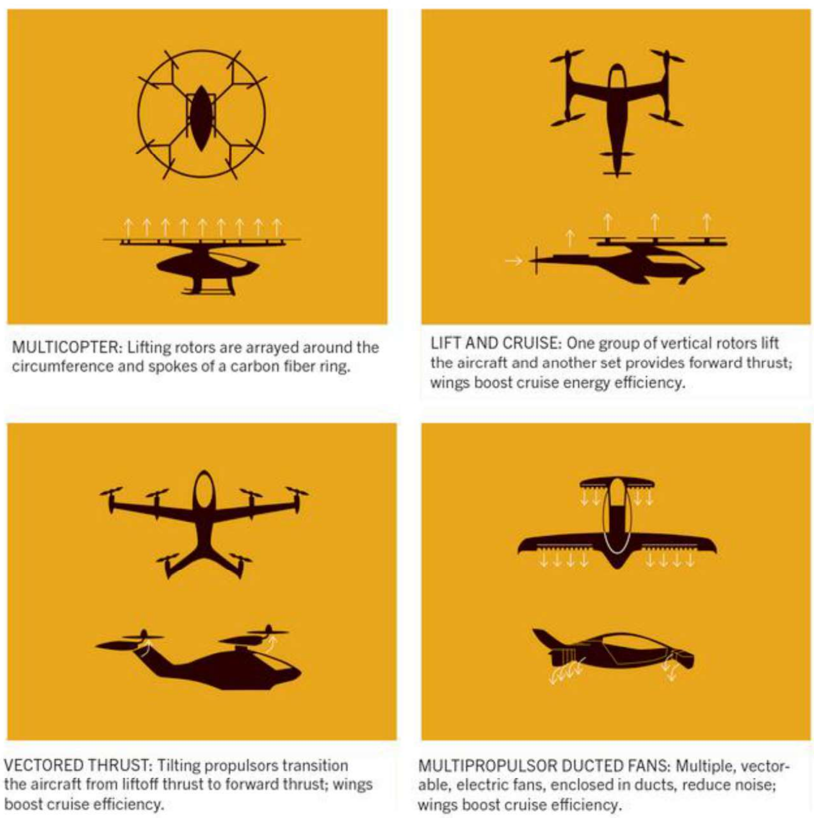
Lift and Cruise: Uses rotors for vertical lift and propellers for cruise.

Vectored Thrust: Redirects the engines or rotor thrust to control movement.

Ducted Fan: Uses fans enclosed in ducts for lift and propulsion.

Conventional: Fixed-wing and needs a runway to take off and land, like for STOL and CTOL.

Figure 24: eVTOL Aircraft Design



MULTICOPTER: Lifting rotors are arrayed around the circumference and spokes of a carbon fiber ring.

LIFT AND CRUISE: One group of vertical rotors lift the aircraft and another set provides forward thrust; wings boost cruise energy efficiency.

VECTORED THRUST: Tilting propulsors transition the aircraft from liftoff thrust to forward thrust; wings boost cruise efficiency.

MULTIPROPULSOR DUCTED FANS: Multiple, vectorable, electric fans, enclosed in ducts, reduce noise; wings boost cruise efficiency.

Source: Aerospace America[133]

Fueling Mechanisms

Electric: Vehicle is powered by energy stored in batteries in the aircraft. Batteries are either charged or removed and replaced with charged batteries between flights (battery swapping). Existing infrastructure readiness is low to medium.

[133] https://aerospaceamerica.aiaa.org/features/evtol-making-the-electric-dream-a-safe-one/

Hydrogen: Liquid hydrogen is burned directly in an engine or used in a fuel cell system (in the early stages of development). Existing infrastructure readiness is low.

Conventional Fuel: Aviation Gas, jet fuel, or other fossil fuel is combusted to power the aircraft; typically, only considered for CTOL aircraft. Existing infrastructure readiness to high.

Sustainable Aviation Fuel (SAF): An alternative fuel made from non-petroleum feedstocks that reduces carbon and greenhouse gas emissions from air transportation. Existing infrastructure readiness is medium to high.

Hybrid: Combines a battery pack with a conventional petroleum-based generator to extend range. Existing infrastructure readiness is high.

Passenger or Cargo Capacity: Vehicles may be designed to primarily carry either passengers, cargo, or emergency equipment. Passenger vehicles typically carry between 2-6 people.

Autonomy: The level of pilot or human engagement in the technology

Human-within-the-loop: Human is always in direct control of the automation.

Human-on-the-loop: Human has supervisory control of the automation and can take full control when required or desired.

Human-over-the-loop: Human passively monitors the systems and is informed by automation if, and what action is required.

Other aspects such as the weight, size, number of fans or rotors, range, and other vehicle specifications also differentiate these vehicles and affect their operational capabilities and infrastructure needs. As the AAM operational environment and battery technology advance, the vehicles will likely evolve with characteristics to meet the emerging needs of AAM.

AAM Vehicle Diversity and Vertiport Design

Certain characteristics of potential AAM use cases may require alternate processes, requirements, and standards for vertiport and AAM proponents to follow. The type and variety of vehicles accommodated at a vertiport will impact the physical and operational characteristics of the future vertiport. The types of vehicles the vertiport will accommodate should be evaluated based on the market(s) the vertiport serves and with consideration that, in the future, additional vehicles will enter the market. AAM operators should research vehicle capabilities, limitations, and requirements, and collaborate with OEMs to fully understand the operating characteristics of the range of vehicles operating at the site.

Interim guidance on vertiport design in FAA's Engineering Brief #105[134] was developed based on the design and performance characteristics of a reference aircraft with certain characteristics that may not apply to desired vehicles at a proposed vertiport.[135] If desired AAM vehicles exceed or differ from the reference aircraft design characteristics or performance criteria, vertiport proponents should coordinate with the FAA Regional Office or Airports District Office (ADO) as soon as possible to review the takeoff and landing (TOAL) area, as these are reviewed by the FAA on a case-by-case basis.[136]

AAM Facilities

The facilities that are used for AAM operations differ by the use, type of vehicle, and other factors. These facilities and surfaces below identify the required components for AAM operations. They can be constructed at ground level or elevated, depending on the location of the site and constraints that may exist. The facilities listed below indicate the essential components necessary for AAM operations.

The term "vertiport" is a collective term to describe both vertiports, the area used for electric, hydrogen, and hybrid vertical takeoff and landing (VTOL) landings and takeoffs, and the associated buildings and facilities, and vertistops. Vertistops describe a minimally developed vertiport for boarding and discharging passengers. Both vertiports and vertistops have a vertipad.[137]

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[134] FAA Engineering Brief (EB) #105. (2022). **https://www.faa.gov/sites/faa.gov/files/eb-105-vertiports.pdf**

[135] The reference aircraft is assumed to be land-based, flying in visual meteorological conditions (VMC), with the pilot on board. Additional characteristics of the reference aircraft include: (1) Distributed electric propulsion driven by electric batteries, (2) 2 or more propulsive units, (3) 2 or more battery systems, (4) Maximum takeoff weight (MTOW) of 12,500 lbs or less, (5) Length of 50 feet or less, (6) Width of 50 feet or less, (7) Vertical takeoff and landing, and (8) Hover out of ground effect (HOGE) in normal operations.

[136] Specifications described in EB 105 do not include taxiway and parking areas and does not address aircraft exceeding design aircraft characteristics of the reference aircraft. Limited information in the EB 105 is largely based on existing standards for heliports set in AC 150/5390-2. Further iterations of the document may better address types of aircraft outside of the design aircraft, taxiing and parking needs, failure situations, and more.

[137] FAA ConOps v.2. 2023. FAA. **https://www.faa.gov/researchdevelopment/trafficmanagement/utm-concept-operations-version-20-utm-conops-v20**

Essential components of a TOAL area for AAM operations are listed below and referenced in **Figure 25**.

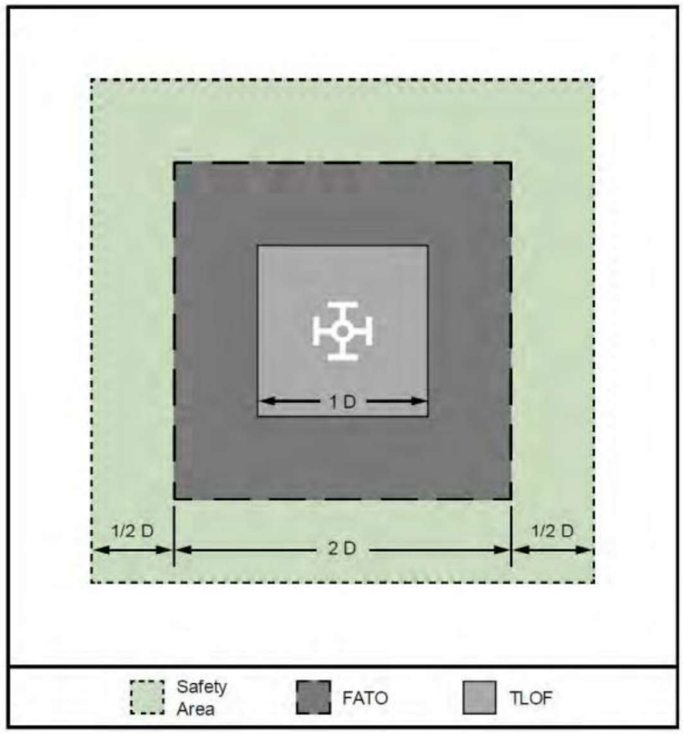

Figure 25
Dimensions of TLOF. FATO. and Safetv Area

Controlling Dimension (D): The D is the diameter of the smallest circle enclosing the VTOL aircraft projection on a horizontal plane while the aircraft is in the takeoff or landing configuration, with rotors or propellers turning, if applicable. The controlling dimension of the design VTOL aircraft impacts other spatial areas of a vertipad.

Touchdown and Liftoff Area (TLOF): The TLOF is a load bearing, generally paved area centered in the FATO, on which the aircraft performs a touchdown or liftoff. It is the width of the controlling dimension (1D).

Final Approach and Takeoff Area (FATO): The FATO is a load-bearing area over where the aircraft completes the final phase of the approach, to a hover or a landing, and from which the aircraft initiates takeoff. Including the TLOF within it, the FATO has a total width of two times the controlling dimension (2D).

Safety Area: The Safety Area is the area surrounding the FATO intended to reduce the risk of damage to aircraft accidentally diverging from the FATO. Including both the FATO and TLOF within it, the safety area has an overall width of three times the controlling dimension (3D).

Approach or Departure Path: The flight track that a VTOL aircraft follows when landing at or taking off from a vertiport.

Short takeoff runway: A short takeoff runway may be necessary in some instances if the vehicles the vertiport is designed for are short takeoff and landing (STOL).

Other facilities that are or may be included in a concept are influenced by the location of the vertiport, the activity levels, and its specific uses. These facilities may include:

Hangars: Single-bay or multi-bay storage facilities to house VTOL vehicles to protect them from weather while receiving maintenance and charging.

Aprons: Paved areas for VTOL vehicles to be parked and tied down, loaded, maneuvered, or charged. The areas also provide space for ground support equipment (GSE) to help with the servicing of vehicles before and after operations.

Taxiways or Taxilanes: Paved paths for vehicles to taxi between vertipads, aprons, and hangars or other storage facilities. Early design standards identified in FAA Engineering Brief #105; state taxiways should be designed to Airplane Design Group (ADG) -I standards.

Terminal or Passenger Processing Facilities: Facilities for processing passengers before or after a passenger AAM operation. Facilities are anticipated to include ticketing, baggage makeup and claim, TSA screening, and other security equipment similar to that of an airport terminal.

General Aviation (GA) or Charter Facilities: Facilities for VTOL vehicles services before and after operations. Similar to a fixed-based operator (FBO) terminal, the GA facilities provide multiple services for customers.

Cargo Processing Facility: Facilities for processing and loading cargo to and from vehicles for transport to other cargo aircraft or other cargo services.

Auto Parking Lots: Areas designated for the parking of automobiles used by passengers and employees.

Access Roads: Roadways that provide access to and from new AAM facilities connecting the to the local and regional roadway system.

As technology will continue to evolve in the coming years, AAM infrastructure and facilities planning should also consider how the maturation of the technologies in AAM, for example, eVTOL aircraft and battery technology, need to be considered in the planning process. By anticipating technological shifts, infrastructure planners can ensure that the vertiports remain adaptable, resilient, and capable of supporting long-term AAM operations, both at an airport and in an urban setting.

Federal AAM Efforts

NASA

NASA has been a leader in the research and development of the integration of AAM into our national airspace. Through its Aeronautics Research Mission Directorate and its Transformative Aeronautics Concepts Program, NASA is exploring new technologies, capabilities, and operational concepts to enable the safe integration of AAM into the National Airspace System (NAS)[138]. Some of those research efforts are happening in the state of California, including

- Conducting simulations of integrating eVTOL aircraft at an airport at NASA's Ames Research Center.[139]
- Conducting and evaluating air taxi passenger comfort studies using a custom virtual reality flight simulator at NASA's Armstrong Flight Research Center.[140]

[138] NASA. (2022). Transformative Aeronautics Concepts Program. Retrieved from https://www.nasa.gov/centers/armstrong/research/tacp

[139] NASA. (2023), https://www.nasa.gov/aeronautics/nasa-joby-pave-the-way-for-air-taxis-in-busy-airports/

[140] NASA (2024). https://www.nasa.gov/centers-and-facilities/armstrong/nasa-prepares-for-air-taxi-passenger-comfort-studies/

Department of Defense

The United States Department of Defense (DoD) has been investing in AAM for several years, recognizing the importance of this technology in maintaining its global aviation leadership role. The DoD's investment in AAM is also motivated by the potential for these technologies to enhance military capabilities, particularly in terms of mobility and logistics. AAM technology has the potential to revolutionize the way we travel, making it faster, safer, and more sustainable. The DoD's investment in AAM is driven by the recognition that this technology can transform military operations, improving efficiency, enhancing capabilities and mission readiness.[141,142]

The DOD's investment in AAM includes funding for research and development of new technologies and partnerships with private companies to bring those technologies to market. The goal of this investment is to advance the development of electric and autonomous aircraft, including eVTOL and electric Short Take-Off and Landing (eSTOL) aircraft, to help ensure the US remains at the forefront of the AAM industry.

The ability to transport people and supplies quickly and efficiently, without relying on traditional ground-based transportation methods, would give the US military a significant advantage on the battlefield.[8] Additionally, while the DoD primarily views AAM as an operational asset and has raised concerns surrounding security, the technology also presents a unique opportunity to strengthen installation resilience by connecting regional assets and enhancing logistical flexibility.

Private Investment

In recent years, significant investments have been made from various sources, including the private sector. With the increasing demand for more efficient, environmentally friendly, and convenient transportation methods, AAM has emerged as a promising solution for urban mobility.

Major AAM companies, including Joby Aviation, Archer Aviation, and Vertical Aerospace, have gone public in the last several years. These companies are actively working on developing and commercializing eVTOL aircraft, which are seen as the next generation in aircraft design. The success of these companies has attracted significant investment from venture capital firms, private equity firms, and other investors.

In addition to these companies, established aerospace players such as Boeing and Airbus have also invested heavily in the AAM sector, recognizing its potential for growth in the future.[143,144] The development of eVTOL aircraft, battery technology, and other enabling technologies has created a new market opportunity, attracting investment from various sources.

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[141] https://www.afrl.af.mil/News/Article-Display/Article/3728233/afwerx-to-discuss-efforts-to-safely-field-advanced-air-mobility-systems-at-xpon/

[142] https://www.faa.gov/newsroom/faa-air-force-team-advanced-air-mobility-efforts

[143] https://www.boeing.com/content/dam/boeing/boeingdotcom/innovation/con-ops/docs/Concept-of-Operations-for-Uncrewed-Urban-Air-Mobility.pdf

[144] https://www.airbus.com/en/innovation/energy-transition/urban-air-mobility/cityairbus-nextgen/urban-air-mobility

As the demand for AAM continues to grow, investment in this sector will likely continue to increase, leading to the development of new technologies and increased commercial viability of AAM systems. This potential growth trajectory affords valuable opportunities for public-private partnerships, where collaboration between government entities and private companies can not only accelerate technology development but also inform regulatory frameworks and facilitate infrastructure planning to support sustainable AAM integration in urban and regional environments. The future of AAM will likely play a crucial role in transforming transportation.

Significance of AAM for Planning and Operations

The FAA is actively working on integrating AAM into the national airspace system, and they recognize the important role that airports will play in the growth of AAM.[145] The FAA provides airport funding through various programs, such as the Airport Improvement Program (AIP), which supports airport development projects.[146] This funding can support future AAM operations, such as developing infrastructure necessary for AAM aircraft, like charging stations and maintenance facilities.

Local, county, and city authorities that proactively prepare for AAM will be better positioned to capitalize on this technology's opportunities. This may include investing in new infrastructure, developing partnerships with AAM service providers, and working closely with the FAA to ensure that their operations and regulations are aligned with the needs of AAM but also meet the priorities and needs of the communities that they will serve.[147]

AAM represents a significant change in how aviation will be conducted in the future. For airports, it presents an opportunity to play a leading role in this transformation, to improve their operational efficiency and competitiveness, and to serve their communities more effectively. By focusing on AAM, airports and cities can position themselves as leaders in the future of aviation, helping to ensure continued growth and success.

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[145] https://www.faa.gov/airports/new_entrants/aam_infrastructure

[146] https://www.faa.gov/airports/aip

[147] FAA UAM ConOps 2.0.
https://www.faa.gov/sites/faa.gov/files/Urban%20Air%20Mobility%20%28UAM%29%20Concept%20of%20Operations%202.0_1.pdf

Appendix B – Smart Atlas Data Layers

No.	Category	Data
1	Existing transportation hubs	Airports (county)
2	Existing transportation hubs	Rail network (state)
3	Existing transportation hubs	Vehicle Miles Travelled
4	Existing transportation hubs	Mobility Zones
5	Existing transportation hubs	Ports
6	Transportation	Noise contours
7	Land use	Heliports (source 1)
8	Land use	Land parcels
9	Land use	Planned Land use
10	Land use	Zoning boundary
11	Environmental restraints	California Land Ownership
12	Environmental restraints	Land use
13	Environmental restraints	Environmental Essential Connectivity Areas
14	Traffic data	Forecasts 2035
15	Traffic data	Traffic analysis zones
16	Traffic data	Historic and near real-time traffic info
17	Census data	Census for San Diego
18	Census data	Census transportation planning package
19	Census data	California and Justice40 Disadvantaged or Low-Income Communities
20	Energy	Zip code and customer types of energy use
21	Energy	Power plants
22	Energy	Energy Demand
23	Energy	Energy Generation
24	Energy	Energy Supply
25	Public amenities	Health centers
26	Public amenities	Hospital heliports
27	Public amenities	Schools
28	Airspace	Public airport s
29	Airspace	Airport boundaries

30	Airspace	Digital Aeronautical Charts
31	Airspace	Military airports
32	Warehouse data	Utilities and warehouse data
33	Weather	Live feed from ESRI Living Atlas

Appendix C[148] - eVTOL Aircraft Controlling Dimensions

Manufacturer / Lead OEM	Aircraft Model	Passenger (PAX)	Wingspan (ft.)	Length (ft.)	Role
Airbus	City Airbus	4	26.3	26.3	Air Taxi
Archer Aviation	Midnight	4	49	-	Air Taxi
Beta Technologies	ALIA-250	4	50		Air Taxi
Bell	Nexus 4EX	4	40	40	Air Taxi
Bell	Nexus 6HX	4	40	40	Air Taxi
Ehang	Ehang 216	2	-	18.5	Air Taxi
Elroy Air	Chaparral	0	-	-	Cargo
Eve Air Mobility	Eve	4	-	-	Air Taxi
Joby Aviation	S4	4	-	24	Air Taxi
Lilium GmbH	Lilium Jet	6	45.6	27.6	Commuter
Overair, Inc.	Butterfly	4	-		Air Taxi
Uber Elevate	eCRM-001	4	-	-	Air Taxi
Vertical Aerospace	VA-X4	4	49.2	42.8	Air Taxi
Volocopter	VoloCity	2	37	-	Air Taxi
Volocopter	VoloConnect	3	-	-	Air Taxi
Wisk	Cora	2	36	21	Air Taxi

Source: ACRP Research Report 236

[148] Preparing your Airport For Electric Aircraft and Hydrogen Technologies, https://nap.nationalacademies.org/catalog/26512/preparing-your-airport-for-electric-aircraft-and-hydrogen-technologies

Appendix D – AAM Outreach Toolkit

The outcome of this Advanced Air Mobility (AAM) Outreach and Education Strategy is an Outreach Toolkit that provides a framework and guidance for those responsible for communicating with stakeholders as San Diego agencies and organizations progress in planning and implementing AAM infrastructure and operations in the region. The users of this guide are assumed to be regional and local planners and their designated contractors. This guide provides initial answers to the following questions.

- **Stakeholder Groups and Organization**
    - Who are the various groups involved in AAM planning and implementation in the San Diego region, and how are they organized? What role do they play in AAM development? Do they need to be *Responsible, Accountable, Consulted, or Informed (RACI)?*
- **Stakeholder Contacts Database**
    - Who specifically do planners and agency/organization representatives need to stay in touch with? Stakeholders in this database will need to be *updated regularly*.
- **Key Messages**
    - What are the talking points and primary messages around AAM? *Everyone conveying information about AAM in the region will need to be on the same page*.
- **Engagement Guide**
    - When and with what communications channels will stakeholders be engaged? What triggers an engagement activity? Following the guide *encourages consistent and transparent communication among agencies, organizations, and across the region*.
- **Library of Collateral Materials and References**
    - Where are the resources, materials, and guides from which communications about AAM can be produced?

The remaining sections of this document answer the aforementioned questions and provide the information or links to the data and information to assist agency and organization representatives in adhering to and maintaining consistent communications and education for AAM stakeholders in the San Diego region.

Stakeholder Groups and Organization

Stakeholders in the AAM domain are diverse entities from public and private sector organizations and reflect a variety of resident and business interests. For this project, all stakeholders expected to be involved or impacted by AAM infrastructure and operations in the San Diego region were grouped into the following twelve categories listed in shown in Figure 1.

Figure 1: Stakeholder Group Summary

By categorizing individual stakeholders into groups, those responsible for continuing communication with these groups can tailor materials and messages that speak to the interests of each group with details and technical information included as appropriate. The Stakeholder Types included in each Stakeholder Group are shown below in Table 14.

Table 14: Stakeholder types in each stakeholder group.

ID	Stakeholder Group	Stakeholder Type
1	**Aircraft Manufacturing, Operations & Maintenance**	Aircraft maintenance and supply companies
		Aircraft manufacturers
		Aircraft operators
2	**Airport and Port Authorities**	Commercial airport authorities
		Port Authority
		Local airport
3	**Community & Non-Profit Organizations**	Community Roundtables
		Local non-profits and NGO's
4	**Economy and Workforce**	Economic development organizations
		Insurance and risk assessment companies
		Local workforce agencies
		Significant local industries/early customers
5	**Educational Institutions & Organizations**	Local colleges and universities
6	**Emergency Services & Public Health**	Emergency management/planning offices
		Emergency services providers
		Healthcare services providers

		Security and Safety authorities and services
7	**Environmental Management & Planning**	Environmental planners, authorities, and services
8	**Government Agencies & Representatives**	Local decision-makers and municipal AAM leads
		Local Elected Officials
		Local planning offices
		State and regional officials
		Federal government agencies - DHS
		Federal government agencies - DOE
		Federal government agencies - FAA
		Federal government agencies - DOD
		Federal government agencies - DOT
		Tribal Governments
		State government agencies - California Coastal Commission (CCC)
		Regional and metropolitan planning organizations
		Federal government agencies - DOI
9	**Land Use, Development, & Management**	Commercial property management companies
		Construction Companies
		Real estate developers
10	**Planning and Modeling**	Organizations Leading AAM Efforts
		Planning and modeling consulting companies
		Industry Support Infrastructure
11	**Public Works & Utilities**	Communications providers
		Engineering and public works
		Local building and safety offices
		Local power companies/cooperatives
		OSHA, ADA
		Water departments and authorities
12	**Transportation Departments, Planners, & Services**	State and local departments of transportation (e.g., California Department of Transportation (Caltrans)
		Public regional transportation entities (e.g., San Diego Association of Governments (SANDAG), Metropolitan Transportation System (MTS), North County Transit District (NCTD)
		Private regional transportation entities (e.g., Tribal Nations, Casinos, Paratransit service providers)

Stakeholder Roles

Role Assignment Method

To assist in organizing and understanding stakeholder roles and developing well-defined communication strategies for stakeholders in all sectors, public or private, the SANDAG AAM outreach and education strategy has adopted the use of a responsibility assignment matrix – a method commonly known as RACI, an acronym that stands for Responsible, Accountable, Consulted, Informed. The RACI methodology was developed by Edmond F. Sheehan to help define roles and responsibilities for projects and processes, which leads to better collaboration, coordination, productivity, and progress. One additional role that is not included in the original RACI method is "Facilitate". The facilitative role may be added, used, or included with other roles as needed to indicate stakeholders that may perform in this capacity--such as SANDAG. The RACI definitions are included below in Table 15.

Table 15: RACI Definitions

Role	Definition
Responsible	These roles are **responsible for completing the task or deliverable**. For example, if the responsibility role is a technical writer, this person may be responsible for writing online help files. A software developer wouldn't write the help files but might incorporate those files into the product, which would be defined as a different task.
Accountable	This type of role **has the final authority on (or is accountable for) the task's completion**. To take the previous example of a technical writer developing online help and a software developer incorporating the help files, a product manager might be responsible for ensuring that the files make it into the product.
Consulted	This role **functions as an adviser to a task**. For example, a team may consult with a subject matter expert (SME). Consider advisers carefully, as having too many people in this role can stretch the task time and raise the risk of poor performance.
Informed	Informed team members are **kept up to date on task completion (or status)**. Charting this role helps to illustrate dependencies among tasks and ensures transparency into task status. It can be difficult to identify those who need to be informed, so consult various roles to determine who needs status updates. For example, the sales manager may require status updates because a customer has a special interest in feature development.

Stakeholder Role Application

The following table, Table 16, indicates which stakeholder groups need to be informed about what aspects of AAM strategies or policies over time and indicates the groups' role (according to the RACI method described above) in the process of implementing, operating, regulating, or monitoring AAM in the region.

By understanding each stakeholder group's role and information needs, those responsible for the coordination and collaboration among the groups will have an opportunity to address and include each group in planning and decision-making conversations in the near term and in operations conversations in the future. This chart also provides an opportunity for the AAM Collaborative to continue to organize itself around aspects of the AAM development processes and know whom to turn to when it is time to make critical decisions. By ensuring that each group is informed according to its role, all voices will be heard, and communications will be timely and appropriate.

Table 16: Application of Stakeholder Roles (RACI)

ID	Stakeholder Group	Infrastructure - Siting, Vertiports, Energy, Comms, Enviro	Standards and Regulation (Crosscutting)	Operations and San Diego Applications	Technology - Aircraft, Airspace, and Groundspace
1	**Aircraft Manufacturing, Maintenance & Operations**	**Responsible**; Sizing, Type of Facility (w/out MRO), Noise, upwash/downwash	**Responsible**; Aircraft certification, Certification of sensors, Training	**Consulted**; Mission Type (Passenger vs. Cargo) demand, forecast	**Accountable**; Safety, approach and departure paths, ground SOPs
2	**Airport and Port Authorities**	**Accountable**; vertiport site (Landside v/s. airside), layout, number of gates, access to terminal or cargo area (for airport and port), separation from taxiway and/or runway	**Accountable**; vertiport sizing, training, electric charger usage, environmental impact regulations	**Accountable**; Access to passenger terminal, FBO, MRO, or cargo; use cases (CBP, first responder, etc.)	**Responsible**; Approach and departure; day and night noise level

3	**Community & Non-Profit Organizations**	**Consulted**; multi-modal integration, noise and visual pollution, community integration	**Informed**; periodical update about community applicable regulations	**Consulted**; consulting the community on the impact of intended operations, impact on noise, traffic, and environment	**Informed**; impact of novel technology on community, low noise, lower emission, etc.
4	**Economy and Workforce**	**Consulted**; economic impact of vertiports, job creation, business opportunities (retail and air travel)	**Informed**; standards affecting job market, business, and personnel training (e.g. handling electric charger, etc.)	**Informed**; operational needs to help inform workforce training	**Consulted**; ground infrastructure operations and workforce needs
5	**Educational Institutions & Organizations**	**Informed**; vertiport sizing and associated infrastructure development; research and development	**Informed**; keep up-to-date with emerging standards and regulations	**Consulted**; commercial, first response operational needs- police, medical, etc.	**Consulted**; industry partnerships
6	**Emergency Services & Public Health**	**Consulted**; access routes to vertiports, emergency response times, and the location of emergency services relative to new facilities	**Consulted**; public health considerations such as air quality, noise pollution, and potential risks from AAM.	**Consulted**; operational readiness, integration with existing services/technologies	**Informed**; airspace restrictions, noise abatement procedures,
7	**Environmental Management & Planning**	**Responsible**; assessment and mitigation of environmental impact (NEPA review)	**Consulted**; environmental standards, land zoning, emissions, etc.	**Consulted**; impact of operations on environment - noise, visual, and emissions	**Informed**; impact of airspace procedures, vertiport locations and operations on environment

8	**Government Agencies & Representatives**	**Accountable**; vertiport site approval, certification, sizing and development requirements	**Accountable**; vertiport and associated infrastructure regulations, for e.g., fire, lighting, marking, etc.	**Accountable**; regulatory oversight of operations, e.g., on-demand, scheduled, or cargo CFRs	**Informed**; aircraft airworthiness, airspace corridor and integration requirements
9	**Land Use, Development, & Management**	**Responsible**; establishing zoning laws, land use requirements	**Consulted**; input on local land use regulations, zoning, and compatibility	**Consulted**; impact of operations on existing land use and zoning laws	**Informed;** technology requirements for operations and compatible land-use
10	**Planning and Modeling**	**Responsible**; provide simulations and modeling to prove concepts and inform stakeholders of how sites will integrate into the current environment.	**Consulted**; helps identify gaps in standards or regulations that may need to be developed or instituted based on models.	**Consulted**; provide simulations and modeling to prove, verify or validate operational concepts and inform stakeholders of how operations will integrate into the current environment.	**Consulted**; provide simulations and modeling to prove, verify or validate operational concepts and, in some cases, expedite testing by technology developers.
11	**Public Works & Utilities**	**Responsible**; available grid capacity, water, and communications services	**Consulted**; compliance with safety and environment regulations	**Consulted**; utility demand, availability, grid capacity	**Informed**; forecast utility demand for eVTOLs, charger capacity (for e.g., fast charging)

12	**Transportation Departments, Planners, & Services**	**Responsible**; airport layout restrictions, vertiport sizing requirement, integration of vertiports into the existing transportation network, including roads, and public transit	**Consulted**; input on transportation regulations, including traffic management for multi-modal integration	**Responsible**; passenger and cargo flow, multi-modal links, emergency service access	**Responsible**; set policy, plan infrastructure, ensure safety and regulatory alignment, manage public funding and outreach, update land use and transportation plans accordingly

Key Messages Guide

Introduction

The following key messages have been generated and derived from inputs and contributions of a variety of resources and reflect advanced air mobility (AAM) best practices gleaned from existing knowledgebases, present-day lessons learned, experience from the AAM industry (via the SANDAG's AAM Collaborative), and domain expertise from the SANDAG AAM project team. Since AAM is a fast-evolving industry and technology, this information and these key messages will need frequent review and adaptation according to decisions surrounding AAM regional infrastructure, policy development, and industry evolution that will be influential in the region's adoption and acceptance of AAM over time. The **intended users of these key messages are the SANDAG staff and collaborating agencies** responsible for communication with AAM stakeholders, primarily in the public, community organizations, and other agencies or jurisdictions that are learning about AAM in the San Diego region.

This current set of messages also includes input from other AAM Regional Implementation Strategy task deliverables to ensure that there is **tight coordination between findings, recommendations, and strategies** developed there and the strategies for the region's AAM Public Outreach and Education as part of that effort.

These key messages for San Diego region's AAM focus on fundamentals and education, phased adoption, public acceptance, social benefits and impacts, San Diego region-centric information and issues around environmental responsibility (such as greenhouse gas (GHGs)), communities (including equity, access, data and real problems), and likely use cases for the region. The following key messages and talking points elaborate on these topics.

Key Messages

Fundamentals and Education – What is AAM?

- AAM is a **new and emerging type of aviation** that will use novel, electrically powered aircraft that can take off and land in different ways. While many of these aircraft will be electric vertical take-off and landing (eVTOL), other aircraft configurations may operate differently, and we may see this in the future. Currently, we are already seeing the use of commercial drones and hybrid vehicles. All these aircraft are highly automated with advanced technologies intended to move people and goods more efficiently and sustainably than current conventional aircraft or ground vehicles.
- **AAM 101**: AAM 101.pptx
- **Collaborative community planning** includes a commitment to transparent, inclusive community engagement in infrastructure development that keeps everyone informed regarding challenges and ongoing development.
- **Consultation with the local community** that actively seeks feedback for consideration in the planning and implementation stages**.**

Phased Adoption – When will AAM be here in the San Diego region?

- The San Diego region may not **be an early adopter** of AAM technologies and services. This exercise intends to **prepare our region for projects and initiatives** that will streamline requirements necessary for **a gradual approach** to the adoption of this technology.
- **Slow and methodical adoption** of AAM gives the San Diego region an opportunity to incorporate lessons learned from other earlier adopters and apply those lessons to fit the unique needs and environment of the San Diego

region of residents and businesses. AAM will be integrated into the San Diego regional transportation system in alignment with the principles, goals, and plans in the regional AAM strategy.

- The San Diego region will adopt a **phased approach** to implementing AAM infrastructure, regulations and polices, operations, and technologies to ensure progress suitable for this region.

Public Acceptance – What are AAM benefits?

- AAM has **benefits** that have been demonstrated in other regions and has potential benefits that are currently being tested and proven. The benefits for the San Diego region will vary depending on how and where it is used. Some of these benefits may include:
  - New **employment and economic development opportunities,** including potential regional investment in aerospace engineering, manufacturing, operations, and related technical industries;
  - **Reduced trip-related GHGs** compared to traditional fossil-fuel transportation modes;
  - Inclusion of **sophisticated safety technologies**, including autonomous flight controls, redundant systems, and rigorous testing protocols;
  - Highly **regulated, controlled and subject to strict regulatory oversight** by aviation authorities;
  - **Improved transportation efficiency** for people, cargo, and emergency supplies;
  - **Reduced and more consistent travel times for AAM users** while providing an alternative for users with limited ground transportation access;
  - **Shorter emergency response times** for medical, public safety, and emergency services with the potential to save lives in time-critical situations;
  - **Faster natural disaster and emergency support** capabilities;
  - **Enhanced connectivity for multi-modal or cargo transportation** modes;
  - **Improved mobility options** for residents and transportation system modernization for cities;
  - **Potential expansion of mode choice** and related infrastructure, including options between rural or suburban and urban areas; and
  - Possible **optimization of currently underutilized infrastructure**.

Public Acceptance – What are AAMs key concerns?

- **Key concerns** for AAM for the San Diego region reflect national and international concerns and unique regional concerns. Transparency in addressing concerns is a best practice that will be instituted as part of the outreach and education strategy. Some top concerns expected to be addressed are:
  - Potential for increased **noise** in new areas;
  - **Safety** of passengers, operators, operations, and infrastructure;
  - **Security** of passengers, operators, operations, and infrastructure;
  - **Air space** management.
  - **Military air restrictions** and counter technology concerns, including AAM operators' awareness of these restrictions;
  - Equitable **infrastructure siting policies** and practices;
  - Equitable **access to services**; and

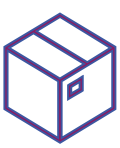
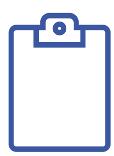
- **Social impacts** and **community involvement** in planning and implementation.

Use Cases – How will AAM be used in the San Diego region?

The use cases will be commensurate with the SANDAG’s strategies for adopting AAM in the region. Table 17 below provides the definitions of the core and other use cases currently defined. The following are the core initial use cases under consideration:

- **Emergency and Public Services** – this includes medical emergency evacuations, rapid air transfer of critical care patients, disaster response and relief, pharmaceutical and medical deliveries, and mobile field hospitals
- **Freight & Cargo** – this includes autonomous delivery of time-sensitive or high-value cargo or goods such as groceries
- **People Movement** – this may include intra-city and inter-city connections or rural transit
- **Other Use Cases that will be incorporated in the future:**
  - **Maintenance, Inspection, Surveying** – this includes surveying of infrastructure, such as power lines, wind turbines, pipelines, bridges, railroads, or aircraft
  - **Research** – this includes assessments of air quality, biodiversity, and habitat using remote sensing and mapping
  - **Testing and Simulation** – this includes assessing new technologies, evaluating aircraft system performance, and training personnel

Table 17: Core Initial and Other Future Use Cases

Core Use Cases	Other Use Cases
 **Emergency and Public Services** – this includes medical emergency evacuations, rapid air transfer of critical care patients, disaster response and relief, pharmaceutical and medical deliveries, and mobile field hospitals	 **Maintenance, Inspection, Surveying** – this includes surveying of infrastructure, such as power lines, wind turbines, pipelines, bridges, railroads, or aircraft
 **Freight & Cargo** – this includes autonomous delivery of time-sensitive or high-value cargo or goods such as groceries	 **Research** – this includes assessments of air quality, biodiversity, and habitat using remote sensing and mapping
 **People Movement** – this may include intra-city and inter-city connections or rural transit	 **Testing and Simulation** – this includes assessing new technologies, evaluating aircraft system performance, and training personnel

Menu of Engagement Activities

The following types of outreach methods, channels, and activity types are possible and can be selected based on stakeholder type and readiness or completion of pre-requisite milestones or accomplishments throughout the implementation of regional AAM strategies as defined in the engagement sequence.

Numerous information and communication channels may be used as appropriate and according to the target stakeholder group.

The key categories of public information channels to be considered for AAM include:

1. **Print Media**: Newspapers (press releases, advertisements), magazines (articles, advertisements), brochures, flyers, or fact sheets
2. **Broadcast Media**: Television news, radio, podcasts, advertisements, interviews, educational/event programs/videos
3. **Digital media**: Social Media platforms, dedicated channels, posts on related channels (Top platforms include Facebook, X, Instagram, YouTube, Pinterest, LinkedIn), influencers on these platforms, community or special interest forums, websites
4. **Direct Communication**: Email blasts, newsletters, texts/SMS alerts, word-of-mouth, and phone calls
5. **Public Events**: Town halls, community meetings/forums, press conferences, business events, school outreach events (elementary through college), County fair, street fairs, career fairs, science fairs (with possible sponsorship of citizen or student science projects)
6. **Public Signage**: Changeable message signs, billboards, sports or concert venue large video display screens (i.e., Jumbotrons), airport signage/displays, transit and train station or stop information displays

SANDAG's outreach channels and strategies have been identified and are discussed in depth in SANDAG's 2025 Regional Plan in their Public Involvement Plan, A Guide for Public & Stakeholder Engagement for the 2025 Regional Plan. This plan should be the definitive guide for public and stakeholder involvement for this project, and engagement activities should remain in alignment with the goals and strategies outlined therein. The plan is linked here: https://www.sandag.org/~/-/media/0BB87FFB724B44E3B58E2EF5FD6AB8AB.ashx **https://www.sandag.org/-/media/SANDAG/Documents/PDF/regional-plan/2025-regional-plan/2025-RP_Public-Involvement-Plan.pdf**

A very brief summary of some of the SANDAG outreach techniques, channels, and methods that may be helpful for AAM engagement are included below

Print media

- **Newspapers**: SANDAG distributes press releases and posts public notices in newspapers of general circulation. Editorials and Op-Eds are also published.
- **Community newspapers**: SANDAG distributes press releases to community newspapers

- **Trade Publications**: SANDAG also provides information and announcements to various trade publications, which may be a unique opportunity to engage with the AAM industry partners.
- **Other print materials**: SANDAG also uses a variety of other print materials such as Fact Sheets, Brochures, Frequently Asked Questions (FAQ) Sheets, and Flyers

Broadcast media

- **Radio and television**: SANDAG distributes information to local and Mexico radio and television stations. These media opportunities may include reporter briefings, press releases and media alerts, press conferences, media kits
- **Podcasts**: SANDAG lists podcasts another type of broadcast media that provides an opportunity to reach public and stakeholder audiences.

Online media

- **SANDAG website**: SANDAG posts information on its website and has project pages for project specific information. There are also Frequently Asked Questions (FAQ) pages for projects and programs.
- **Email lists**: SANDAG sends information to email lists and provides the opportunity to subscribe to SANDAG's Newsletter or project/plan-specific Newsletters.
- **Text messaging**: SANDAG sends information via text messaging and can conduct text surveys.
- **Social media**: SANDAG uses social media channels to share information on Facebook, X (formerly Twitter), Instagram, LinkedIn, and YouTube, and other video information opportunities.

Other in-person or public event techniques to consider based on SANDAG's plan include:

- **Mobile Project Information Booths**: a type of tabling for use at community events

Engagement Sequence

The following table, Table 18, outlines the high-level expected engagement activities, including the appropriate prerequisite-based sequence of outreach activities and events vs. a specific timeline. Each engagement activity may be selected according to the triggering event and/or stakeholder type(s) and will be dependent upon the readiness or completeness of pre-requisite milestones or accomplishments needed to successfully engage the specified stakeholders at this stage of AAM development in the San Diego region. The entire field of triggering events is unknown at this time, but those included here are ones that may be customarily or initially expected with the introduction of a new AAM technology, new or expanding AAM service, or other AAM-related events. This table is an initial list that is not inclusive of all possibilities, may occur in an order other than what is presented, and should be updated periodically based on the evolution of AAM in the San Diego region.

The table is organized by the following definitions and flows as depicted in Figure 24: Engagement Triggers and Sequence Activities Flow that follows:

- **Milestone or Event ID** – Reference ID number for this milestone or event
- **Triggering Milestone or Event Description** – This is an event or milestone that triggers a need to communicate with one or more stakeholder groups
- **Stakeholder Group(s)** – These are the categories of stakeholders that have been identified for this study and the AAM regional strategy that must be included in communications about a triggering event, either as a consulted party or the recipient of communications regarding the triggering event. Those groups that are responsible or accountable for conducting the triggering activity or event will likely be the consulted group. The stakeholder groups are listed by number, referencing Table 16: Application of Stakeholder Roles (RACI).
- **Inputs/Prerequisites** – These are the triggering events or activities that must have already been conducted before communication with the indicated stakeholder groups about this particular event or activity.
- **Engagement Categories or Activities** – These are the categories of engagement or specific suggested engagement activities that could be used to communicate with the stakeholder group(s) regarding this triggering event or milestone.
- **Outputs** – This is the expected outcome of the engagement activity.
- **Notes** – Additional details that describe the triggering event, milestone, engagement activity, or intent.

Figure 24: Engagement Triggers and Sequence Activities Flow

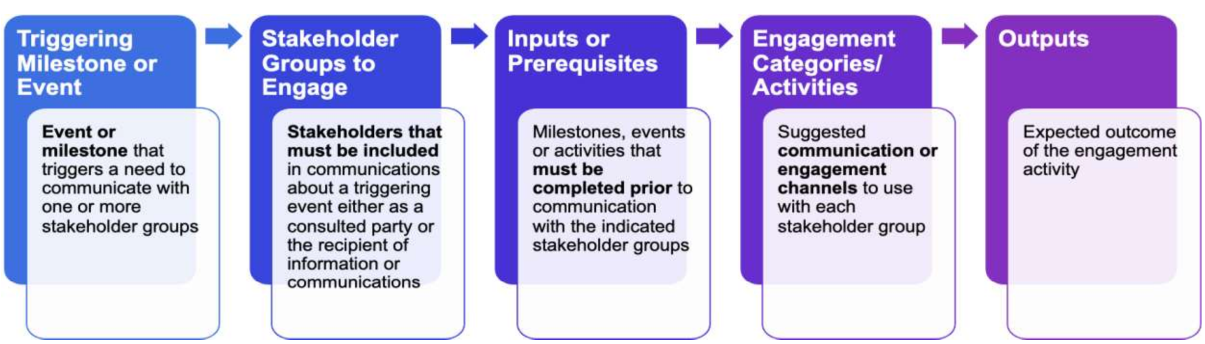


Table 18: AAM Engagement Triggers and Sequence Guide

ID	Triggering Milestone or Event	Stakeholder Group(s) to Engage	Inputs/Pre-requisites	Engagement Categories/ Activity(ies)	Outputs	Notes
1	**Policy and Planning**: Initial Regional Vision, Goals, Strategy Development, and Establishment	All or most stakeholders represented in the Stakeholder Groups identified in this document; represented in the AAMSD Collaborative	Impetus to direct and guide the adoption of AAM policies, plans, infrastructure, and operations in the San Diego region. This includes the identification of AAM objectives, stakeholder mapping, and identification of baseline studies.	AAMSD Collaborative	AAM Regional Implementation Strategy AAMSD Collaborative periodic meetings	The AAM Regional Implementation Strategy report is the outcome of this initial activity under the facilitation of SANDAG, with the guidance of the Collaborative. The Collaborative should be included on all major communications that are the result of this Engagement Guide.
2	**Policy and Planning:** Policy Formation and Regulatory Development Needs as AAM Strategies Proceed	1. Aircraft Manufacturing, Maintenance & Operations, 7. Environmental Management & Planning, 8. Government Agencies & Representatives, 10. Planning and Modeling	AAM Regional Implementation Strategy Also, regulatory framework analysis, risk assessments, preliminary stakeholder feedback	1. Print Media, 3. Digital Media, 4. Direct Communication, 5. Public Events	AAM Policy Framework Regulatory Gap Analysis Public Policy Recommendations and Draft Ordinances	Early-stage studies, stakeholder input, and baseline data collection are critical for most planning and research milestones.

3	**Policy and Planning:** Regional Infrastructure Planning – Key decision(s)	2. Airport and Port Authorities, 3. Community & Non-Profit Organizations, 7. Environmental Management & Planning, 9. Land Use, Development & Management, 11. Public Works & Utilities, 12. Transportation Departments, Planners & Services	AAMSD Regional Implementation Strategy Industry and coordinating jurisdiction plans or applications Land-use studies, identification of potential sites for infrastructure, regulatory approvals, community consultation	Interagency and industry engagement using 1. Print Media, 3. Digital Media, 4. Direct Communication, 5. Public Events	Announcement or publication of key regional infrastructure key decisions, proposed siting, and supporting utility projects or plans	This includes coordinated and preplanned utilities, communications, facility siting zones, intermodal considerations, and route planning that will serve all regional facilities or operations and regional AAM needs parallel or prior to planning construction of specific facilities or specific operations.
4	**Research and Development:** Operational Testing Milestones/ Outcomes	1. Aircraft Manufacturing, Maintenance & Operations, 5. Educational Institutions & Organizations, 7. Environmental Management & Planning, 10. Planning and Modeling	Funding allocation, research goals, partnerships with academic institutions and industry	2. Broadcast Media, 3. Digital Media, 5. Public Events	Announcement or publication of the outcome of operational testing	Technology readiness must be verified and demonstrated before operational implantation.

5	**Research and Development:** Feasibility Studies Outcomes	1. Aircraft Manufacturing, Maintenance & Operations, 5. Educational Institutions & Organizations, 7. Environmental Management & Planning, 10. Planning and Modeling	Preliminary concept designs or concepts of operation, data collection (e.g., market demand, cost analysis), and stakeholder workshops	2. Broadcast Media, 3. Digital Media, 5. Public Events	Links to and/or publication of Feasibility study report, outcomes, or summaries	
6	**Implementation and Deployment:** Operational Testing Events or Demonstrations	1. Aircraft Manufacturing, Maintenance & Operations, 2. Airport and Port Authorities, 6. Emergency Services & Public Health, 11. Public Works & Utilities, 12. Transportation Departments, Planners & Services	Completion of feasibility studies, technology testing, regulatory certifications, technology and infrastructure readiness, and verification. Certification of prototypes, safety and environmental impact evaluations, community notification.	1. Print Media, 2. Broadcast Media, 3. Digital Media, 5. Public Events	Announcement of testing events or demonstrations	Regulatory approvals and public/community engagement and buy-in are essential for operational milestones.

7	**Implementation and Deployment:** Regulatory Certification completed	1. Aircraft Manufacturing, Maintenance & Operations, 2. Airport and Port Authorities, 6. Emergency Services & Public Health, 11. Public Works & Utilities, 12. Transportation Departments, Planners & Services	Regulatory framework establishment, submission of technical and operational documents, compliance checks	1. Print Media, 3. Digital Media, 4. Direct Communication	Announcement of essential certification information or completion	Regulatory approvals and public/community engagement and buy-in are essential for operational milestones.
8	**Implementation and Deployment:** Infrastructure Development - New AAM Facility planned	1. Aircraft Manufacturing, Maintenance & Operations, 2. Airport and Port Authorities, 3. Community & Non-Profit Organizations, 7. Environmental Management & Planning, 9. Land Use, Development & Management, 11. Public Works & Utilities	Responsible manufacturer, maintenance & operations organizations plans submitted;	1. Print Media, 3. Digital Media, 5. Public Events, 6. Public Signage	Plan information/ visualizations shared with stakeholders Proposed facility announcements Request(s) for input, feedback on plans	

9	**Implementation and Deployment:** Infrastructure Development - New AAM Facility construction underway	1. Aircraft Manufacturing, Maintenance & Operations, 2. Airport and Port Authorities, 3. Community & Non-Profit Organizations, 7. Environmental Management & Planning, 9. Land Use, Development & Management, 11. Public Works & Utilities	Completion of planning milestones, acquisition of land and permits, stakeholder approval Responsible manufacturer, maintenance & operations organizations progress reported ;	1. Print Media, 3. Digital Media, 5. Public Events, 6. Public Signage	Construction progress reports and information	
10	**Implementation and Deployment:** Infrastructure Development - New AAM Facility construction completed and ready for operation	1. Aircraft Manufacturing, Maintenance & Operations, 2. Airport and Port Authorities, 3. Community & Non-Profit Organizations, 7. Environmental Management & Planning, 9. Land Use, Development & Management, 11. Public Works & Utilities	Responsible manufacturer, maintenance & operations organization's facility completion dates submitted; facility completed; facility open for operation	1. Print Media, 3. Digital Media, 5. Public Events, 6. Public Signage	Announcement/ publication of: Planned completion date, Facility completion, facility opening, continuing operations and operational status Facility use promotions shared with stakeholders	

11	**Implementation and Deployment:** Intermodal Integration	2. Airport and Port Authorities, 3. Community & Non-Profit Organizations, 7. Environmental Management & Planning, 9. Land Use, Development & Management, 11. Public Works & Utilities	Completion of feasibility studies, technology testing, regulatory certifications, infrastructure readiness and intermodal facility integration plan completed and approved	2. Broadcast Media, 3. Digital Media, 5. Public Events, 6. Public Signage	Announcement/ publication of: Planned intermodal connection completion date, Facility integration and connection completion, opening, continuing operations and operational status Connection promotions shared with stakeholders	
12	**Implementation and Deployment:** Integration with air traffic systems	1. Aircraft Manufacturing, Maintenance & Operations, 2. Airport and Port Authorities, 12. Transportation Departments, Planners & Services	Regulatory alignment, airspace assessment, coordination with existing aviation stakeholders	1. Print Media, 3. Digital Media, 4. Direct Communication	Announcement of approved plans and completion of integration with industry stakeholders	

13	**Operational Launch:** New AAM Operation – New Service Rollout	1, 3, 7, 9, 11, 12 3. Community & Non-Profit Organizations, 4. Economy and Workforce, 7. Environmental Management & Planning, 12. Transportation Departments, Planners & Services	Responsible operator's operational applications/ plans submitted; Service rollout schedule known Completion of all testing, final regulatory approvals, infrastructure readiness Service marketing campaigns, final infrastructure inspections, operator training	1. Print Media, 3. Digital Media, 4. Direct Communication, 5. Public Events, 6. Public Signage	Operational plan information/ visualizations shared with stakeholders Proposed operation announcements Request input, feedback on operational plans	
14	**Operational Launch:** New AAM Operation – Emergency Preparedness Activities	3. Community & Non-Profit Organizations, 6. Emergency Services & Public Health, 11. Public Works & Utilities	Development of emergency response plans, coordination with local emergency services, and completion of safety reviews	1. Print Media, 3. Digital Media, 5. Public Events	Announcement, publication, and promotion of events and emergency preparedness information Awareness posts and publications	

15	**Operational Launch:** New AAM Operation – Early user feedback and data collection	3. Community & Non-Profit Organizations, 10. Planning and Modeling, 12. Transportation Departments, Planners & Services	Initial service rollout, user surveys, collection of operational data	3. Digital Media, 4. Direct Communication, 5. Public Events	Survey, Survey hosting and Survey promotion in coordination with service operator(s)	
16	**Continuing Operations Periodic Update:** AAM Operator Service Expansion	3. Community & Non-Profit Organizations, 4. Economy and Workforce, 7. Environmental Management & Planning, 9. Land Use, Development & Management, 12. Transportation Departments, Planners & Services	Regular safety and performance reviews, community feedback, environmental monitoring Analysis of operational success, demand forecasting, stakeholder approval for new infrastructure or services	1. Print Media, 3. Digital Media, 4. Direct Communication, 5. Public Events	Announcements and publication of service expansion promotional materials as appropriate in coordination with service operator	
17	**Continuing Operations Periodic Update:** Periodic Safety Reviews	1. Aircraft Manufacturing, Maintenance & Operations, 6. Emergency Services & Public Health, 8. Government Agencies & Representatives	Collection of operational safety data, accident/incide nt analysis, regulatory oversight	1. Print Media, 3. Digital Media, 4. Direct Communication	Publication of safety review reports or summaries	

18	**Continuing Operations Periodic Update:** Policy Updates and Adjustments	3. Community & Non-Profit Organizations, 5. Educational Institutions & Organizations, 12. Transportation Departments, Planners & Services	Results of operational reviews, stakeholder input, changes in regulatory or market conditions	1. Print Media, 3. Digital Media, 4. Direct Communication	Publication of policy change reports or summaries	
19	**Public and Community Engagement Events:** Education Campaigns, launch then periodic promotion	3. Community & Non-Profit Organizations, 5. Educational Institutions & Organizations, 8. Government Agencies & Representatives	Planning milestones, identification of key community concerns, development of engagement materials Completion of initial planning, identification of specific educational goals, creation of public awareness content	2. Broadcast Media, 3. Digital Media, 5. Public Events	Continuously available webinars providing AAM 101 and similar education Regularly scheduled town halls, webinars (live or self-paced), (once specific community projects are identified) Regularly scheduled social media posts	

20	**Public and Community Engagement Events:** Stakeholder or Community Forums, launch and periodic promotion	7. Environmental Management & Planning, 8. Government Agencies & Representatives, 12. Transportation Departments, Planners & Services	Identification of key stakeholder concerns, alignment of goals across stakeholder groups	4. Direct Communication, 5. Public Events	Announcements for Regular meetings with SANDAG, AAM Industry, and/or community representatives to engage and ensure ongoing dialog about specific/new/ ongoing AAM impacts and benefits	
21	**Public and Community Engagement Events:** Special Public Awareness Programs	3. Community & Non-Profit Organizations, 5. Educational Institutions & Organizations, 10. Planning and Modeling	Development of promotional materials, identification of outreach platforms/ methods/ techniques, community feedback	1. Print Media, 3. Digital Media, 5. Public Events	Announcements and publication of awareness program launch, updates, or periodic promotion	
22	**Public and Community Engagement Events:** AAM Technology News	3. Community & Non-Profit Organizations, 5. Educational Institutions & Organizations, 10. Planning and Modeling	Launch or completion of R&D, development of prototypes, regulatory permissions for testing, or similar new technology milestone achieved	Any	Announcements, publications, articles, videos, etc. providing informational and educational material for new, changing, or emerging technologies related to AAM	Coordinate with AAM Collaborative for periodic updates

23	**Public and Community Engagement:** Crisis Management Communication, periodic or event specific	3. Community & Non-Profit Organizations, 6. Emergency Services & Public Health, 11. Public Works & Utilities	Emergency response plans, pre-established communication protocols, stakeholder coordination	2. Broadcast Media, 3. Digital Media, 4. Direct Communication, 6. Public Signage	Immediate announcements or publication of crisis information with frequent and transparent updates Preparedness and debrief meetings with partners	Proactively engage with stakeholders during any incident or operational challenge to maintain trust and transparency

Library of Collateral Materials and Reference Documents

An online folder or "library" includes a set of materials and reference documents to support specific stakeholder outreach activities pertaining to AAM in the region.

The contents of this library are expected to be the starting point for any AAM engagement activities and the development of new materials for presentations, events, publications, posts, and other outreach activities. SANDAG's current and existing templates are expected to be the baseline for any AAM-related materials that must be developed. The initial publication is a Fact Sheet, and additional materials may be developed as needed but should be kept simple and flexible for future use, in alignment with the agreed-upon key messages and stakeholder groups, as AAM policies, procedures, and plans evolve. All supporting items are organized into a folder with an index for future reference.

The folder exists in SANDAG's library here: SANDAG AAM_Task 2_Industry and Market Assessment_FINAL

Engagement Library

The following information and materials are included in this library:

- **Outreach Toolkit** – This report and contents therein, along with the Engagement library contents. This report is also included as an Appendix in the final AAM SD report
- **Stakeholder Database** – a list of stakeholder groups and the expected contacts in those groups as of the publication of this document
- **AAM 101 Presentation** – a presentation providing the fundamentals of AAM for any stakeholder group with no or limited familiarity with AAM.
- **Fact sheet** – A publication for general use and the primary outlet for key messages
- **AAM Engagement References** – a list of documents or websites provided for reference that provide a deeper understanding of AAM

AAM Engagement References:

Included below are documents included in the Outreach Toolkit folder and links to documents, websites, presentations, and lessons learned that informed this report and can be used for further information and understanding by SANDAG staff and partner agencies.

Important Note: During the development of Key Messages and engagement strategies, SANDAG has adopted select stakeholder and public engagement lessons learned and practices from these reference documents where appropriate for the San Diego region's unique needs, and since recommendations and strategies are typically tailored for the regions in which they were developed. SANDAG has developed the stakeholder and public engagement approach recommended here in cooperation with San Diego's AAM Collaborative so that they applies best to our region and current conditions. Since AAM is fast evolving, this reference list is current as of the publication of this document but will become outdated quickly and will need to be updated periodically with more recent, relevant materials that reveal new approaches, lessons learned, and experiences that may help SANDAG and partner agencies continue to successfully engage and involve the region's stakeholders.

- Preparing Miami-Dade for Electric Urban Air Mobility: https://www.eveairmobility.com/storage/2023/04/MiamiDade_Blueprint_phase2-1.pdf
- Miami-Dade ConOps – Miami-Dade Air Mobility Blueprint: https://www.eveairmobility.com/storage/2023/03/EVE_Miami_Conops_v9_Screen-Version.pdf
- United Kingdom Community Benefits – The Launch of Electric Urban Aviation: https://www.eveairmobility.com/storage/2023/03/UK_Community_Benefits.pdf
- Open Mobility Foundation – How Cities Are Thinking About Air Mobility, Data & Digital Infrastructure: https://www.openmobilityfoundation.org/advanced-air-mobility-2024/
- NASA Advanced Air Mobility Community Integration Considerations Playbook
- Miami-Dade Transportation Planning Organization – Urban Air Mobility, Policy Framework and Strategic Roadmap, Executive Summary (Nov 2023)
- Miami-Dade Transportation Planning Organization – Urban Air Mobility, Policy Framework, and Strategic Roadmap (Nov 2023)

- Miami-Dade Transportation Planning Organization – Urban Air Mobility, Interim Progress Report: State of the Industry (Nov 2022)
- Florida DOT – Report and Recommendations, FDOT Advanced Air Mobility Working Group (May 2023)
- How will Advanced Air Mobility Benefit Communities, Community Air Mobility Initiative (CAMI) (Jun 2021)
- Drones as First Responder: Future of Public Safety, Chula Vista Police Department (2022)
- Integration Pilot Program: San Diego's Foundation for Emerging Aviation Technology, Katelyn McCauley, San Diego Regional EDC (Dec 2020)
- Components of Public Acceptance for AAM & UAM, CAMI (Q3 2020)
- Drive Ohio – Advanced Air Mobility, Ohio AAM Framework (Aug 2022)
- Urban Movement Labs – Shaping Urban Air Mobility in Los Angeles through Community Engagement (Aug 2021)
- McKinsey and Company – Short-haul flying redefined: The promise of regional air mobility (May 2023) https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/short-haul-flying-redefined-the-promise-of-regional-air-mobility?cid=soc-web
- Los Angeles DOT – Urban Air Mobility, Policy Framework Considerations (Sep 2021)
- Federal Aviation Administration (FAA) – Urban Air Mobility, Concept of Operations (Apr 2023)

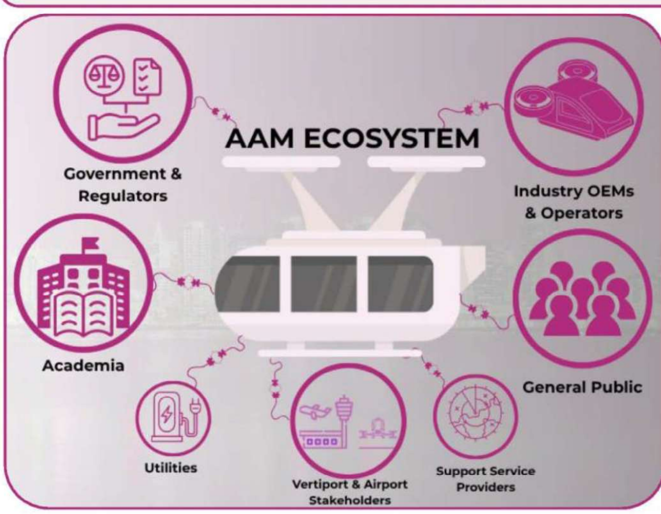
SANDAGSEARCH.AAM

WHAT IS ADVANCED AIR MOBILITY (AAM)?

ⓘ Advanced Air Mobility (AAM) is a **new means of transportation** that uses novel aircraft for different use cases. These aircraft, often referencing electric Vertical Takeoff and Landing (eVTOL), can take off and land in different ways, meaning they can **take off and land straight up and down**, similar to a helicopter. While eVTOLs are most widely known throughout the industry, other aircraft are also considered AAM but may look and/or work a bit differently to achieve their goal. Today, we **already use things like drones** and **hybrid aircraft**. These new aircraft use smart technology systems to better prepare for a more automated future. **AAM aims to move people**, **cargo**, and **services more efficiently** and sustainably than regular airplanes or cars.

WHO IS WORKING ON AAM?

ⓘ Many stakeholders are preparing for AAM, including **government agencies**, **private industry**, **and regulators**. Specialized groups are teaming up to help inform **rules**, **technology needs**, and **infrastructure requirements** to help make AAM safe, reliable, and work for our communities.

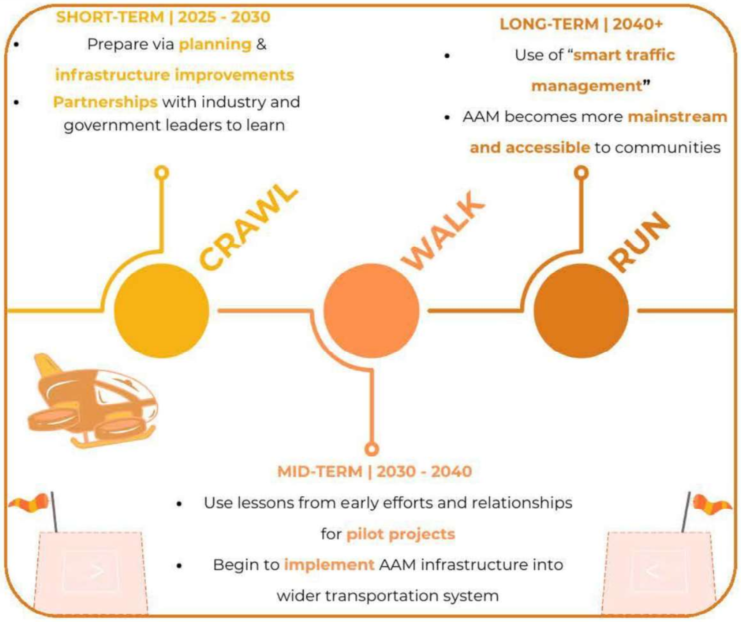


ⓘ In the San Diego Region, SANDAG has led a regional effort, called the **SANDAG AAM Collaborative**, to plan how AAM could be integrated within the region. The group included **partners** from some **jurisdictions**, **aviation experts**, **industry leaders**, and **academia**. Together, this group explored various **challenges and potential solutions** from aircraft operations to energy capacity and community accessibility.

WHEN WILL AAM BE HERE?

ⓘ San Diego won't be the first to adopt AAM, but it's **preparing**. AAM will be introduced into the region's transportation system gradually, **following the "crawl, walk, run" approach**.

This lets us **learn** from other cities and **make sure AAM works well for San Diego's people, businesses, and communities**. AAM projects will **align with SANDAG's regional goals** and plans to ensure safe, smart, and strategic integration over time.



HOW MIGHT AAM BE USED IN THE REGION?

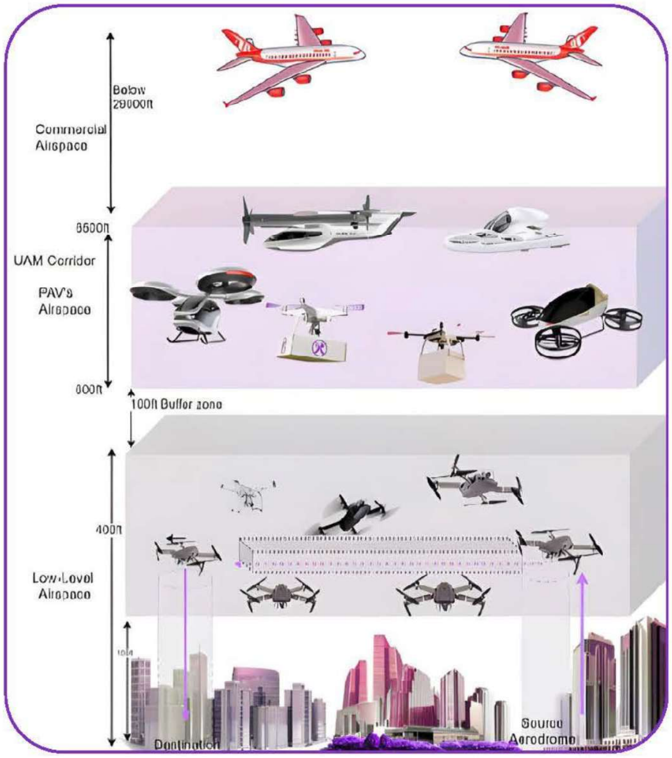
ⓘ AAM has many potential uses that may enhance the ability for **goods or people to be transported in a new, safe way**. The San Diego region's AAM Collaborative has selected a small number of **use cases, below, that reflect the highest and best use** of this new technology according to **current regional needs**. These needs and the capabilities of AAM are **expected to change** over time with additional uses added **as regional demands shift**.

Emergency & Public Services	Freight & Cargo	People Movement	Future Use Case Opportunities
Medical Evacuations	Autonomous On-Demand Delivery	Intra-city & Inter-city Connections	Maintenance, Inspection
Disaster Response & Relief	Goods and Freight Movement	Rural Air Mobility	Testing & Simulation
Pharma & Medical Deliveries			
Mobile Field Hospitals			

WHERE WILL AAM OPERATE?

ⓘ **Small drones usually fly low**, up to 400 feet above the ground. **AAM aircraft**, which are larger and can carry people or cargo, **will fly higher than drones** but **lower than large commercial aircraft**. AAM aircraft will fly in airspace that keeps them **safely separated from both drones and passenger airplanes**. They'll be allowed to fly in **most types of airspace**, except for the highest level (Class A), which is usually designated for commercial operations.

AAM aircraft will take off from and land on "**vertiports**," similar to helipads, designated for vertical take-off and landing (VTOL) vehicles.



WHY PREPARE FOR AAM?

ⓘ **AAM is coming fast** with new aircraft that can move people and goods efficiently, safely, and sustainably. However, having learned many lessons from the sudden appearance of electric scooters and bike share programs, our communities and region see value in having the opportunity to prepare for this new technology.

Planning organizations, **governments**, and **industry** are preparing now to ensure that AAM **fits into our communities in a smart, safe, and responsible way**. Early planning helps to prepare the **right infrastructure, policies,** and **locations** for when AAM takes off.

Appendix E – AAM Industry & Market Assessment Report

The following appendix contains the AAM Industry & Market Assessment Report prepared by Arcadis on behalf of SANDAG. The following report was the predecessor to this final report and was delivered in April 2024.

Advanced Air Mobility in San Diego

Industry and Market Assessment Report
Task 2 – Industry Assessment

Document Ref: *30199161-ARC-XX-XX-TR-TP-00001-C-A1*

Revision: 03

April 2024

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Advanced Air Mobility in San Diego

Industry and Market Assessment Report
Task 2 – Industry Assessment

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Document Ref.	30199161-ARC-XX-XX-TR-TP-00001-C-A1
Date	April 2024

Version Control

Version	Date	Author	Checker	Reviewer	Approver	Changes
P01	Jan 2024	IC; MG	AJ	CK	TP	Progress review submission
P02	Feb 2024	IC; MG	AJ	CK	TP	Draft submission
C	Mar 2024	IC; MG	AJ	CK	CM	Final revision

Contents

Figures

Glossary

Term	Definition
AAM	Advanced Air Mobility
AAM SG	Advance Air Mobility Study Group
AIA	Airport Influence Area
AICUZ	Air Installations Compatible Use Zones
ALUC	Airport Land Use Commission
ALUCPs	Airport Land Use Compatibility Plans
AWOS	Automated Weather Observing Station
BVLOS	Beyond Visual Line of Sight
CAELUS	The Care & Equity – Healthcare Logistics UAS Scotland Project
CBP	Customs & Border Protection
CD	Controlling Dimension
CONOPS	Concept of Operations
CTOL	Conventional Take-off and Landing
CVPD	Chula Vista Police Department
DAA	Detect and Avoid
DFR	Drone as First Responder
DOT	Department of Transportation
eVTOL	Electric Vertical Take-off and Landing
FATO	Final approach and take-off area
FRA	Federal Railroad Administration
GA	General Aviation
ICAO	International Civil Aviation Organization
IFP	Instrument Flight Procedures
IFR	Instrument Flight Rules
LHA	Landing Hazard Avoidance
MCAS	Marine Corps Air Station
MRO	Maintenance, Repair and Overhaul
NASA	National Aeronautics and Space Administration
NAS	National Airspace System
NFPA	National Fire Protection Association

OEM	Original Equipment Manufacturer
PAV	Passenger Air Vehicle
RAM	Regional Air Mobility
RPAS	Remotely Piloted Air Systems
RPASP	Remotely Piloted Aircraft Systems Panel
SANDAG	San Diego Association of Governments
SARPs	Standards and Recommended Practices
STOL	Short Take-off and Landing
SWOC	Strengths, Opportunities, Opportunities, Challenges
TLOF	Touchdown and liftoff area
TSA	Transportation Security Agency
UA	Unmanned Aircraft
UAM	Urban Air Mobility
UAS	Uncrewed Aerial Systems
UAS	Unmanned Aircraft Systems
UAS-AG	Unmanned Aircraft Systems Advisory Group
UAV	Unmanned Aircraft Systems
VFR	Visual Flight Rules
VTOL	Vertical Take-off and Landing

Executive Summary

Advancements in technology have led to an emerging industry, Advanced Air Mobility (AAM). An influx of manufacturers are developing new and varying forms of AAM vehicles leading to a revolutionary form of transport. AAM aims to provide efficient, sustainable, and accessible air transportation solutions for both urban and rural areas. It will lower operating costs when compared to similar helicopter operations and bring mobility and connectivity to underserved regions and markets, whilst offering new transport use applications.

San Diego Association of Governments (SANDAG) is seeking to prepare the region for future integration of AAM operations aimed at ensuring equity and integration into a broader transportation network. It hopes to develop a strategy that lays the groundwork for potential AAM deployments across the region.

Benefits of AAM

AAM has the potential to reduce travel time, lower carbon emissions, provide public good missions in the form of medical and emergency response, decrease delivery times, and overall improve transportation efficiency by utilizing the airspace and ground space more effectively.

This report is intended to inform SANDAG about the AAM industry from a high-level perspective. It is intended to be used to prepare SANDAG for discussions with staff, senior leadership, and other key stakeholders throughout the region, about the emerging AAM Strategy.

The San Diego Region will be a second-wave adopter and will follow the 'crawl, walk, run' principle. The initial focus for SANDAG AAM is on use cases prioritization, with a focus on public and emergency services, and logistics. SANDAG envisions people movement as a longer-term effort that evolves as AAM services become more cost effective and attainable for the greater community. These use cases best align with the wider regional objectives and policies relating to comprehensive planning and implementation and advancing social and economic equity. The Guiding Principles established as part of the AAM Collaborative will provide the core of planning for and implementing AAM.

SANDAG's approach to regional AAM is to consider implementation in two broad phases:

- **Phase 1: - The initial phase will focus on public services and logistics.**
- **Phase 2: - People movement and integration into public transport.**

SANDAG AAM Guiding Principles

What Happens Next

The intelligence and information gathered from the Industry and Market Assessment will be used to contribute to the Implementation Strategy. The next phase of this project considers what SANDAG aims to achieve with AAM. Knowledge and best practices will be incorporated into the strategy, and the AAM Collaborative will be the tool to engage and refine the strategy requires to meet the needs of the region.

From a regional perspective, there are a number of questions to consider that will be necessary in shaping the regional strategy. The following questions have been prompted by the Industry and Market Assessment. This list is not exhaustive and may become irrelevant for the region; however, it provides a starting point for regional considerations and determining what SANDAG AAM is seeking to achieve.

Strategic Considerations
What does SANDAG aim to achieve with AAM?
What problems is SANDAG aiming to solve with AAM?
What is the purpose of AAM in the region?
How does AAM contribute to the 5 Big Moves?

Use Case Considerations
What are the relevant use cases to support the vision?
How do we integrate SANDAG with existing public good, freight and public transport missions?
How can AAM improve existing transportation infrastructure and provision?
How do we use AAM across the US-Mexico Border?

Learning from AAM Best Practice
What should SANDAG observe and learn from early adopters of AAM?
What the most appropriate AAM Strategies to adapt to a San Diego regional perspective?

Utilizing and effectively engaging the AAM Collaborative
How will the AAM Collaborative help to progress the vision and objectives over the long term?
Implementation Strategy
What is enabling AAM in the region?
What is blocking AAM in the region?

Overview of AAM

AAM Vehicles

AAM aircraft come in multiple configurations with the majority capable of vertical take-off and landing. The majority of these vehicles are and will most likely continue to be electric powered, although hybrid systems and hydrogen fueled vehicles are also being developed. The future vision for the operation of AAM vehicles is to be highly autonomous.

Airspace

The San Diego region is home to a diverse range of airspace users. including civilian aerodromes, military bases, an international border and overfly traffic. SANDAG will collaborate with other airspace users, such as airports, military installations, and the US Customs and Border Protection (CBP) as to the implications of AAM operations in the region. The San Diego County Regional Airport Authority should be consulted with regarding the implications for AAM operations from any of the county’s aviation facilities.

The complexities of managing airspace are supported by ground infrastructure, some of which may be located at vertiports. These services that can be bracketed under 'vertiport management systems'. Automated systems at vertiports and en-route are needed in the following areas:

RADAR surveillance systems

Flight management systems to schedule resources and services for flight operations

Localized weather monitoring

Future Airspace Planning

Between airspace complexity and the vast array of physical and digital infrastructure associated with supporting the airspace of the future, planning organizations will have to contend with expeditiously developing implementable strategies concurrent with the rapidly developing technologies.

Existing airspace rules and regulations are sufficient to enable a low-density level of AAM operations. However, airspace is a complex issue and complexity is amplified when introducing autonomous aircraft into established airspace. To achieve high-density, highly autonomous Beyond Visual Line of Sight (BVLOS) operations will require coordinated efforts internationally and nationally to develop the rules and guidelines for introducing AAM aircraft into the National Airspace System (NAS). The responsibility for this is being coordinated at a federal level and is not the responsibility of SANDAG.

Air navigation requirements, airspace operating rules and exclusion zones will all be identified, assessed, and integrated into the AAM Strategy.

Ground Infrastructure Considerations

Existing heliports and airports may prove to be useful assets at the first stage of implementing AAM operations in the region. However, the infrastructure has not been designed with AAM in mind and may have to adapt to ensure it is safe for AAM vehicles to operate from. At later stages, dedicated 'vertiport' facilities can be designed and constructed to specific specifications. Considerations include:

Location

- Existing heliports and airports
- Train stations
- Intra-city, inter-city and regional connections

Size

- Forecast demand
- Future expansion
- Size and number of facilities

AAM Vehicles

- Type of AAM vehicles using the facility
- Vehicle's requirements
- Using suitable infrastructure design standards

Touchdown and Lift-Off Positions

- The number of TLOF positions
- Low or high density operations
- Coordinated with the number parking positions

Fuel

- Fuel supply, grid connection
- Storage and capacity
- Fuel type – electricity, hybrid, hydrogen
- Fuel dispensing –
- Recharge speed (turnaround times)

Parking Positions

- Number of parking positions
- Operational capacity
- Space for boarding and disembarking
- Space for ground handling services
- Overnight parking

AAM Use Cases

There are typical anticipated use cases for AAM operations that could bring numerous benefits to the region. As the regional strategy develops, the use cases relevant in a regional context should be identified. Use cases may require different operational and facility requirements and the Collaborative should be cognizant of these as it continually considers the end user and how vertiports will be used by vertiport operators.

Public Safety and Emergency Services

Rapid emergency response services that can transport medical professionals, equipment, or medical deliveries.

Applications could include medical emergency evacuations, rapid passenger transfers, disaster response and relief, medical deliveries, and setting up mobile field hospitals.

Facility and Operational Considerations

- Dedicated facilities and equipment
- Space requirements
- Fast charging for quick response times
- Space for vehicle and equipment maintenance
- Secure environment
- Space to cater for multiple types of emergency response

Freight/Cargo

Likely to be one of the first main uses of AMM operations, AAM transport lends itself well to cargo operations, particularly with the potential of fully autonomous delivery in the future. Bypassing limitations associated with ground infrastructure it could reduce delivery times reach less accessible regions and reduce delivery costs.

Applications could include the delivery of time sensitive goods, high-security/high-value cargo services, last mile delivery, takeaway and food deliveries and, cross-border trade.

Facility and Operational Considerations

- Processing, transferring, and handling equipment
- Specialized equipment and operational procedures.
- Space and capacity
- Strategy should incorporate the needs of the region’s industry

Maintenance, Inspection and Surveying

AAM can be used to maintain, inspect, and survey critical infrastructure and equipment with greater accessibility, enhancing both efficiency and safety.

AAM aircraft equipped with sensors and cameras can efficiently and safely conduct inspections on infrastructure such as power lines, wind turbines, masts, pipelines, or bridges, capturing data and identifying maintenance requirements.

Facility and Operational Considerations

- Likely to require smaller and less complex facilities
- May have specialist equipment
- Could operate from dedicated vertiports not accessible to the public

People Movement

A core vision for the use of AAM operations, people movement will open up a whole new mode of transport that can reduce transport times and open up access to new areas. AAM has the advantage of being able to operate from dense urban areas, allowing transport links to operate within cities, between cities, to and from rural areas, and integrate with other modes of transport to create multimodal transport hubs.

Applications could include scheduled or on-demand services, cater to the tourism industry, private operations, commuter services and business travel, special events (sports, festivals), connecting remote rural communities to essential services.

Facility and Operational Considerations

- Scale of facilities and operations dependent on size
- Air navigation, weather monitoring, obstacle assessment and safety critical features
- Surface access
- Parking and drop-off/pick-up
- Private car, taxi, public transport
- Transport interchanges
- Passenger check-in facility
- Security screening
- Confirmation of passenger identity and issuing of tickets
- Baggage facilities
- Departure and waiting areas
- Commercial and retail facilities

Research

Mounting different types of sensors to AAM aircraft can provide a wealth of research opportunities. Data could be gathered from large areas and from multiple altitudes over all terrains.

Applications could include research for protected areas and wildlife, high-resolution imagery and topographic data, geospatial mapping, ecosystem analysis, air quality tests, biodiversity assessments, and habitat assessments.

Facility and Operational Considerations

- Similar facility requirements as maintenance, inspection and surveying
- Likely to require smaller and less complex facilities
- May have specialist equipment
- Could operate from dedicated vertiports not accessible to the public

Testing and Simulation

AAM can provide a safe and controlled environment to assess new technologies, evaluate system performance, and train personnel.

Applications could include using vertiports as a testbed for AAM technologies and vehicles prior to full-scale implementation, supporting the development of new aircraft technology and designs, development of air traffic systems, training pilots and air traffic controllers.

Facility and Operational Considerations

- Similar facility requirements as research applications
- Likely to require smaller and less complex facilities
- May have specialist equipment
- Could operate from dedicated vertiports not accessible to the public

Military

With various applicability for military operations, AAM can be utilized for uses including transportation, logistics, and rapid response.

Applications could include enhanced supply chain and logistics, accessing remote locations, MEDEVAC, special operations support, resupply missions, aerial refueling, bomb disposal, and research and development.

Facility and Operational Considerations

- Specialized facility requirements
- May have specialist equipment
- Could operate from dedicated military vertiports not accessible to the public

Common Requirements for any Vertiport

Regardless of the user operating at the vertiport, there are common facilities that should be considered for any operations.

Facility and Operational Considerations

- Subject to state and municipal building and codes
- Fire protection systems to respond to emergencies
- Diversionary facilities
- Emergency response capabilities
- Ground handling equipment
- Back-office functions
- Areas for 3rd parties, including commercial operators
- Passenger processing facilities
- Passenger transfer facilities
- Security screening facilities
- Baggage handling
- Electric charging
- Commercial units

Industry Assessment Introduction

Purpose of report

The purpose of this report is to inform the San Diego Association of Governments (SANDAG) about the Advanced Air Mobility (AAM) industry from a high-level perspective. It is intended to be used to prepare SANDAG for discussions with staff, senior leadership, and other key stakeholders throughout the region, about the emerging AAM Strategy. The content in this report builds on the initial discussions held with the AAM Collaborative, the contents of the AAM 101 session held with the AAM Collaborative can be found in **Error! Reference source not found.**.

The report communicates and establishes a starting point for understanding the industry, the potential impacts arising from AAM, and the technology involved to enable AAM. It will be used to aid the AAM implementation strategy within the region. It provides the foundation upon which SANDAG can build by identifying opportunities and projects that will advance both AAM efforts, and ultimately, improve access, equity and connectivity across the region as part of a multi-modal transportation system.

The Industry Assessment provides the foundation for the technical work in developing the strategy. It will also help by providing guidance and insights necessary for executing the additional task requirements such as the AAM Collaborative and the Public Outreach Strategy. This will be primarily through the identification of AAM industry elements and use cases.

The report focuses on the aspects of AAM that relate to the San Diego region. An intended purpose of the report is to provoke the following two overall questions:

Question 1:

How can AAM be leveraged at SANDAG to meet its transportation planning and social equity objectives?

Question 2:

How can SANDAG best prepare for AAM infrastructure and prime the region for AAM adoption?

This analysis will help define what the AAM Strategy is trying to achieve, what it can achieve, and what it cannot.

AAM in the San Diego Region

SANDAG is taking the lead on the development of a regionwide AAM integration strategy. However, it is important to note that while this strategy will be imperative for a comprehensive multi-modal transportation plan, San Diego is not seeking to become an early adopter in the market for AAM technologies.

The focus of the strategy is to prepare the region for the integration of AAM, and to establish the knowledge and conditions to enable future AAM operations to be equitable and part of a wider multi-modal transportation network.

This initial strategy will help lay the foundations for potential AAM operations to be deployed across the region to support emergency services, freight, and people movement, amongst other emerging uses. Forms of AAM are already operating in the area with the Chula Vista Police Department (CVPD) being the first in the USA to develop and deploy the Drone as First Responder (DFR) program[149]. The potential versatility of AAM can be demonstrated in other ways including, the delivery of medical supplies, such as UC San Diego Health's pilot to transfer medical supplies between sites[150], and food delivery, such as Uber Eats successfully testing food delivery by drones in San Diego[151].

San Diego presents a challenging environment to introduce, scale and enable high density AAM operations due to the geography of the area and the multitude of airspace users. The presence of San Diego International Airport, military facilities, an international border with Mexico and the physical geography of the wider area make it a unique environment. The view of SANDAG is that these are challenges to overcome but should not impede AAM developing in the region.

Structure of the Industry Assessment

This Industry Assessment highlights the state of the industry and the market. The conclusions are focused on the components that are relevant to the SANDAG AAM vision and how they can be used to inform the implementation strategy.

The first section of this report provides a **Market Assessment of AAM**. It provides an overview of what AAM is and describes its main **elements**. It then provides an overview and analysis of the key **actors** within the industry, split into broad groups. The assessment then highlights the anticipated typical **use cases** that are expected for AAM. It includes those expected to be the most suitable AAM applications relating to SANDAG, in the short-term and for the time being.

The following section provides a **Review of Previous Notable Work** in the AAM industry with a focus on relevance to SANDAG's own interest in AAM. This is supported by an accompanying dashboard interface of the notable work. The volume of research and guidance and its relevance is such that these are brief overviews as the information and data can become obsolete quickly.

The final section of this report asks the question **SANDAG AAM - What happens next?** It discusses the implications, recommendations and areas to focus on for SANDAG's regional AAM vision. It identifies some strengths, weaknesses, opportunities and challenges for key aspects relating to AAM implementation.

149 Drone Program | City of Chula Vista (chulavistaca.gov)

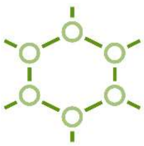
150 UC San Diego Health Launches Drone Transport Program with UPS, Matternet (ucsd.edu)

151 Uber Tests Drone Food Delivery, Launches New Autonomous SUV – NBC 7 San Diego (nbcsandiego.com)

Market Assessment of AAM

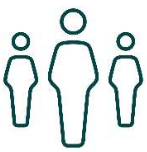
Introduction

The Market Assessment of AAM analyses the main **Elements** and key **Actors** within AAM. It is then followed by an indication of early anticipated **Use Cases**.



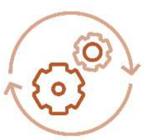
Elements

The main Elements of AAM are described in the subsequent section. It includes a technical analysis of what AAM is and provides an identification of the typical terms and definitions of its features. It also includes the details that should be addressed in the SANDAG AAM Strategy, for example, considerations for airspace and ground infrastructure requirements.



AAM Actors

The key AAM Actors that have been identified are a broad range of organizations, companies, developers, and regulators that are involved in the emerging AAM industry. The purpose is to identify the main Actors, but also to explain their role and notable work to date regarding AAM.



Use Cases

There are many foreseeable benefits to AAM operations, and the end of this section presents an overview of the typical Use Cases that have been identified. In addition, the most relevant use cases for AAM applications relating to the San Diego region specifically are also highlighted.

Elements

Introduction to Advanced Air Mobility

Advanced Air Mobility (AAM)

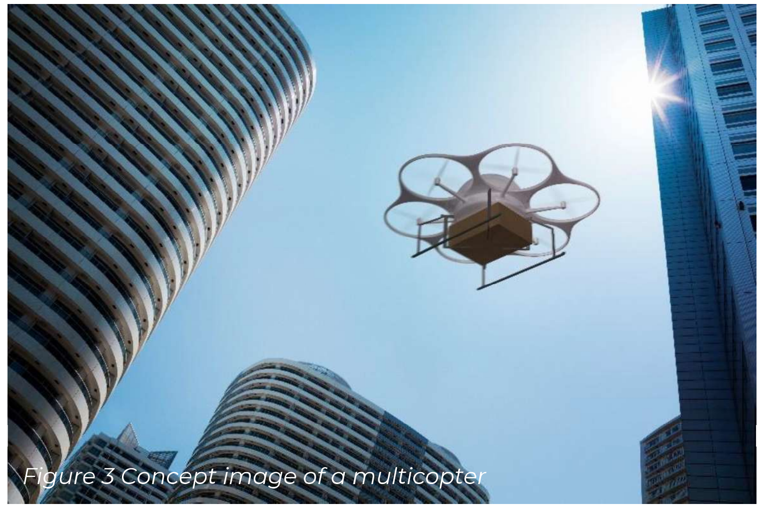


Figure 3 Concept image of a multicopter

Advanced Air Mobility (AAM) is a term commonly used to define an emerging concept of mobility and transportation of people, goods, and services via aircraft. These rapidly emerging aircraft are being developed with cutting-edge technology and materials, advancements in battery technology to deliver electric vertical takeoff and landing (eVTOL) aircraft, electric short take-off and landing (eSTOL) aircraft, electric Conventional Take-off and Landing (eCTOL) aircraft, and highly autonomous uncrewed aerial systems.

AAM aims to provide efficient, sustainable, and accessible air transportation solutions for both urban and rural areas. AAM will lower operating costs when compared to similar helicopter operations and bring mobility and connectivity to underserved regions and markets, whilst creating a new industry with the advent of new transport use applications.

AAM has the potential to reduce travel time, lower carbon emissions, provide public good missions in the form of medical and emergency response, decrease delivery times, and overall improve transportation efficiency by utilizing the airspace and ground space more effectively.

Developing an AAM ecosystem in a rapidly evolving aviation and transportation system is complex. Building a robust, sustainable AAM ecosystem requires extensive investment in research and development across multiple domains. This includes vehicle development, airspace redesign, integration of operations, and effective community and stakeholder engagement.

Industry and regulators have been working together to develop and support potential standards and policies. This collaborative approach is necessary to understand the initial requirements and develop well informed recommendations to build scalable AAM systems to help enable the industry to flourish.


Figure 4 Concept image of a lift and cruise style vehicle

AAM Vehicles

AAM has been made possible due to advancements in propulsions systems, materials, and technologies that have enabled the creation of AAM vehicles. These vehicles can have many different shapes and characteristics and are often categorized by the **vehicle's configuration**, their **take-off and landing style** and the **fuel** they use.

Vehicle Configuration

AAM vehicles have been designed to different configurations with different methods of thrust. The typical configurations are shown in Figure 5. The different configurations of AAM vehicles affect how the aircraft will takeoff, land, and maneuver through the air. Depending on the configuration, some aircraft types may be more suited to certain use cases over other configurations and, thus, it will dictate the type of landing infrastructure required. Picking one vehicle configuration as an example, a multicopter configuration can use its thrusters to take off and land vertically, allowing it to operate from a fixed spot, such as a helipad, whereas more conventional configurations will require a runway.

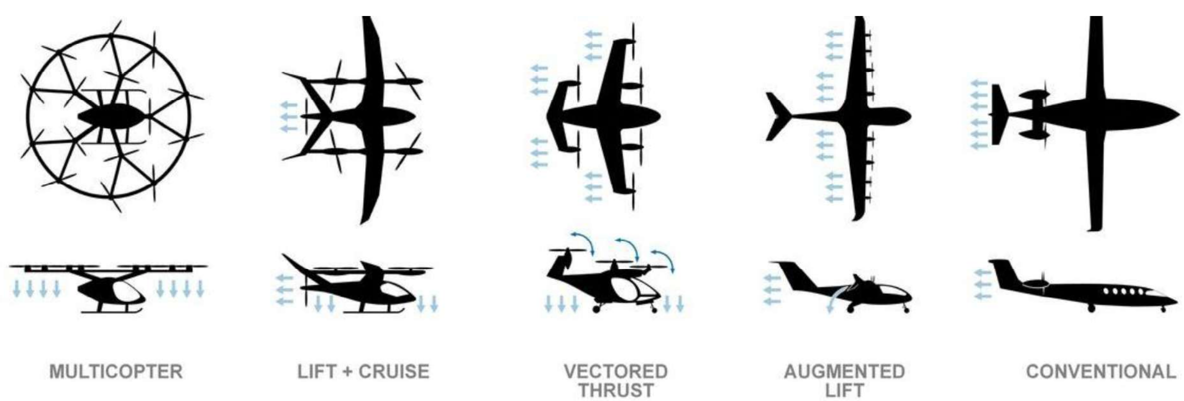
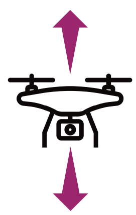


Figure 5 Typical vehicle configurations (Source: AAM Reality Index, SMG Consulting)

Take-Off and Landing Style

Three classifications of take-off types are understood by the industry, Vertical Take-off and Landing (VTOL), Conventional Take-off and Landing (CTOL) and Short Take-off and Landing (STOL).



Vertical Take-off and Landing (VTOL)

VTOL aircraft can be piloted remotely or with onboard crew. Operating from vertiports, they are versatile aircraft and do not require runways. They can theoretically operate from multiple locations, subject to planning, design, and compliance, including existing airports, existing heliports and vertiports. VTOL are flexible to serve a variety of locations and are expected to form a large proportion of AAM aircraft.

Conventional Take-off and Landing (CTOL)

CTOL aircraft are fixed wing aircraft that require a runway to take-off and land. From an AAM perspective CTOL can be existing aircraft that are retrofitted with zero emission fuel or newly designed zero emission fixed wing aircraft.

Short Take-off and Landing (STOL)

STOL aircraft are fixed wing aircraft that have the capability to take-off and land on shorter distances compared to conventional aircraft and do not necessarily need runways. Depending on the specifications of the aircraft they can operate from lengths as short as 30m-50m. They would not operate from vertiports, but they could be part of regional air mobility (RAM) services.

Fuel Types

There are several types of fuels or energy sources that have been explored for use in AAM, such as electric, hybrid electric systems, hydrogen and hydrogen fuel cells. For the time being, the majority of AAM vehicles are electric powered, the industry tends to prefix the names of aircraft with the letter ‘e’ to denote ‘electric’. However, all fueling infrastructure needs will need to be addressed and considered as the technology advances.

Hydrogen powered vehicles are currently in the minority. However, large scale investment in research and development could change this. It is important to consider this when developing the strategy as the fuel sources may be different in the future, and future proofing should be embedded as far as reasonably practical.

Trends in power and fuel sources should be monitored and tracked as different technology requires additional planning, design, operational and safety considerations.

Autonomous and Remotely Piloted Vehicles

As the industry navigates the “crawl” phase of integration, many original equipment manufacturers (OEMs) have opted for vehicle models that are designed to support initial piloted operations with increased automation to eventual fully autonomous operations. The progression to fully autonomous operations will be highly dependent on the progress of regulatory rulemaking, standards development for operations, and ability to integrate these operations into the national airspace system (NAS). Such tools include new technological capabilities and standards pertaining to object detection and avoidance, stability augmentation, auxiliary support systems to make vehicles easier to fly and reduce the risk of Near Mid-Air Collisions (NMAC) in take-off, flight, and landing.

Vehicle Certification

Vehicle certification is a key requirement for AAM vehicles before they can be brought to market and used for commercial operations. Regulators, such as the FAA, are required to certify an aircraft’s airworthiness to ensure it is safe to operate. Product certificates are required for individual **parts** of the product, the overall **type** of design of the product as well as an **airworthiness** certificate for each individual aircraft.

Conventional aircraft have been certified by regulators for a long time, however, AAM vehicles are novel and unique compared to conventional aircraft. As such, the current certification regulations do not cover all the possible variations of design, configuration, propulsion systems and other technologies that can be attributed to AAM vehicles. In order to accommodate this new breed of aircraft, regulators are having to either adapt their existing certification regulations (such as the FAA) or having to create new ones dedicated to AAM aircraft (such as EASA[152]). Desires in the AAM industry to develop vehicles capable of operating autonomously and beyond visual sight (BVLOS) presents additional complexity as there are no precedents in the aviation industry to compare to. It will take some time for regulators to develop new and appropriate regulations for the relatively fast paced development of AAM vehicles.

Type Certification is the most time-consuming part of the process experienced by OEMs, estimated to take anywhere between three to eight years before it is achieved. Current AAM players are expecting certification within the next year or two with some aiming to commence commercial operations as early as this year.

		Responsible Authority			Accountable Organization			
		FAA 1)	EASA	NAA 2)	Supplier	Integrator	Operator	
Product certificates	1 Part Certificate	✓	✓		✓	✓		
	2 Type Certificate	✓	✓		✓	✓		Focus
	3 Airworthiness Certificate	✓		✓		✓	✓	
Organizational approvals	4 Design Organization	✓ 3)	✓		✓	✓		
	5 Production Organization	✓ 3)		✓	✓	✓		
	6 Maintenance Organization	✓	✓ 4)	✓ 4)			✓	
	7 Air Operator Certificate	✓		✓			✓	

1) FAA acts also as a national aviation authority (NAA) 2) National aviation authority 3) Organizational approvals at FAA are based on direct inspection and oversight using the services of Designated Engineering Representatives (DERs) and Designated Airworthiness Representatives (DARs). 4) Depending on the principal place of business (EASA member state vs. non-member state)

- *Figure 6 Required certifications and approvals (Source: Up and away: Certification for AAM aircraft, Roland Berger)*

[152] SC-VTOL (Special Condition for VTOL), EASA

Figure 7 EHangs EH216-S aircraft (Source: EHang)

In October 2023, EHang announced that it has obtained Type Certificate for its EH216-S from the Civil Aviation Administration of China (CAAC).[153]

Figure 8 Volocopter's VoloCity aircraft (Source: Volocopter)

Volocopter is anticipating starting commercial operation in Paris in 2024 and is working towards achieving Type Certification for its VoloCity air taxi.[154]

Figure 9 Joby Aviation aircraft (Source: Joby Aviation)

In the US, Joby Aviation is working towards receiving Type Certification from the FAA with the desire of commencing operations in 2025.[155]

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[153] EHang Successfully Obtains Type Certificate for EH216-S (ehang.com)

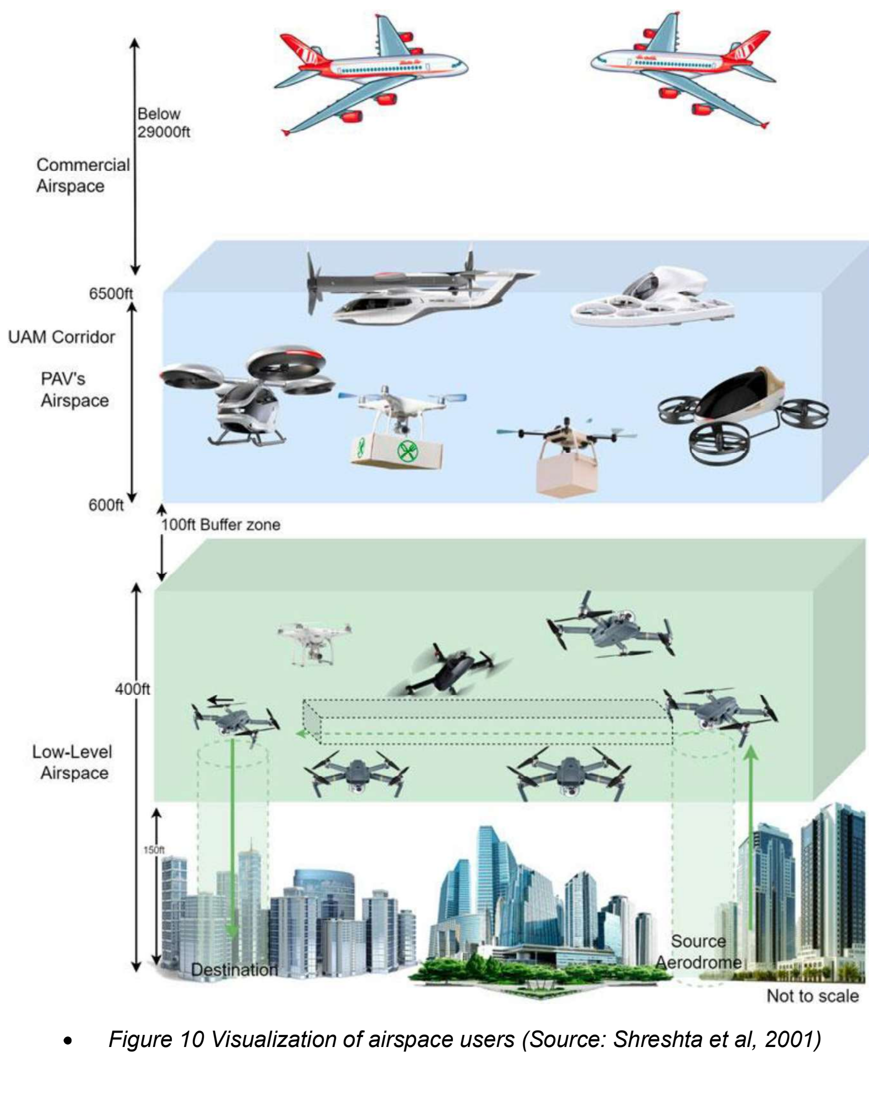
[154] French Evolution: What is Volocopter Doing in Paris to Fly there First by 2024? (volocopter.com)

[155] Joby Completes Submission of Stage Three Certification Plans to the FAA (jobyaviation.com)

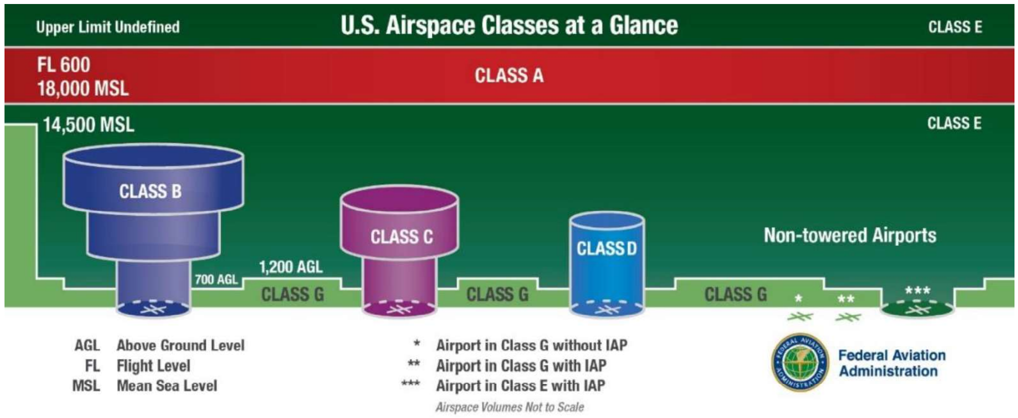
Airspace

Airspace is a complex issue, and this is particularly true for the Southern California region. The San Diego region is home to a diverse range of airspace users. It includes civilian aerodromes, military bases, an international border and overfly traffic. Complexity is amplified with the requirements of introducing autonomous aircraft into established airspace as autonomous aircraft would be operating in and sharing airspace with manned aircraft.

In order to understand and visualize the airspace where AAM aircraft typically operate, *Figure 10* presents a helpful image showing three distinct sections of airspace: *"Low-Level"*, *"UAM Corridor"*, and *"Commercial"*. Small Unmanned Aircraft Systems (UAS) and Unmanned Aircraft Systems (UAV) are shown to operate in *"Low-Level airspace"*, from ground level up to, and including, 400ft. Aircraft generally considered as part of AAM, such as AAM Passenger Air Vehicles (PAVs) shown in Figure 10, will operate in what is known as the UAM Corridor. At early AAM deployment stages, AAM vehicles will typically operate from ground surface up to 4000'/6500', considerably lower than typical commercial aircraft.



- *Figure 10 Visualization of airspace users (Source: Shreshta et al, 2001)*



- *Figure 11 United States Airspace Classes (Source: FAA)*

US Airspace is split into different categories or 'classes' The classes are Class A, B, C D, E and G. Classes A to E are considered controlled airspace and Class G uncontrolled. Vehicles have different operating procedures depending on the class of airspace they are operating in and whether they are flying under Instrument Flight Rules (IFR) or Visual Flight Rules (VFR).

IFR operations apply only when aircraft can use instruments to fly, this allows aircraft to fly in weather conditions with poor visual conditions. AAM aircraft operations are initially anticipated to follow VFR, generally meaning that the aircraft may only operate in weather conditions such that the pilot can see clearly.

AAM will operate in all classes of airspace, except for Class A which requires aircraft to fly under IFR. Classes B, C, and D airspace is typically defined airspace around an airport traffic area such as an airport, with Class B in operation around the busiest and largest aerodromes, Class C for smaller aerodromes and Class D for even smaller aerodromes. Flying into Class B, C or D airspace requires communication with and clearance from air traffic control (ATC).

All other controlled airspace that does not fall into Class A, B, C or D is defined as Class E airspace. It does not require ATC communication for VFR operations. All airspace not classified as controlled falls under Class G airspace which includes all airspace under 14500' mean sea level (MSL). However, Class G airspace is typically beneath controlled Class E airspace up to an elevation of 1200' above ground level (AGL).

The complexities of managing airspace are supported by ground infrastructure, some of which may be located at vertiports. These services that can be bracketed under 'vertiport management systems'. Automated systems at vertiports and en-route are needed in the following areas:

- RADAR surveillance systems
- Flight management systems to schedule resources and services for flight operations
- Localized weather monitoring

Future Airspace Planning

Between airspace complexity and the vast array of physical and digital infrastructure associated with supporting the airspace of the future, planning organizations will have to contend with expeditiously developing implementable strategies concurrent with the rapidly developing technologies.

Existing airspace rules and regulations are sufficient to enable a low-density level of AAM operations. To achieve high-density, highly autonomous Beyond Visual Line of Sight (BVLOS) operations will require coordinated efforts internationally and nationally to develop the rules and guidelines for introducing AAM aircraft into the National Airspace System (NAS). The responsibility for this is being coordinated at a federal level and is not the responsibility of SANDAG.

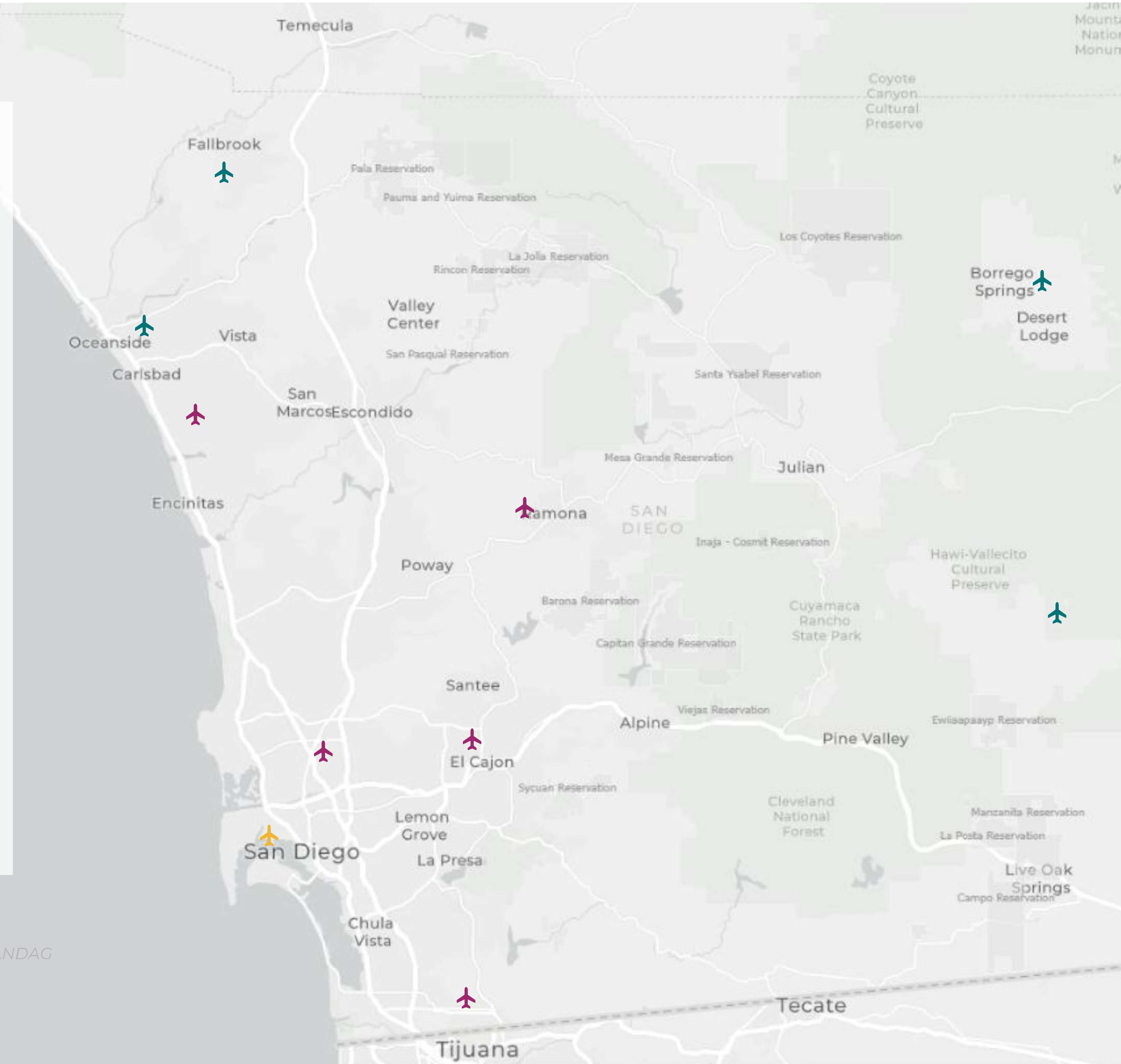
Civilian Airspace Considerations

The San Diego region is home to numerous international airports, general aviation airports and other airfields and aerodromes. There are 12 public-use and four military airports and airfields within San Diego County. There are also 19 private airports and 17 heliports/helipads.

International Airports
- San Diego (SAN)

Towered GA Airports
- Brown Field (SDM)
- Gillespie Field (SEE)
- McClellan-Palomar (CLD)
- Montgomery-Gibbs Executive (MYF)
- Ramona (RNM)

Non-Towered GA Airports
- Agua Caliente (LID)
- Borrego Valley (BXS)
- Fallbrook Community Airpark (LID)
- Jacumba
- Oceanside (OCN)
- Ocotillo



Background image sourced from SANDAG

Civilian Airspace Considerations

San Diego County Regional Airport Authority serves as the Airport Land Use Commission (ALUC) for San Diego County. Airport Land Use Compatibility Plans (ALUCPs) detail the policies and standards of noise, safety, and airspace compatibility in the vicinity of airports. It does not apply outside of the airport boundary and has no influence on ground operations or master planning.

The ALUCP designates an Airport Influence Area (AIA), as illustrated in Figure 12. This is an area defined on the length and orientation of runways, operating hours, and aircraft fleet mix. As ALUCPs predate AAM, the SANDAG AAM Strategy will need to consult with San Diego County Regional Airport Authority as to the implications for AAM operations from any of these facilities. This is an important factor to make AAM equitable, not be imposed on communities and be used for public good.

> **Recommendation**
>
> *SANDAG collaborates closely with the San Diego County Regional Airport Authority as to the implications for AAM operations from any of the County's aviation facilities.*

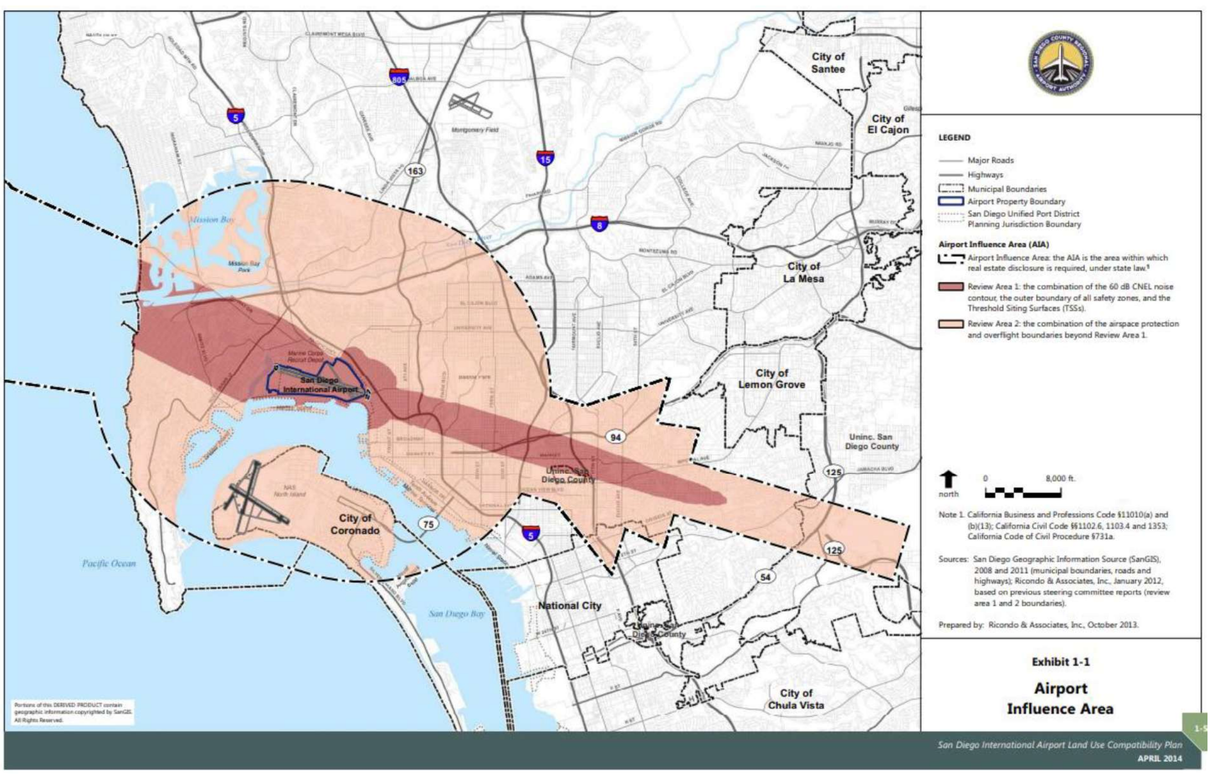


Figure 12 Airport Influence Area - San Diego International Airport (Source: Airport Land Use Commission – San Diego County Regional Airport Authority)

Military Airspace Considerations

The strategy must consider the restrictions and operational parameters of military installations in the region, including military airports as well as navy and coast guard facilities. Special use airspace may have limitations imposed upon aircraft operations within its area of influence. Depending on the area's specific requirements, this could involve additional procedures being followed, restricted use or outright prohibition.

The military airports have adopted ALUCPs and are also complemented by the Air Installations Compatible Use Zones (AICUZ). They detail land use compatibility focusing on noise exposure contours and accident potential safety zones.

The following military installations need to be integrated into the strategy:

- Coast Guard Air Station based at San Diego International Airport
- Naval Air Station North Island
- Naval Outlying Landing Field, Imperial Beach
- Marine Corps Air Station (MCAS) Pendleton
- MCAS Miramar

Air navigation requirements, airspace operating rules and exclusion zones will all be identified, assessed, and integrated into the AAM Strategy.

Border Airspace Considerations

US Customs and Border Protection (CBP) has a strong presence in the region and is also a primary user of airspace. The Air and Marine Operations (AMO) section of CBP safeguards airspace by confronting security threats and unlawful activities. San Diego is home to one of the Southwest Region AMO's, San Diego Air and Marine Branch, based at Naval Air Station, North Island.

Cross-border AAM services will require extensive coordination and regulatory support, thus inhibiting the use case to adoption; however, the assumption and intention across the industry is that AAM will be operated internationally.

San Diego is uniquely positioned as the largest bi-national urban region on the United States-Mexico border, as such, bi-nationality is woven into the social and economic fabric of the region, which collectively generates approximately $230 billion annually. San Diego's bi-national status plays a significant economic and social role to the region and serves as an essential corridor for the movement of people and freight. These imperative ports of entry provide access to the nearly 600 export manufacturing plants located no greater than 15 miles south of either port of entry.

The San Ysidro Land Port of Entry, connecting San Diego with Tijuana, MX, is the single busiest land port of entry in the Western Hemisphere, serving over 90,000 northbound commuters on any given day. Just six miles east is the busiest commercial port in California, Otay Mesa, processing over 1 million trucks, 5 million vehicles, and 2.1 million pedestrians annually and generating an almost $68 billion in trade in FY 2022.

While the border provides unique positioning for the region and generates an exorbitant amount of commerce via daily trade, the border congestion and subsequent delays at both ports of entry have tremendous impacts on the region. In 2017, a SANDAG economic analysis determined that San Diego County and the Baja California economies suffer an estimated $6 billion-dollar annual loss in gross output due to wait times, this equates to approximately 3% of the regions annual GDP, or about $1,200/person (pre-COVID population). Thus, it is reasonable to assume that operators will aim to capitalize on the potential of AAM, and the region's implementation strategy should prioritize the phased bi-national freight movement use case.

Given the continued demand for manufacturing capabilities in Mexico and the convenient proximity for distribution of goods over land into the U.S., bi-national trade makes for a compelling future use case. First, however, there are practical issues that require addressing, specifically pertaining to security, immigration and emigration, customs, and passenger and freight processing. The SANDAG AAM Strategy should seek to understand the market potential, use cases, ongoing or planned project synergies, and impacts upon the existing border crossing points.

Ground Infrastructure and Facilities

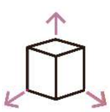
Heliports are the nearest comparable facilities today in relation to the infrastructure required for AAM. Heliports are typically facilities intended for the landing and take-off of helicopters. A heliport could have capacity for a single or multiple landing pads and parking positions for helicopters.

To facilitate AAM operations, ground infrastructure tailored to aircraft and equipment needs to be provided. Existing infrastructure and facilities, including airports and heliports, are anticipated to be used in the early phases of AAM, provided it is safe and practical to do so and in compliance with regulations. However, to unlock the full potential of AAM applications, new ground infrastructure solutions will have to be developed and integrated with existing transportation networks. Emerging design standards and guidelines are being created specifically for AAM infrastructure. The term '**vertiport**' is the recognized industry term being used to describe the fixed ground-based infrastructure where vertical take-off and landing AAM operations will operate from.

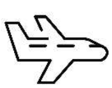
Infrastructure and Facility Overview

The exact type of infrastructure and facilities required at any vertiport will be largely governed by its location, size and type of operation it provides. It could be influenced by the numerous factors, for example:

Location
Facilities based in a built up, urban setting may use rooftops for their main AAM operations. Moving outside of the city where there is more space, bespoke vertiports could be constructed and/or combined with other transport modes such as rail and airports to create multimodal network hubs.

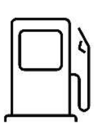


Size
The size of the vertiport will be driven by the demand and the available space for the overall facility. When planning a vertiport, it would be prudent to forecast the anticipated traffic that will be using the facility to size the facility appropriately and safeguard its possible expansion in future years. The size of the facility will have to include not only area for any passenger spaces and AAM vehicle spaces, but also for any staff areas, fueling infrastructure, maintenance, repair and overhaul (MRO) facilities, back of house areas, etc.



New or Existing Infrastructure
Airports and heliports already have many of the required infrastructure and facilities to support AAM operations. Basing initial AAM operations within an existing airport or heliport could prove a useful step to introduce AAM operations in a region.

AAM Vehicles
The type of vehicles using the AAM facility will have to be considered to ensure the facility is designed to their needs. Close communication with OEMs and adherence to planning standards will ensure an appropriate vertiport design is developed.



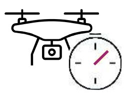
Fuel
Fuel will have to be provided for the AAM vehicles that intend to operate from the facility. Fuel supply, storage and dispensing will have to be considered. For example, electric powered

aircraft need sufficient connections to and capacity within the grid to enable recharging. Aircraft typically need quick turnaround times to maximize their time spent servicing commercial operations. Recharging eVTOL aircraft will require a significant amount of electrical input to ensure a suitable recharging time is met. This is a situation that is even more complex when multiple aircraft require charging simultaneously.

Vertiport Planning and Design

The FAA has announced that it intends to publish a new Vertiport Planning & Design

Touchdown and Lift-Off Positions
The number of TLOF positions will determine the overall capacity of the vertiport and the intensity of operations able to be achieved. In the planning of vertiports the number of TLOF positions will need to be coordinated with the number parking positions.



Parking positions
Parking positions will be required for AAM vehicles during aircraft turnarounds for the boarding and disembarking of passengers and/or cargo as well as for refueling and maintenance inspections. Overnight parking will also be required.

Ground support equipment
Ground support equipment (GSE) will be required to services and maintain aircraft. These are typically bespoke pieces of equipment, requiring suitable storage space.

Vertiport Overview

To facilitate AAM operations, ground infrastructure and equipment tailored to specific aircraft types needs to be provided. The nearest comparable facility that exists today in relation to the type of infrastructure required for AAM operations is a heliport. Heliports are typically facilities intended for the landing and take-off of helicopters. A heliport could have capacity for a single or multiple landing pads and parking positions for helicopters. Heliports are very similar to airports in that they cater to aircraft, with the only difference being that heliports can only accommodate vertical take-off/landing vehicles.

As they share similar infrastructure and facility requirements, heliports and airports are anticipated to be used in the early phases of AAM, provided it is safe and practical to do so and in compliance with regulations. These facilities could be used or modified for AAM purposes, however, there are still differences between a heliport and a vertiport. Helicopters and AAM aircraft have different technical parameters regarding landing and take-off approaches, ground handling procedures and different safety requirements. Additional complexity arises from the wide array of designs for AAM aircraft – helicopters have a fairly uniform design making it much simpler to design a touchdown/take-off pad for whereas AAM vehicles come in a myriad of different shapes, sizes and designs which may not be compatible with existing heliports. Furthermore, the majority of AAM aircraft will typically be electric powered, unlike helicopters, and heliports may not have the required electricity capacity to cater to AAM operations.

To unlock the full potential of AAM applications, new ground infrastructure solutions will have to be developed and integrated with existing transportation networks. Emerging design standards and guidelines are being created specifically for AAM infrastructure. The term ‘**vertiport**’ is becoming the recognized industry term used to describe the fixed ground-based infrastructure where vertical take-off and landing AAM operations will operate from.

A vertiport encompasses multiple facilities associated with the operating of AAM vehicles, such as providing aircraft parking, fueling/recharging, passenger processing, cargo/freight processing and support facilities.

The technical definition of a vertiport as stated by the FAA is: *An area of land, or a structure, used or intended to be used for electric, hydrogen, and hybrid VTOL aircraft landings and takeoffs and includes associated buildings and facilities.*

This definition is included in *FAA Engineering Brief #105*, which is currently the most up to date design guidance for vertiports in the US. Standards and guidance on the planning of vertiports is still in progress, further complicated by more and more varied AAM vehicles with different specifications being continually developed. Until sufficient data is available to validate AAM aircraft performance and characteristics, the standards, and guidelines for vertiports will be based upon several factors. This involves utilizing existing guidance where relevant and adopting a conservative approach to account for the variety and evolving types of AAM aircraft designs.

Figure 13 Vertiport concept (Source: NASA)

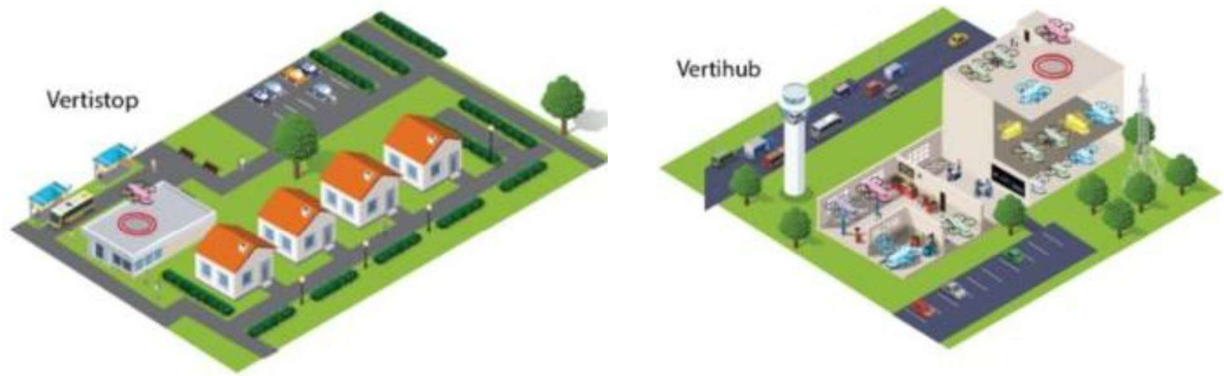


Figure 14 Concept images of a 'vertistop' and 'vertihub' (Source: NASA)

The infrastructure and facilities required at a vertiport will be dictated by their function and size of the operation. NASA's AAM Vertiport Automation Trade Study[156] identifies three typical functions:

1. **Small Suburban *"Vertistop"***:
   A vertistop is a facility used for the landing and taking off of VTOL aircraft. The technical definition of a vertistop as stated by the FAA is:
   "A vertistop is a term generally used to describe a minimally developed vertiport for boarding and discharging passengers and cargo (i.e., no fueling, defueling, maintenance, repairs, or storage of aircraft, etc.)."
   Vertistops will be the smallest part of the system, typically with one take-off/landing pad and one or two parking positions. These will be basic facilities that are only designed for loading and offloading with basic handling facilities. They would generally not have any ancillary functions.
   Due to their size, vertistops could be located in suburban areas and serve as multimodal connection points to a handful of transport modes such as cars, buses, and bikes.

Medium Urban *"Vertiport"*:

This is defined as a vertiport with high traffic volumes that is located in the heart of urban areas. Due to the size restrictions, based on its location in the busy built environment, urban vertiports will lack the type and number of services they can offer when compared to larger 'hub' style vertiports.
(*Note that in NASA's study they refer to vertiports as mid-sized urban vertiports whereas this report defines a vertiport as any piece of fixed ground infrastructure that supports VTOL AAM operations*).

Large Periphery *"Vertihub"*:

These are multimodal facilities with capacity for multiple simultaneous and high-density operations. It is envisioned that these facilities would be situated on the edge of urban areas due to the large land footprint they would occupy. With the capacity to handle higher throughput, the vertihub terminal facilities could resemble that of an airport, including retail / food and beverage outlets, and dedicated lounges.
A vertihub concept would have sufficient capacity to store aircraft overnight and accommodate multiple aircraft departing and arriving. These facilities could also serve as multimodal transport hubs that connect passengers to private vehicles, public transport networks, and additional micro-modalities depending on the jurisdiction's priorities.
A vertihub facility, if it is designed to store aircraft overnight, could also incorporate maintenance, repair and overhaul (MRO) facilities that could be used by an operator or a maintenance sub-contractor or OEM specialist.

Different types of vertiports will constitute the same facilities in many aspects, particularly in regulatory matters, but the main difference is the capacity, intensity of use and ancillary functions. The AAM

[156] AAM Vertiport Automation Trade Study, NASA

Collaborative and the AAM Strategy can recommend typical emerging infrastructure and the facility requirements to the needs of the region.

The table below provides a high-level overview of the facility and infrastructure requirements for different vertiport sizes, based on the three vertiport sizes defined previously: Small Suburban *"Vertistop"*, Medium Urban *"Vertiport"*, and Large Periphery *"Vertihub"*: This could provide guidance to developers in what is expected of them at a vertiport. It could also be expanded to include local planning and building codes to provide a one-stop source of information.

	Vertistop	Vertiport	Vertihub
Number of landing sites	1	2+	2+
Charging infrastructure	✓	✓	✓
Vertiport Manager Support	✓	✓	✓
Gate infrastructure		✓	✓
Aircraft servicing	✓	✓	✓
Base maintenance			✓
Hangar space			✓

- *Figure 15 Vertiport features (Source: Wisk ConOps)*

The Basics: Take-Off and Landing Infrastructure (TLOFs and FATOs)

To enable safe VTOL operations, a vertiport must have the following features with definitions, as stated in the FAA's engineering brief and illustrated in Figure 16:

Final Approach and takeoff area (FATO): *The FATO is a defined, load-bearing area over which the aircraft completes the final phase of the approach, to a hover or a landing, and from which the aircraft initiates takeoff.*

Touchdown and liftoff area (TLOF): *The TLOF is a load bearing, generally paved area centered in the FATO, on which the aircraft performs a touchdown or liftoff.*

Safety Area: *The Safety Area is a defined area surrounding the FATO intended to reduce the risk of damage to aircraft accidentally diverging from the FATO.*

The TLOF, FATO and Safety Area combine to create the takeoff and landing areas for a vertiport. The sizes of each area are dependent on the aircraft using the vertiport and their dimensions. The areas are based upon the 'Controlling Dimension' (CD) which is the diameter of the smallest circle on a horizontal plane enclosing the aircraft when in takeoff or landing configuration. The CD is the distance between the two outermost opposite points on the aircraft. In simple terms, the larger the aircraft, the larger the landing area required. Therefore, when designing a vertiport, care should be taken to confirm the most appropriately designed aircraft are selected to ensure the sizes of the landing area can be calculated accurately. It would be sensible to consider any potential aircraft that could use the facility in the future to safeguard their operation.

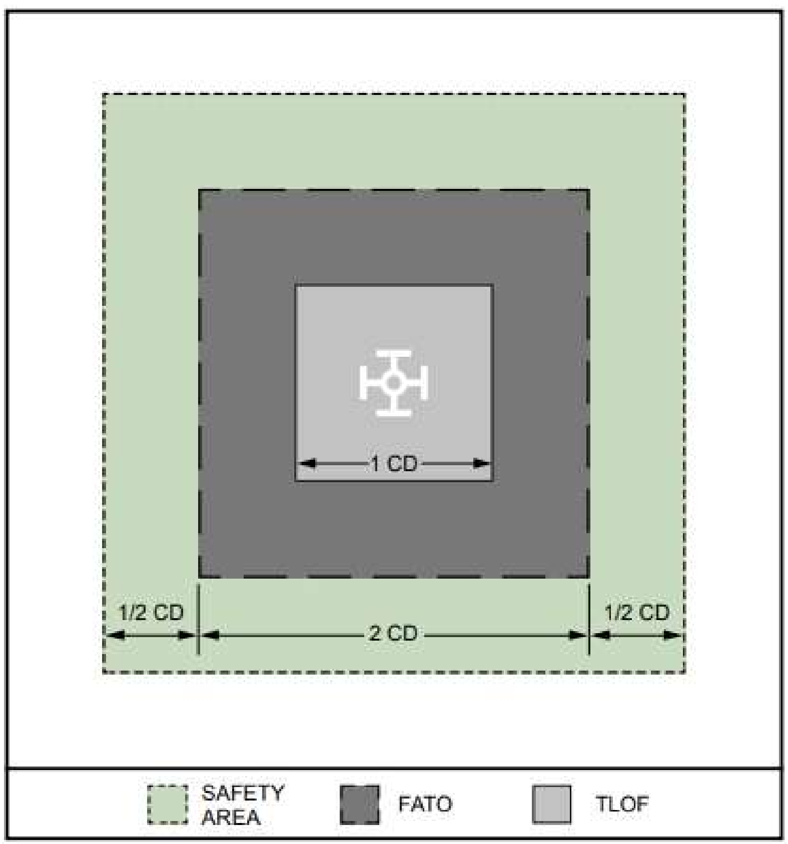


Figure 16 Typical arrangement of TLOF, FATO and Safety Area (Source: FAA)

Other Basic Considerations

Aside from the basic requirement of a take-off and landing zone, other infrastructure and facilities will have to be considered to safely operate AAM operations from a given site. The following features need to be considered, as detailed in *FAA Engineering Brief #105*:

- Marking, Lighting and Visual Aids
- Charging and Electric Infrastructure
- Fire Fighting equipment
- Security Screening areas
- Automated Weather Observing System (AWOS)
- Winter Operations equipment
- Access to people with disabilities

Aircraft Parking (Stands)

The majority of vertiports will require dedicated parking positions for AAM aircraft (or as it is commonly referred to in the aviation industry, aircraft 'stands'.). Stands will be utilized by aircraft for several functions and require sufficient space and facilities for the aircraft turnaround processes, such as:

- Arrival on stand
- Disembarkation of freight, passengers, crew and waste
- Security inspections
- Maintenance inspections
- Embarkation of freight, passengers, crew
- Dispatch and hand over to air traffic service

The layout of stands at an airport will have to be considered for any vertiport. It will be influenced by numerous factors such as how the vertiport is operated, the space available, the number of parking positions required, the characteristics of the aircraft using the vertiport, and the future expandability of the vertiport layout.

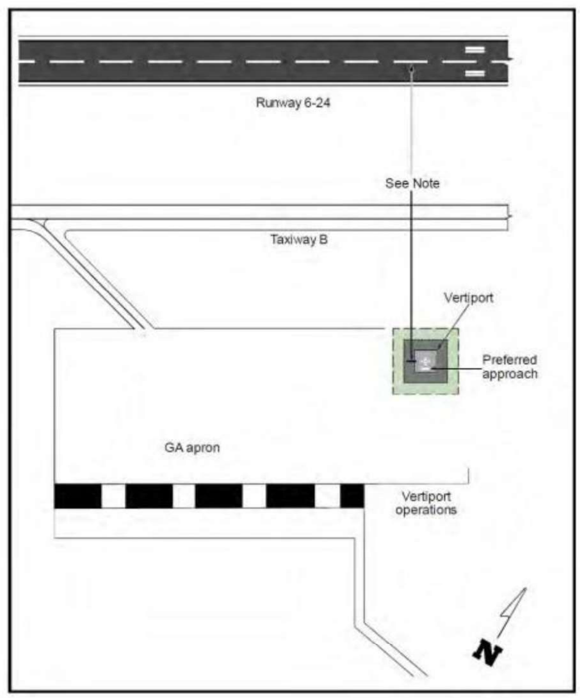


Figure 17 Example of an on-airport vertiport (Source: FAA)

FAA Engineering Brief #105 does not currently detail aircraft stand layout. The layout in Figure 17 shows aircraft parking in a General Aviation (GA) apron layout. It illustrates a typical arrangement and layout anticipated for an on-airport setting. Although this is shown for an airport setting, it could be adopted for a purpose built vertiport.

The European Union Aviation Safety Agency's (EASA's) approach, as detailed in the Prototype Technical Specifications for vertiports, illustrates a range of general layouts depending on how the vertiport is operated. Figure 18 illustrates a layout whereby aircraft can ground-taxi through aircraft stands that can be operated simultaneously and in either direction. Figure 19 illustrates the same principle but for air-taxiing aircraft. Figure 20 and Figure 21 illustrate aircraft stands in different operating modes, both adopting an air-taxi route. Figure 20 shows stands spaced far enough part so they may be active simultaneously, whereas the stands shown in Figure 21 are within closer proximity to one another, reducing the space required per stand but limiting the independent operability between stands.

Figure 22 illustrates further high level vertiport layout examples from OEMs, Wisk, Concept of Operations.

These are all examples of arrangements to consider, and the most appropriate layout at each vertiport will be dependent on the specific operation.

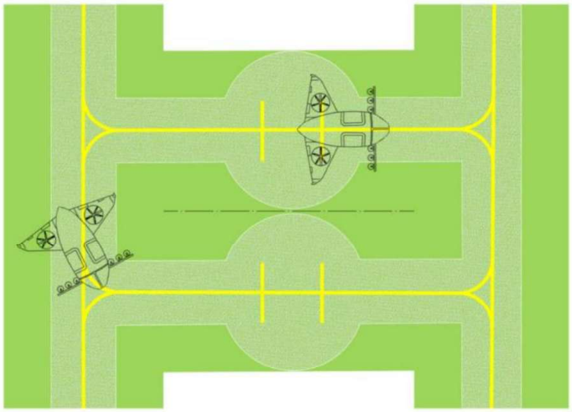


Figure 18 Ground taxi-through aircraft stands operating simultaneously (Source: EASA)

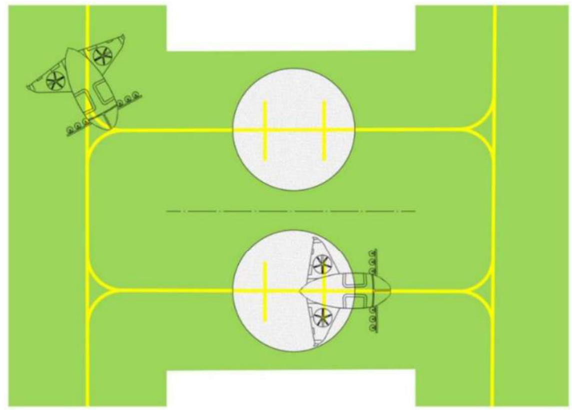


Figure 19 Air taxi-through stands operating simultaneously (Source: EASA)

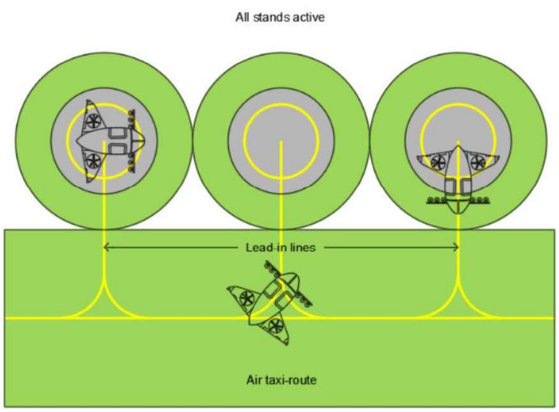


Figure 20 Adjacent stands operating simultaneously (Source: EASA)

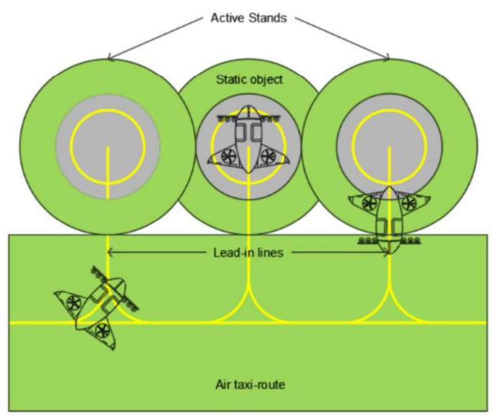


Figure 21 Turning stands operating non-simultaneously (Source: EASA)

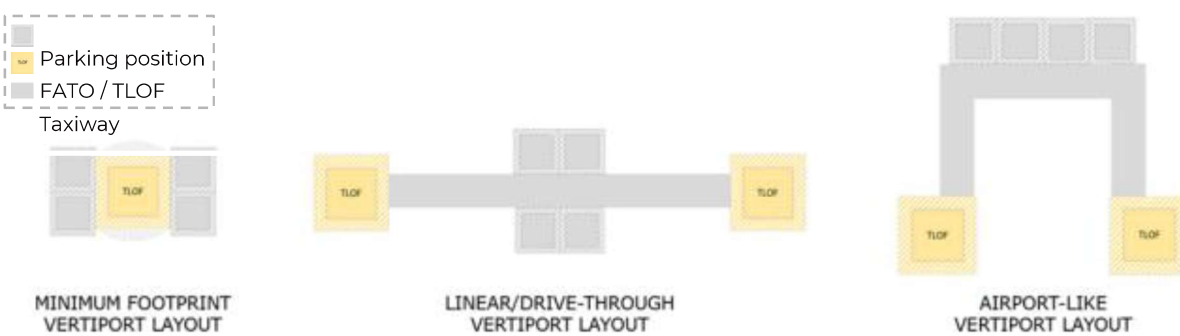


Figure 22 Vertiport topology configurations (Source: Wisk)

Facilities at Vertiports

Vertiports will require numerous facilities and features to support their intended use, some specifically related to their operations and other common features across the various types of vertiports. This section highlights those needs from high-level use cases to ensure the project and the Collaborative continually consider the end user.

Public Safety and Emergency Services

Public Safety and Emergency Services require unique facilities and equipment. Early engagement through the AAM Collaborative will detail the typical space and facility requirements to consider. The specific operations for emergency services will differ but the principles will be consistent. This includes fast charging infrastructure, space for vehicle and equipment maintenance, a secure environment and space to cater for multiple types of emergency response.

Chula Vista Police Department (CVPD) are already operating small Uncrewed Aerial Systems (UAS) to respond to Priority 1 emergency calls. The UAS are operated remotely from five launch sites across the city. CVPD has authorization from the FAA for Beyond Visual Line of Sight (BVLOS) operations, and as a Public Aircraft Operator (PAO) has obtained permission to launch from anywhere in the city. Additionally, CVPD obtained a two-to-one waiver meaning CVPD can launch two drones per each pilot during operations.

Freight/Cargo

Processing, transferring, and handling equipment for freight operations involves specialized equipment and operational procedures. The SANDAG AAM Strategy will not detail specific equipment requirements but will consider the general requirements from a space and capacity perspective. Vertiports handling freight and cargo will only be one step in an overarching integration process, and the strategy must incorporate the needs of the industry in the San Diego region, including which stakeholders will be imperative to the success of integrating the AAM freight use cases into the region.

Maintenance, Inspection and Surveying

Operators related to maintenance and inspection of assets are generally likely to require smaller and less complex facilities than emergency, freight, and people movement use cases. These will primarily be operators taking off and landing with specialist surveying equipment onboard the aircraft. Operating from vertiports not accessible to the public, the facilities would not generally be complex.

People Movement

A vertiport specializing in people movement will likely be one of the most complex facilities. A simple vertistop may only need limited physical facilities but will still require air navigation, weather monitoring, obstacle assessment and safety critical features. Vertiports with higher density operations and passengers processing will need:

- **Landside access**
  Connector roads to the main local road network.
  Curbside parking or pick-up / drop-off bays for private vehicles or public transport vehicles i.e. taxis and buses.
  Car parking facility.

Interchanges with other transport modes and mass transit networks, if operating as part of a multimodal transport hub.

- **Passenger processing facilities**, possibly including security. Security has the potential to be a key driver of how long a passenger is required to dwell within the terminal. Check-in processes would need to be incorporated, and depending on the operation, confirmation of passenger identity and issuing of tickets considered. It is possible that much of the check-in process could be done with automation using equipment such as self-service kiosks and bag drop facilities, similar to airports. A suitable location for check-in equipment could be in the main entrance foyer. Baggage handling facilities may be a core component of a vertiport passenger handling facility. The size of the baggage handling facility is likely to be influenced by the nature and operation of the vertiport and average size of bags carried by passengers.
- **Departure and waiting areas** for passengers will need to be sized accordingly based on the type of vertiport facility and average dwell times of passengers before boarding. For example, a vertistop facility could offer a relatively basic level of comfort compared to a vertihub, which could offer a high-quality facility.
- **Commercial and retail facilities** could be provided to enhance the passenger experience. The type of facilities would be dependent on the type of vertiport being served and the average dwell time of passengers using the facility. For example, a basic facility could consist of vending machines whilst a larger facility may offer a café or restaurant outlet.

Common Facility Requirements

There are numerous common requirements related to facilities, services and equipment that may be required, regardless of the type of operation at the vertiport.

All vertiports will require to be designed subject to state and municipal building and fire codes. Vertiports will also require fire protection systems to respond to emergencies at least during operational hours. FAA EB #105 refers to National Fire Protection Association (NFPA) 418 – Standards for Helicopters as the current guidance for vertiport firefighting and safety considerations.

Foam fire protection systems, with either a fixed discharge outlet or a hose line, are required on vertiports situated on rooftops, unless located on open parking structures or buildings that are not normally occupied. Portable foam extinguishers are permitted in certain circumstances in place of fixed or hose line systems. If trained personnel are not available as an on-site fixture at the vertiport, a fixed fire protection outlet is required.

Vertiports may be used as diversionary facilities in the event of an aircraft emergency that involves an emergency landing, and these locations may require emergency response capabilities during all operational hours. Vertiports will need to be readily capable of responding to emergencies related to AAM aircraft, namely battery fires. The basic people resourcing, and equipment needs are expected to be agreed upon nationally, or even at an International Civil Aviation Organization (ICAO) level. NFPA 418 is being updated to account for electrical hazards and fire safety standards for vertiports.

Ground handling equipment in various formats will be required for most vertiports. Equipment will vary depending on the use but said equipment needs must be considered early to ensure that vertiports can be equipped with the physical space to store, park, and operate equipment.

Other common requirements include:

- Back-office functions
- Areas for 3rd parties, including commercial operators
- Passenger processing facilities
- Passenger transfer facilities
- Security screening facilities
- Baggage handling
- Electric charging
- Commercial units
- Landside access

Operations at Vertiports

The nature of the facility will define the operational requirements at each vertiport. Similar to facilities, this section highlights those needs from high-level use cases to prompt the project and the Collaborative to begin addressing how vertiports will be used by those responsible for operating them.

Emergency Services

Crew areas for flight briefings, debriefings and training need to be provided. The rapid response needs will require fast charging facilities and uninterruptable power supply back-up infrastructure to ensure continuous operations. FAA guidance refers developers to NFPA standards.

Flight operations will be irregular and erratic, requiring a high degree of operational readiness, and ensuring all components of the facility are compliant.

Freight/Cargo

Consideration of processing and handling of freight from arrival at the facility by land, processing through the facility, handling to the aircraft and then the opposite process for arriving aircraft. Security screening of goods may be required prior being loaded into an aircraft.

Transportation Security Administration (TSA) requirements states that all cargo transported on passenger aircraft must be security screened to the same level as checked passenger baggage. The majority of AAM aircraft in development are either designed to carry passengers or cargo, rather than both.

In an all-cargo operation, operators must comply with the TSA's Twelve-Five Standard Security Program requirements if operating aircraft with a maximum certificated take-off weight (MTOW) of more than 5,670 kg (12,500 lbs.). This exceeds the MTOW of the majority of AAM aircraft in development and so will not apply.

Maintenance, Inspection and Surveying

These will be relatively simple operations, primary conducted by professional organisations with no public passenger or freight carrying requirements. These types of operators are already established various sectors, including building and structures inspections, and utility infrastructure surveys.

People Movement

Vertiports with passenger operations will require a multitude of features:

- Landside and curbside access
- Passenger processing facilities for check-in and waiting areas.
- Passenger transfer facilities, for vertihubs and vertiports located at airports or multi-modal transport facilities.
- Security Screening facilities.
- Baggage Handling
- Commercial Units
- Full access for Passengers and Individuals with Disabilities. FAA guidance is to treat vertiports as airports in this regard, therefore AC150/5360-14A – Access to Airports by Individuals with Disabilities applies.
- Ticketing facilities and potentially integrated ticketing with other modes of transport

Common Operational Requirements

There are numerous common requirements related to operating AAM aircraft that may be required.

Electric Charging infrastructure and equipment will not be required at all vertiports, but the challenge will be to incorporate facilities that are compatible with multiple operators. It is in the interests of the wider industry to develop common standards. Joby, an AAM vehicle manufacturer, has developed a universal ultra-fast charging system that is compatible with all electric aircraft currently under development.

The majority of AAM aircraft under development are electric powered. However, there are hydrogen aircraft under development, such as the Lyte Aviation electric-hydrogen hybrid aircraft and ZeroAvia's hydrogen-electric aircraft. These are some of the larger AAM aircraft and tend to focus on the people movement sector.

Procedures for monitoring and mitigating obstacles and structures are essential to maintain the integrity and deconfliction of the airspace and protect the air navigation procedures.

Regardless of the use of the facility, consideration should be given at the early concept stage to future proofing the capacity of the vertiport. Forecasts are notoriously difficult to develop with accuracy but to set the foundation for AAM, vertiports need to be developed with appropriate capacity horizons in place. This is crucially important in heavily built-up urban areas where land availability, land costs, developments costs and integration with the built environment could already be challenging.

Landside Access needs to be considered for each type of operation and needs to cater for staff, freight, passengers, visitors, and servicing.

AAM Actors

Actors within the AAM industry constitute a diverse range of organisations and groups. This section identifies and describes the relevant Actors and what their roles are, particularly from the perspective of SANDAG AAM. Policy and Regulation will form the basis of AAM, and the section lists the relevant bodies and organizations in this area.

AAM Infrastructure providers and AAM Operators will emerge and the focus of the AAM Strategy is not to provide specific details of organisations and the operations, but to highlight the requirements for certification, anticipated entry into service and what the operations will entail.

AAM Actors

***Policy and Regulation** will form the basis of AAM operations. **Infrastructure providers** and **Operators** will emerge as policies and regulations develop and the industry matures.*

Policy, Guidance and Standards Makers

ICAO

The International Civil Aviation Organization (ICAO) is a United Nations (UN) agency that acts as the global forum of States for international civil aviation. ICAO develops policies and standards to help countries develop aviation in a consistent manner.

The Remotely Piloted Aircraft Systems (RPAS) Section was established and supports the following expert groups:

- The **Remotely Piloted Aircraft Systems Panel (RPASP)** – coordinates and develops ICAO SARPs, procedures and guidance material for remotely piloted aircraft systems.
- The **Advanced Air Mobility Study Group (AAM SG)** – assists the Secretariat in developing a holistic vision and framework regarding AAM, coordinated with other ICAO expert groups as appropriate.
- The **Unmanned Aircraft Systems Advisory Group (UAS-AG)** – supports the Secretariat in developing guidance material and expedites the development of provisions to be used by Member States to regulate UAS with industry and international partners.

Recognising that states and jurisdictions are proceeding with AAM with different approaches, ICAO is increasingly taking a lead in the development of AAM policies, standards and guidelines. ICAO has traditionally focused on aviation from a global perspective and the majority of AAM flights are anticipated to initially be within State borders, but this will evolve to operations between states, which will prove imperative to SANDAG in prioritizing trade as a use case with Mexico.

ICAO has set up the Advanced Air Mobility Study Group (AAM SG), and it met for the second time in December 2023. It aims to create the global framework for AAM and realise the vision of ICAO member states. AAM SG focuses on vertiports, flight rules, data management and licensing.

Member States asked ICAO to develop a regulatory framework for uncrewed aircraft systems (UAS) that operate outside of the IFR International arena. ICAO reviewed the existing UAS regulations of a number of States to find commonalities and best practices that were consistent with the ICAO aviation framework and could be implemented. The outcomes of this were ICAO Model UAS Regulations titled Parts 101, 102 and 149.

- **Part 101**
  - All unmanned aircraft should be registered.
  - Unmanned aircraft (UA) weighing 25kg or less and operating in Standard Unmanned Aircraft Operating Conditions (101.7) require no additional operational review. However, if the UA weights more than 15kg, it must be inspected and approved under 101.21 or 102.301.
- **Part 102**
  - Addresses all UA operations using UA that weigh more than 25kg or those weighing 25kg or less but do not adhere to Part 101 requirements.
  - Enables ongoing operations or one-time events through certification.
  - Enables a more expeditious review when manufacturers declare a type or model of UA as being sufficiently tested for a specific operational category that has received an approval through an Approved Aviation Organization.
- **Part 149**
  - Promotes the use of an Approved Aviation Organization to serve as a designee authorised by a Civil Aviation Authority to perform specific tasks. Once the organization has been certified, the authorized tasks (remote pilot licensing, UA inspection, UA approval etc.) may provide more expeditious processing and may reduce the workload for inspectors.

The following Advisory Circulars have also been provided for additional insight into the ICAO Model UAS Regulations:

- **AC 101-1 –** provides guidance associated with rule 101 regarding UAS operations in the Open Category.
- **AC 102-1 –** provides guidance associated with rule 102 regarding the Specific Category, UAS authorizations or a UAS operator certificate. It also addresses requirements for manufacturers.
- **AC102-37 –** provides guidance for the carriage of dangerous goods transported by UA. This document is helpful to understand the risks and responsibilities for safe carriage and includes information for packing and making.

NASA

The National Aeronautics and Space Administration (NASA) is an agency of the US Federal Government, operating independently and responsible for the civil space program and research into aeronautics. NASA's AAM research aims to provide the technical solutions required to enable AAM to develop. It does this through research of aircraft development, aircraft operations, airspace design, airspace management, and, importantly, various efforts pertaining to community integration. This involves research partners from across the private and public sector and through AAM Ecosystem Working Groups.

NASA and its partners' work includes modelling and simulation to understand how airspace, vertiports and AAM aircraft can work in harmony. The outputs of NASA research are helping to inform emerging standards and regulations and are crucial components in enabling AAM to integrate in the NAS.

United States Department of Transportation

The Department of Transportation (DOT) AAM Interagency Working Group was established with the aim of facilitating a multi-agency to plan and coordinate safety, operations, infrastructure, and security to develop the AAM ecosystem. Its members comprise 19 Federal departments, including NASA. It is organized into five subgroups:

- Air Traffic Federation
- Automation Strategy
- Community Roles
- Infrastructure Development

- Security Requirements

The objective is to report to Congress with a comprehensive set of recommendations and develop a national strategy. It will include:

1. Recommendations necessary to support early adoption of AAM to evolve to higher levels of activity and societal benefit.

A plan detailing the roles and responsibilities of each Federal agency, State, local and Tribal governments necessary to implement the recommendations.

States and Local Governments

Numerous states, local governments and cities have developed and published or are in the process of developing frameworks, roadmaps, strategies, feasibility studies and/or committees for AAM, as indicated below[157]:

- Alabama
- Alaska
- Arizona
- Arkansas
- City of Orlando
- Colorado
- Georgia
- Illinois
- Florida
- Los Angeles
- Louisiana
- Miami Dade
- Minnesota
- New Jersey
- Oklahoma
- Ohio
- Texas
- Utah
- Virginia
- Washington

Their role is to implement policies and strategies at a State and Local level to integrate AAM into existing networks.

The most relevant policies, guidance and outputs from other regional plans and studies in the San Diego region are being incorporated into the AAM Strategy.

SANDAG AAM is also engaging with other Southern California stakeholders in the regional vision of AAM operations.

Regulators

Federal Aviation Administration (FAA)

The FAA, the aviation operating mode under USDOT, is responsible for the safety of civil and commercial aviation in the U.S. From an AAM perspective the relevant activities of the FAA relate to:

- Safety Regulation
- Airspace and Air Traffic Management
- Air Navigation Facilities

The FAA is responsible for the regulation of AAM operating in the National Airspace System (NAS). Its primary role is to ensure that safety is prioritized for all operations in the NAS, including AAM.

From an AAM perspective, the FAA are certifying manufacturers and operators, as they do in other aspects of aviation. The majority of AAM aircraft are being designed with up to 10 passengers. In the absence of specified AAM aircraft airworthiness certification, both passenger and cargo operators are being certified under 14 CFR Part 135.

European Union Aviation Safety Agency (EASA)

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[157] AAM State Reports, Association for Uncrewed Vehicle Systems International

EASA is responsible for ensuring safety and environmental protection in air transport in Europe and will provide the equivalency in regulatory and safety oversight for AAM as the FAA. While EASA's work is not directly relevant to SANDAG AAM, it is progressing standards and regulations that enable AAM development within Europe, and said work is worth monitoring for best practice around technical specifications in the design of vertiports.

The 2024 Summer Olympics in Paris may be an early demonstration of passenger AAM services. Volocopter, an AAM OEM and operator, proposes to operate services to connect airports with Olympic venues. The proposed services would not be at a large scale but would provide invaluable knowledge and experience for the industry. SANDAG will monitor this trial event and understand how the industry will learn from and respond to real-life AAM passenger carrying operations.

AAM OEMs

OEMs

Original Equipment Manufacturers (OEMs) will produce aircraft, and in some cases, operate them. This assessment does not analyze the individual OEMs, but instead provides useful insights to understand the markets future and use case priorities of each OEM. SMG Consulting published a comprehensive index of OEM's, the use cases each aircraft is designed for, an index detailing order numbers, and anticipated entry into service and type of vehicle.

Secondary System Suppliers

These are systems related to airspace, aircraft, and ground infrastructure. This includes vertiport management systems that will integrate and manage processes such as aeronautical data, flight scheduling, air traffic coordination, and real-time air monitoring data. These can all be supplied and managed by the vertiport management system provider.

The FAA is recommending that vertiports be equipped with Automated Weather Observing Stations (AWOS).

Secondary System Suppliers also provide safety critical flight systems, which may include Detect and Avoid (DAA) systems, and Landing Hazard Avoidance (LHA) technology. DAA systems aim to prevent aircraft from mid-air collisions with other airborne vehicles. LHA technology aims to prevent aircraft from collisions with obstacles.

Commercial and Operational Models of Vertiports

There are various commercial and operational models for the development and management of vertiports emerging. The two broad elements of vertiports are the ground infrastructure and the airspace. Much of the focus was initially on the airspace requirements, but the ground infrastructure aspects are now being developed in more detail.

Numerous companies are engaged in the planning and design of vertiports, including identifying optimal specifications, locations, and identifying opportunities to develop a coherent network of vertiports. These companies offer specialized consulting services in the identification of sites, site acquisition, planning, and concept design.

Many other companies are involved in constructing and/or operating vertiports. This also includes companies that will build and maintain the physical vertiport infrastructure, as well as fueling infrastructure for aircraft.

Additionally, AAM operations will be data intensive and will require physical infrastructure to store data, as well as specialists in airspace traffic management, and design approach and take-off procedures for aircraft flying in and out of vertiports.

AAM Infrastructure Providers

Airport and Airfield Operators

It is anticipated that early integration efforts will include AAM operations at existing airports and airfields. Facilities will be required to obtain an FAA approval in place for existing operations and may find it relatively straightforward to adapt to AAM.

Regardless of whether an aviation facility within the region will host AAM operations, each relevant stakeholder must be involved in the development of the regional implementation strategy. Airspace is a critical component of AAM integration, AAM operations will need to be well coordinated and deconfliction mitigated early within the complex airspace.

Building Owners/Operators (Vertiport Facilities)

Vertiports located on the roofs of buildings, and on land adjacent to buildings, are expected to form a considerable part of AAM networks. Retrofitting existing buildings and developing standards for new construction will require creative solutions to the vast range of issues to consider and resolve before breaking ground. Unless these are facilities with existing helipads, it is unlikely that contractors, developers, and property management groups are sufficiently knowledgeable or experienced in operating aviation facilities.

Power and Charging Providers

Vertiports will require charging facilities for aircraft, and these can be provided using different operational and commercial models. The facilities could be provided as part of the fabric of the vertiport under the ownership of the operator, or could be outsourced to specialist providers, or a combination under a public-private partnership model. The type of refueling facility, number of charging points, its fuel/energy capacity, and recharging speeds must be considered in the planning stages of the vertiport.

Data and Communications Providers

AAM will generate a monumental amount of data in the support of flight operations, particularly for highly autonomous flying. The amount of data that will be generated demands solutions on how to best manage, store, and appropriately disseminate the data to those who need it, whilst ensuring its security. The data requirements will be integrated into the vertiport management system.

Weather Monitoring and Reporting

FAA guidelines state that AWOS is optional at vertiports. The civil aviation industry is equipped with detailed weather forecasting and reporting mechanisms. To enable BVLOS AAM operations at scale will require more detailed and localized weather reporting below 5,000ft. In the Wisk ConOps, Wisk state that 3D wind analysis data may be necessary at vertiports for the safe operations of AAM vehicles.

AAM Aircraft Operators

There are different models emerging for AAM Operators, including airlines diversifying into AAM, and entirely new entities being formed.

Emergency Services

CVPD operates mainly in Class G airspace, operating above 200’ AGL and below 400’ AGL. CVPD publishes the rules, regulations, and policies they have in place for their UAS pilots as a mechanism of transparency between the agency and the public. This is a model to be encouraged for all users.

Health Services

Operators in the San Diego region already offer fixed wing and rotary transport for patients. AAM would be an extension of these to provide greater capabilities and be able to access areas by aircraft that traditional fixed wing and rotary aircraft cannot. This is specifically true for missions such as wildland firefighting and search and rescue missions that require expeditious response but may prove hazardous for emergency personnel given terrain or other operational limitations.

Cargo/Freight/Logistics

The logistics use case encompasses an array of delivery services, typically as low-altitude operations using VTOL small UAS. Examples could include medical and healthcare supplies and equipment, business and residential small package delivery and food and drink, the latter of which is already happening on the UAS scale.

Deliveries by drone are continually evolving with operators being granted authorization for BVLOS operations, enabling scaling up of operations as seen with Wing drone delivery in the suburbs of Dallas, Texas. These transport networks become limitless when considering the use of both small UAS and AAM vehicles as part of the more holistic, comprehensive transportation system that exists today.

BVLOS and additional aircraft capacity provides a plethora of opportunities to further develop this industry on a regional basis. The SANDAG AAM strategy will focus on how AAM as a modality can assist with achieving regional objectives and connecting the needs of various stakeholders and priorities throughout the greater Southern California region.

Standalone AAM Operators

This type of operator will purchase aircraft from a manufacturer and conduct independent operations; this model is largely used in traditional aviation today. An operator, such as a commercial passenger airline, may purchase different fleets of aircraft from several OEMs to suit diverse use cases. Operators could own vertiports or simply be an operator, with leasing or concession agreements from the owner.

National Postal Services

This is an early use case for AAM, as postal and package delivery services are already being trialled and/or in operation across the U.S., including in California. Expanding this at scale will require BVLOS operations and when operators achieve certification to enable BVLOS, then it is expected that this sector will see significant growth. AAM in this sector could resolve many of the 'last mile' issues by using flexibility to access final deliveries more efficiently than road-based transport.

Airlines

AAM would be an extension of the services offered by commercial airlines, envisaging passengers and freight services. Indeed, some US airlines have already placed orders and/or options for AAM aircraft with manufacturers, notably United Airlines and American Airlines. Intentions from traditional airlines for AAM include commuter services, adding capacity to airline hub and spoke models and using AAM as part of regional connectivity between airports.

Passenger Carrying Service Providers (Uber, Lyft, etc.)

It is envisioned that existing passenger carrying service providers (and/or new entrants) may develop AAM services. Passenger carrying service providers may integrate with existing ground vehicles and/or provide standalone AAM services, such as on-demand rides upon the evolution of highly autonomous flight.

Use Cases

The specific scenarios or examples that illustrate the use of AAM to address various transport needs can be defined as use cases.

This section identifies typical anticipated use cases, the specific scenarios or examples that illustrate the use of AAM to address various transport requirements. There are a variety of use cases already identified and some are in the early stages of operation with delivery of freight and cargo by drones.

As the strategy for the region develops, the use cases relevant in a regional context will be identified.

Emergency and Public Services

Medical Emergency Evacuations

AAM can provide rapid response and access to areas with limited ground infrastructure and can therefore leverage to quickly transport medical professionals and equipment to remote areas or transport patients in critical condition to hospitals. This is a variation on air ambulance services but the capabilities of AAM could complement air ambulance services and provide increased coverage.

Rapid Air Transfer of Critical Care Patients

Ensuring patients requiring critical time sensitive care can be transported to where their needs are best met is achievable through AAM. Rapid Air Transfer would likely require dedicated aircraft and infrastructure available at short notice.

Disaster Response and Relief

Emergency disasters can often affect transport links at a time when response and relief are critical, AAM aircraft can provide rapid transportation of supplies, personnel, and medical aid to affected areas, bypassing damaged or inaccessible ground infrastructure. For the San Diego region, this may include support such as firefighter or fire victim supplies and relief, earthquake flood zone and landslide/mudslide assessments, and supplies and relief drops.

Pharmaceuticals and Medical Deliveries

Time sensitive medical deliveries such as organ transplants and blood supplies can be transported via AAM. It is anticipated that AAM will provide a reduction in transport and delivery time, decreasing time in transport and delivery, which addresses a critical concern in the viability of specimen, as well as increases the catchment area for appropriate supplies.

Zipline, a San Francisco based UAS company, started delivering medical supplies via small UAS in the U.S. in 2020. Zipline has recently been authorized by the FAA to conduct BVLOS operations in select locations in the United States.

The Ministry of Health in Saudi Arabia has completed flight trials to transport blood units for patients using drones and noted that the transfer time reduced from 2.5 hours to 2 minutes in the scenarios they tested.

The Care & Equity – Healthcare Logistics UAS Scotland Project (CAELUS) has completed live flight trials in a step towards a national distribution network for healthcare. The objective is to use drones to transport medical supplies including blood, organs, and medications.

Mobile Field Hospitals

Temporary medical facilities may be required in areas affected by disasters. Damaged infrastructure can be avoided, and efficient delivery of large quantities of medical equipment and personnel can be enabled through AAM.

Freight/Cargo

Autonomous Delivery

To expedite the delivery of goods, AAM aircraft can transport time-sensitive or high-value cargo between distribution centers, reducing delivery times, and enhancing logistics capabilities. AAM also provides the capability to bypass ground infrastructure limitations meaning remote locations can be more easily accessed.

Across the globe, there is continuously increasing demand for shortened delivery times, less chance of delay, and reduced cost of delivery. In addition to reducing delivery times, AAM offers cost reductions from aspects such as road tax, parking, and tolls.

The last mile of delivery is a key inefficiency in the delivery process, AAM could play a role in the direct final delivery from distribution centers or retail hubs to bypass congestion.

Takeaway and grocery food and drink delivery has seen exponential growth in recent years. The ability for AAM to contribute to this market is considerable, reducing delivery times in densely populated urban areas. The perishable nature of food also makes timely delivery of vital importance and AAM has the potential to deliver goods in optimal condition. Delivery models to various types of residences are continuously being explored and implemented. Early deployments of drone delivery in some U.S. markets indicate that there is a market demand for more expeditious delivery options, which further indicates a positive impact on driving down both greenhouse gas emissions and vehicle miles travelled as compared with ground-transport delivery options.

Grocery delivery to remote areas can be better facilitated through AAM. AAM aircraft can overcome geographical barriers and deliver goods to areas with resource scarcity, and/or limited or challenging ground transportation infrastructure, such as rural or mountainous regions.

AAM has the potential to offer a high-security supply chain that could be utilized for the delivery of high-value items, such as currency, electronics, medical supplies/medications, etc. Heightened security measures could mitigate the risks of theft, tampering an unauthorized access, safeguarding valuable assets throughout their journey.

The region’s proximity to an international border presents opportunities for international trade operations. As above, a high security delivery network could provide the potential for the transfer of high value, high security cargo. However, cross-border operations may prove complex in the beginning until international agreements are reached, and operational protocols are agreed upon.

Maintenance, Inspection and Surveying

AAM can be used to maintain, inspect, and survey critical infrastructure and equipment with greater accessibility, enhancing both efficiency and safety. AAM aircraft equipped with sensors and cameras can efficiently and safely conduct inspections on infrastructure such as power lines, wind turbines, masts, pipelines, or bridges, capturing data and identifying maintenance requirements.

The Federal Railroad Administration (FRA) uses drones for surveying and inspecting railroad infrastructure, including bridges and structures. FRA has also used drones for public safety purposes by conducing line-of-sight analysis to input into redesigning highway-rail at grade crossings.

The airline industry already uses drones for conducting inspections of aircraft. LATAM, Emirates and Korean Air are among several airlines and airline groups using drones to speed up and enhance the quality of inspections, replacing manual processes.

Research

The ability to mount different types of sensors to AAM aircraft provides a wealth of research use cases. Aerial platforms are required for a multitude of assessments such as air quality, biodiversity and habitat assessment. AAM is able to cover large areas and obtain data from multiple altitudes over all terrains, the non-invasive nature of AAM also provides applicability for protected area and wildlife. Remote sensing and mapping with AAM can capture high-resolution imagery and topographic data, aiding in land surveys, geospatial mapping, and ecosystem analysis.

The Scripps Institution of Oceanography at UC San Diego use drones to create digital records of buildings to assist with detecting damage following earthquakes and other extreme events. The Coastal Processes Group at the Institution use drones fitted with scanners to monitor an array of features including waves and coastal erosion.

Testing/Simulation

AAM can provide a safe and controlled environment to assess new technologies, evaluate system performance, and train personnel. New technologies and concepts related to electric propulsion, autonomous systems, navigation, and communication could use AAM as a testbed before full-scale implementation. Aircraft system performance can also be assessed through the testing of elements such as energy efficiency, range, endurance, payload capacity, and overall system reliability. AAM can safely deploy into high-risk test scenarios such as weather or approaching flight envelope limitations whilst ensuring the safety of the remote operator.

AAM can support safety and certification testing for new aircraft designs, components, or systems. AAM aircraft can undergo rigorous testing to ensure compliance with safety standards, including flight stability and control, emergency procedure and fail-safe mechanisms.

To contribute to the development and evaluation of air traffic management systems for urban air mobility, AAM can simulate various scenarios to assess the efficiency, safety, and scalability of airspace integration, communication protocols, traffic flow management, and collision avoidance systems.

AAM can provide training platforms for pilots, air traffic controllers, and emergency response personnel, allowing trainees to practice flight operations, emergency procedures, and decision-making in a safe and controlled environment.

Passenger

Intra-city connection

Current aviation infrastructure has limited urban use due to aspects such as the footprint required, noise impact, and local air quality. AAM, and specifically VTOL, aircraft that can operate off vertiports or helipads, provides the opportunity for a use case within urban areas.

AAM could be used as an Urban Air Taxi Service to provide on-demand air taxi services within urban areas. This could involve eVTOL aircraft transporting passengers between designated vertiports or helipads, alleviating traffic congestion and reducing travel times.

Tourism and sightseeing could employ AAM to provide additional services. VTOL aircraft can provide unique perspectives and experiences for tourists, showcasing landmarks and scenic areas from the air. Private AAM services can cater to high-end customers who seek exclusive and luxurious travel experiences.

Private AAM vehicles owned by individuals or organizations may also operate from private vertiports and helipads with independent infrastructure for personal or specific business needs. This could reduce use of low occupancy road vehicles, reducing congestion and increasing efficiency for the passengers. Private AAM also allows individuals more control and flexibility over their travel schedules.

Inter-city connection

The market for aircraft with a range of more than 124 miles (200 km) is expected to grow faster than the market for eVTOL vehicles with shorter operational ranges.

The ability for AAM aircraft to fly direct routes with no reliance on the land routes restricting both road and rail considerably reduces travel time and increases the breadth of accessible locations. AAM can integrate with existing transportation models to ease pressure and open up new routes. Infrastructure for AAM strategically placed close to existing transport hubs will increase integration and allow passengers to easily transfer between modes of transport. By increasing the efficiency of the transport network, layovers and diversions could be reduced – easing pressure on accommodation and congested services.

Leveraging faster and more efficient inter-city transport would also benefit commuters and business travel, saving time during the workday and widening the reach of opportunities.

Special events, such as festivals and sports events that may cause local infrastructure to exceed capacity could also benefit from the introduction of AAM easing pressure on the network when required.

Rural transit

Passenger services for those living in rural regions has significant importance due to the unique challenges in transportation and connectivity.

AAM can enhance access to essential services such as healthcare, education and shopping, improving quality of life for rural residents and reducing the rural-urban divide. Faster and more convenient travel options could also enable rural communities increased opportunities to connect with friends and family and access social and cultural events, improving social inclusion. Additionally, AAM could provide a commuting route, boosting not only prospects for residents but economic development for rural regions. Regular and scheduled routes of AAM services have the potential to maintain and grow populations in rural and remote areas.

The natural beauty of rural scenery is often a key driver for tourism in these areas, AAM can offer unique tourism experiences which in turn would increase revenue for the local communities.

The unique challenges and considerable benefits posed by AAM in rural areas present an opportunity for early adoption of new technologies. This could serve as a catalyst and exemplar model for knowledge transfer to enable wide-spread AAM implementation.

From a regional perspective, San Diego County has more Native American reservations than any other county in the U.S. The combined total area of these is small but as rural and dispersed communities, they experience a greater hinderance in access to critical resources, and access is further exacerbated by the typical challenges, such as connectivity, food scarcity, and economic mobility faced in rural communities.

Military

With various applicability for military operations, AAM can be utilized for uses including transportation, logistics, and rapid response. Troops and equipment that require rapid deployment at scale could leverage AAM to increase efficiency and reduce logistical challenges. There are opportunities for AAM to enhance military supply chain and logistics operations by providing efficient and flexible transportation for critical supplies, equipment, and spare parts. eVTOL aircraft can transport items directly to forward operating bases or remote locations, reducing dependency on ground transportation.

Specific expert teams may also have specialized cases for AAM. Medical Evacuation (MEDEVAC) using AAM can play a crucial role in military medical operations by enabling the rapid evacuation of injured personnel from the battlefield and reducing response times. AAM can provide support for special operations forces by facilitating covert insertions, extractions, and resupply missions. eVTOL aircraft can act as aerial refueling stations or resupply points, enabling longer endurance and increased flexibility for military aircraft on extended missions.

The use of AAM for bomb disposal offers unique advantages, primarily through highly autonomous vehicles to increase safety. Aerial reconnaissance utilizing advanced sensors can gather real-time intelligence from a unique perspective to help inform expert teams. AAM can also rapidly deploy expert teams and equipment to required sites, reducing any time wasted due to ground infrastructure challenges or congestion. With future technological developments, AAM may also be able to incorporate remote manipulation systems, remotely controllable by experts, greatly increasing the levels of safety for the team.

AAM presents a tremendous opportunity to the Department of Defense, especially in the San Diego region, whether it be by the expeditious movement of personnel between MCAS Miramar to Camp Pendleton, to research and development for Smart Battlefield capabilities.

SANDAG AAM Use Cases

The San Diego Region will be a second-wave adopter and will follow the 'crawl, walk, run' principle. The initial focus for SANDAG AAM is on use cases prioritization, with a focus on public and emergency services, and logistics. SANDAG envisions people movement as a longer-term effort that evolves as AAM services become more cost effective and attainable for the greater community.

These use cases best align with the wider regional objectives and policies relating to comprehensive planning and implementation and advancing social and economic equity.

The Guiding Principles established as part of the AAM Collaborative will provide the core of planning for and implementing AAM, and focuses on the following:

- *Figure 23 SANDAG AAM Guiding Principles*

During this initial phase of planning, the short-term opportunities focus on public and emergency services, and logistics operations. People movement will be introduced in succeeding planning phases and should be reassessed during each subsequent planning phase. The working assumption is 'short-term' is envisioned as over the next 5-10 years, while 'longer-term' is anticipated as beyond 8-10 years.

The approach by SANDAG for AAM is to consider implementation in two broad phases:

Phase 1: - The initial phase will focus on public services and logistics.

Phase 2: - People movement and integration into public transport.

Short-term

Emergency Services in the region have already adopted AAM into their operations, as demonstrated by CVPD. Clear public benefits are apparent from their use of drones as a first responder, as it set national precedent and became the nationally adopted model. An objective of the AAM Strategy is to provide the framework for the region to enhance the service provision and capabilities of all emergency and public services operating within the region.

The Collaborative can focus on how emergency services have already adopted AAM, how this was accomplished, what they are using AAM for, and the prospective benefits of AAM adoption. Identifying infrastructure and additional planning projects that will advance AAM across different agencies can be an outcome from the Collaborative. This could include efficiencies from integrating vertiport management systems and co-location of facilities.

Long-term

Many of the airspace and operational complexities will have matured by future planning stages, leading to public acceptance and affordability for other use cases that may support people movement. Therefore, people movement is a longer-term objective for SANDAG.

Cross-border is going to be one of the most complex use cases; however, could conceivably make a drastic positive impact. The technology will not be the barrier to cross-border; however, it is anticipated that the regulation, connectivity, and complexities of operating internationally will be the main issues to resolve.

As a subset of AAM rather than a defined used case, Regional Air Mobility (RAM) will be developed as part of a larger network in the longer term and has the potential to complement public transport options in the region.

The first part of this section describes some of the possibilities that could be achieved with AAM. These are not specific to the San Diego Region.

The second part of this section begins to assess more specific applicable near-term use cases for the San Diego Region. The intention is to illustrate the use cases that will contribute to SANDAG and regional objectives, including the ‘5 Big Moves’.

This project and report will inform the AAM Collaborative on the region’s end goals for AAM by focusing on use cases that are relevant, realistic, and

Review of Previous Notable Work

There exists an enormous, diverse, and growing range of work from various organizations including, but not limited to, FAA, NASA, individual states and cities, consultants, and researchers into AAM.

This section provides a review of this work, focusing on the notable AAM work, including AAM strategies, regulations, guidance, policies, and any other relevant and pertinent information that will help to progress the SANDAG AAM Strategy. It includes high-level AAM strategy, design guidance, industry, and market intelligence.

The purpose is to provide a brief overview of the referenced studies and focus on the most relevant summary and conclusions that will inform the AAM Strategy. As an emerging industry, there is an abundance of information, some of which becomes obsolete quickly and may not be relevant to the region. The review, therefore, focuses on aspects that are relevant to SANDAG AAM.

As of the date of this report, at least 60 pieces of previous notable work have been identified. Following an initial review of these they have were categorized into:

Essential to SANDAG AAM

Prioritizing policy makers, regulators, and government authorities and existing AAM strategies.

Useful for SANDAG AAM

Including industry research, industry guidance and research publications that are relevant at a general level to developing SANDAG AAM, but not specifically.

Less Useful for SANDAG

Various sources of AAM research, opinions, guidance, and articles are relevant from high-level perspective but do not necessarily relate to SANDAG AAM. They are all useful for background knowledge and research.

The reviews are all available from the Power BI database and the ‘Essential to SANDAG AAM’ are summarized in this report, referencing the highlights of each. Further useful documents are listed in 0.

To make this summary the most relevant to SANDAG AAM, the research in this report is filtered by the type of document.

Research

Policy

Regulation

AAM Strategy

Guidance

Opinion

Author	Report/Document	Headlines
United States Government Accountability Office	Transforming Aviation - Stakeholders Identified Issues to Address for 'Advanced Air Mobility'	Workforce planning essential to recruit and train a new generation for multiple disciplines. Public acceptance of AAM is crucial and this requires extensive stakeholder and community engagement. Ownership, operation and finances of ground infrastructure and facilities is a concern of the public.
NASA	Regional Air Mobility report	1. RAM in the San Diego region could utilize the existing airports and airfields in the region, making use of the spare capacity. Primary use cases would be passenger transport and cargo. For RAM to be scaled, it is likely to require autonomous flight capabilities to be approved, otherwise it could experience the same issues with pilot shortages as traditional aviation. The economics of regional aviation can be commercially challenging so whilst RAM has potential, it will only work with lowering operating costs than traditional regional aviation.
NASA	UAM Airspace Research Roadmap Rev 2.0	1. The UAM Airspace research roadmap's primary aim is to support the execution of NASA's research over the next ten years. However, the UAM Maturity Level provides guidance on UAM maturity and could be useful for regional planning activities. Capabilities, organized into 10 categories, make up the roadmap and contain associated requirements for progression stages. 83 capabilities are listed, showing the level of detail in the roadmap, and each goes into sufficient detail such as listing relevant regulations. While specific to UAM, the capabilities and progression stages are applicable to other AAM systems.
NASA	Advanced Air Mobility Vertiport Considerations: A List and Overview	1. This document is a starting point for local decision makers and researchers as they begin to study various multi-vertiport systems and plan for early adoption of AAM. The 18 groupings were: Federal Regulatory, State, Tribal & Local Regulatory, Physical – Fixed, Physical - Mobile and Temporary, Surrounding Uses, Vertiport Configuration, Economic, Environmental, Airspace, Demand, Contingency, Equity, Communications and Data, Security, Utilities, Safety, Automation, Other. This document should be viewed as a snapshot in time, policies and regulations are developed, taxonomies mature, and vertiports are sited, designed, and begin to operate. Other improvements that could be made to the list were noted as the following: a. Gap assessment for each category to identify factors that may have been missed. b. The potential impact on safety for each consideration. c. Organization of factors by timeframe in which they need to be considered.

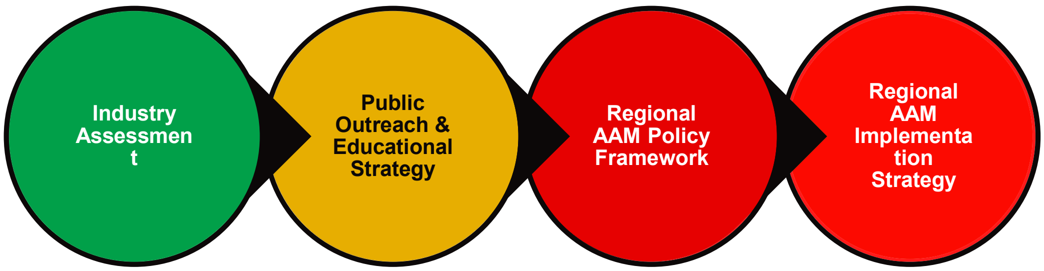
NASA	Advanced Air Mobility Community Integration Considerations Playbook	1. This is a useful guide for the initial stages of developing an AAM strategy, but it is for general use and needs to be adapted for a localized setting. The list of potential types of stakeholders is useful to be comprehensive and they particularly focus on community engagement and making AAM equitable and accessible. The integration challenges are a useful reference to make sure the broad list is considered as part of the AAM Strategy.
City of Orlando	Advanced Air Mobility (AAM) Transportation Plan	1. The City of Orlando is taking a phased approach integrated with the Florida DOT timescales. 2. The vision is to be a 'Future-Ready City,' and AAM is anticipated to be a part of this and incorporated into the Orlando Future-Ready City Master Plan, alongside issues including Connectivity, Energy, Mobility and Placemaking. 3. The City of Orlando will not be an operating of eVTOL but aims to show leadership across the region and provide the framework to prepare for AAM at scale.
Los Angeles DOT (LADOT)	Los Angeles DOT Urban Air Mobility Policy Framework	1. This is a framework and many of the aspects detailed are evolving, but using the crawl, walk, run approach. LADOT emphasize integrating AAM into the LA transport network, but it must be equitable, and the interests of communities will inform policy decisions. Technically and operationally, existing rules, regulations and guidelines will be used to get AAM started. LADOT is not proposing to wait for specific AAM rules and regulations.
Ohio Department of Transportation	DriveOhio AAM Framework	1. The framework was developed alongside industry experts and local stakeholders to ensure it is tailored to the area. The framework has sufficient detail to begin early route planning analysis and design parameters for vertiports situated in urban, suburban and rural environments. Ohio is investigating requirements for operating across international borders - US/Canada.
EASA	Prototype Technical Specifications for the Design of VFR Vertiports for Operation with Manned VTOL-Capable Aircraft Certified in the Enhanced Category	1. EASA has included sufficient detail for planning and design purposes of the essential air infrastructure components of vertiports. The guidelines have been developed with industry, including OEM's and ground infrastructure providers. The equivalent FAA document would be Eng. Brief #105, but EASA provide more details around operational requirements specifically for vertiports, such as procedures for rescue & fire fighting.

FAA	Advanced Air Mobility (AAM) Implementation Plan (I28 version 1.0)	1. I28 is the framework to be used for early adopters of AAM, particularly for guidance on integrating AAM operations into existing airspace. I28 contains a detailed list of activities in the Integrated Master Schedule. Many of these will be relevant beyond I28 and should be adapted for SANDAG AAM. I28 is a useful reference for developing the AAM Strategy but does not address many of the details around ground facilities including processing passengers and cargo, safety features at vertiports and environmental compliance.
FAA	FAA Engineering Brief EB - 105	1. The guidance enables vertiports to be designed to a high level of detail, particularly the siting in an airport setting and for the dimensions of TLOF and FATO. Guidance will be refined and developed as more validated aircraft performance data is available and is supplemented in other areas with existing airport guidance and legislation involving issues such as access for individuals with disabilities and winter operations. Used as the basis for a compliant vertiport but can be adapted for local conditions, such as air turbulence. Compliance, standards and guidance for other issues, including firefighting and charging infrastructure, still needs to evolve for a vertiport setting.
FAA	FAA's UAM Concept of Operations Report	1. AAM is an evolutionary process, initially using existing infrastructure. New air corridors required for scaling up. Full autonomy is longer term and not before the first two steps.
FDOT	FDOT AAM Recommendation Standards	The GAP Analysis focuses on where further information on operational parameters, infrastructure and facilities requirements need to be developed: - Charging Infrastructure - Battery Swap Capability - Thermal Management - Maintenance, Repair and Overhaul (MRO) services - Battery Cells Recycling - Aircraft Rescue and Firefighting (ARFF) - High-speed data
FDOT	FDOT AAM Working Group Final Report	1. The Florida Department of Transportation (FDOT) has established an AAM Working Group with key stakeholders to provide recommendations on the integration of AAM into Florida's transport system. The AAM working group has identified four focus areas for AAM implementation: Public Education and Community Engagement, Infrastructure and Zoning, System Planning and Access, and

		Airspace and Safety. They have developed 18 recommendations categorized by Legislative, Regulatory, Advisory, and Local Government aspects. The Working Group will continue to advise FDOT, currently FDOT has utilized the 18 recommendations to develop an Implementation and Outreach Plan with estimated timelines for actions to take place in order to facilitate the integration of AAM in Florida.
FDOT	FDOT Advanced Air Mobility Planning - Airport Compatibility Considerations	1. FDOT has examined AAM compatibility of individual airports and airfields within the State. Developers are provided with clear areas where development is permitted and others where it may be permitted. It is a tool that can be used for a variety of purposes - planning, stakeholder engagement, safety etc.
Texas Department of Transportation	Report & Recommendations of the Urban Air Mobility Advisory Committee	1. The UAM Advisory Committee was set up with a clear guiding vision. Four critical topics were identified with associated working groups. The working groups provided recommendations for approval by the full advisory committee. The Committee recognizes that the recommendations will require additional resources and responsibilities for various state agencies but does not go as far as addressing how this will be accomplished.
Wisk	Concept of Operations for Uncrewed Urban Air Mobility	1. This is a comprehensive ConOps based upon existing regulations and guidance and can be used universally - it is not exclusively a Wisk ConOps. It is written in a style that provides an excellent guide to the obligations of prospective operators of vertiports and what to expect as a passenger transiting through a vertiport. It is a technical document to aid in understanding the mechanics of vertiports based upon current standards and regulations. Further updates and versions are anticipated as standards and guidelines become established.
ACI	Policy Brief - Advanced Air Mobility: Integration into the Airport Environment	1. AAM offers an opportunity for airports to increase revenue and enhanced services for passengers and cargo. AAM infrastructure and facilities need to be developed with the master plan. Airports should consider AAM as part of an integrated transport system.

SANDAG AAM - What happens next?

The Industry and Market Assessment concludes the first overall task of the project. The intelligence and information gathered from this stage will be used in the next tasks and contribute to the Implementation Strategy. The next phase of this project considers what SANDAG aims to achieve with AAM. Knowledge and best practices will be incorporated into the strategy, and the AAM Collaborative will be the tool to engage and refine the strategy requires to meet the needs of the region.



- *Figure 25 SANDAG AAM Development Overview*

Industry and Market Assessment – Ever-evolving.

This Industry and Market Assessment provides the basic knowledge of what AAM is, what it can be used for, the emerging regulations, and other strategies that have been developed. It is just a snapshot of the publicly available research, guidance, and information available. This industry is new, dynamic and rapidly evolving with new and updated information being published regularly. In order to stay up to date and relevant, continually monitoring of data is advised. However, as there is an increasing abundance of data it is recommended to prioritize only the most relevant data for review and minimizing the amount of less relevant data gathered as it will be time consuming and will most likely yield little gain.

As the project proceeds on to developing the regional implementation strategy, the aim is to monitor the abundance of new material, research, regulations, guidelines, and recommendations most pertinent to SANDAG AAM in a streamlined and organized way.

Implications, recommendations, and areas to focus for SANDAG AAM

To help the strategy to progress and answer the plethora of questions, the AAM Collaborative has already started being asked to consider the Strengths, Weaknesses, Opportunities and Challenges (SWOC), focusing on:

Operations

Public Engagement

Infrastructure

Environment and Economy

Operations

Strengths	Weaknesses
Existing multi-modal transport system	Congested and complex airspace
Suitable year-round weather for AAM	SAN is the busiest single runway airport in the US
Land available in the region for AAM infrastructure	Multiple agencies in the region to coordinate
Opportunities	Challenges
US-Mexico border could test international AAM	Military operations may restrict AAM airspace users
Many tourist destinations and inbound travellers	Community acceptance of AAM in dense areas
Opportunity to develop AAM with marine industry	Charging infrastructure and resources

Infrastructure

Strengths	Weaknesses
Established regional partnerships	Strict environmental laws and permitting
Large international airport (SAN) and aviation assets	Congested and complex airspace
Strong renewable energy generation potential	SAN is physically constrained
Opportunities	Challenges
US-Mexico freight and cargo potential for AAM	Scalability of infrastructure in dense areas
Significant potential for Regional Air Mobility	Operational issues - fire codes, fire and rescue, etc
Many great educational establishments	Concerns with privacy and noise pollution

Environment and Economy

Strengths	Weaknesses
Proximity to Los Angeles – good for RAM.	Nimbyism
Strong and diverse regional economy	Noise ordinances
Strong technology and R&D industry in the region	Challenging airspace
Opportunities	Challenges
Economic development potential of AAM	Political turnover and changes
AAM as an addition to multi-modal transport	Federal regulation
Connections with local workforce development	Competing technologies and funding

Public Engagement

Strengths	Weaknesses
High level new technology acceptance, generally	Logistical challenges with power in certain areas
Creating thinking and engagement with communities	Broadband communication integration
Public used to seeing different aircraft in the region	-
Opportunities	Challenges
Collaboration with existing regional airports	Airspace conflict with DOD operations
Expansion of AAM public good capabilities	-
Utilize local technology companies and expertise	-

What will SANDAG AAM now focus on?

The Industry and Market Assessment enables the questions at the beginning of the document to be considered in context of what is happening in the industry. From a regional perspective, there are a number of further questions to consider that will be necessary in shaping the regional strategy.

The following questions have been prompted by the Industry and Market Assessment. This list is not exhaustive and may become irrelevant for the region; however, it provides a starting point for regional considerations and determining what SANDAG AAM is seeking to achieve.

Strategic Considerations
What does SANDAG aim to achieve with AAM?
What problems is SANDAG aiming to solve with AAM?
What is the purpose of AAM in the region?
How does AAM contribute to the 5 Big Moves?

Use Case Considerations
What are the relevant use cases to support the vision?
How do we integrate SANDAG with existing public good, freight and public transport missions?
How can AAM improve existing transportation infrastructure and provision?
How do we use AAM across the US-Mexico Border?

Learning from AAM Best Practice
What should SANDAG observe and learn from early adopters of AAM?
What the most appropriate AAM Strategies to adapt to a San Diego regional perspective?

Utilizing and effectively engaging the AAM Collaborative
How will the AAM Collaborative help to progress the vision and objectives over the long term?

Implementation Strategy
What is enabling AAM in the region?
What is blocking AAM in the region?

Appendix A

Review of Previous Notable AAM work – List of Research Materials

As part of this report's assessment, a research exercise was completed whereby numerous documents regarding AAM were reviewed. The highlights of this exercise are presented in Section 0

Review of Previous Notable Work.

This section was developed alongside a Power Bi library that contains a review of the 'essential' documents listed below. Further to these 'essential' documents a list of other useful documents are also presented below.

In addition to the documents listed below, it is also advised that SMG's AAM Reality Index is continually monitored as it provides useful information on the readiness of AAM vehicles and AAM infrastructure.

Essential to SANDAG AAM

Transforming Aviation - Stakeholders Identified Issues to Address for 'Advanced Air Mobility', United States Government Accountability Office

Regional Air Mobility report, NASA

UAM Airspace Research Roadmap Rev 2.0, NASA

Advanced Air Mobility Vertiport Considerations: A List and Overview, NASA

Advanced Air Mobility Community Integration Considerations Playbook, NASA

Advanced Air Mobility (AAM) Transportation Plan, NASA

Los Angeles DOT Urban Air Mobility Policy Framework, Los Angeles DOT

DriveOhio AAM Framework, Ohio Department of Transportation

Prototype Technical Specifications for the Design of VFR Vertiports for Operation with Manned VTOL-Capable Aircraft Certified in the Enhanced Category, EASA

Advanced Air Mobility (AAM) Implementation Plan (I28 version 1.0), FAA

FAA Engineering Brief EB – 105, FAA

FAA's UAM Concept of Operations Report, FAA

FDOT AAM Roadmap, FDOT

FDOT AAM Recommendation Standards, FDOT

FDOT AAM Working Group Final Report, FDOT

FDOT Advanced Air Mobility Planning - Airport Compatibility Considerations, FDOT

Report & Recommendations of the Urban Air Mobility Advisory Committee, Texas Department of Transportation

Concept of Operations for Uncrewed Urban Air Mobility, Wisk

Policy Brief - Advanced Air Mobility: Integration into the Airport Environment, ACI

Other Additional Documents and Sources

ACRP 236 Appendices - Electric Aircraft Characteristics, ACRP

ACRP Research Report 243 – Urban Air Mobility – An Airport Perspective, ACRP

Preparing Your Airport for Electric Aircraft and Hydrogen Technologies (2022), ACRP

Urban Air Mobility: An Airport Perspective (2023), ACRP

Urban Air Mobility and Sustainable Development, Aerospace, Security and Defence Industries Association of Europe (ASD)

ACT Advanced Air Mobility White Paper, American Association of Airport Executives

Advisory Circular AC139 - Guidance for vertiport design, Australian Government - CASA

UAM Market Study, NASA / Booz Allen Hamilton

Bringing Advanced Air Mobility (AAM) to Brisbane, South East Queensland (SEQ), Australia, Council of Mayors - South East Queensland

Design Criteria and Accommodating Capacity Analysis of Vertiports for Urban Air Mobility and Its Application at Gimpo Airport in Korea, Department of Aerospace Engineering, and Convergence Engineering for Intelligence Drone, Sejong University

Request for Information on Advanced Air Mobility, U.S. Department of Transportation

Repurposing Existing Infrastructure for Urban Air Mobility: A Scenario Analysis in Southern California, Department of Urban Planning and Design, School of Architecture, Tsinghua University, Beijing, China

EASA Vertiports, EASA

Introduction of a regulatory framework for the operation of drones - Opinion No 03/2023, EASA

Operational Analysis of Vertiport Surface Topology, NASA

Initial Research on the Vertiport for the UAM – Report, Flight University of China

Navigation Autonomy in Commercial Unmanned Systems Growth Opportunities, Frost & Sullivan

Impact of Urban Air Mobility on the Airline Industry, Frost & Sullivan

Roadmap of Advanced Air Mobility Operations, Helicopter Association International

AAM Study Group, ICAO

Advancing Air Mobility in Illinois, Illinois Department of Transportation

Are Commuter Air Taxis Coming to Your City? A Ranking of 40 Cities in the United States, Journal of Urban Mobility

Getting Mobility off the Ground, KPMG

Integrating Air Mobility into Wider Infrastructure, KPMG

Passenger use cases in the Advanced Air Mobility revolution, KPMG

Development of Vertiport Capacity Envelopes and Analysis of Their Sensitivity to Topological and Operational Factors, Massachusetts Institute of Technology

Evaluating the Interoperability of UAM Systems and Airports, Massachusetts Institute of Technology

Building digital platforms to enable advanced air mobility, McKinsey

Land Use Analysis on Vertiports Based on a Case Study of the San Francisco Bay Area, Mineta Transportation Institute

Impact of Regional Air Mobility and Electrified Aircraft on Airport Electricity Infrastructure and Demand, National Renewable Energy Laboratory (NREL)

Electrification of Aircraft Challenges, Barriers, and Potential Impacts, National Renewable Energy Laboratory (NREL)

Security Considerations for AAM Operations at Airports, National Safe Skies Alliance, Inc.

Do we already see the impact of Advanced Air Mobility or is it too early to tell?, Roland Berger

Regional Air Mobility - How to unlock a new generation of mobility, Roland Berger

Up and away: Certification for Advanced Air Mobility aircraft - A path to commercial certification, Roland Berger

Advancing Aerial Mobility: A National Blueprint (2020), The National Academies of Sciences, Engineering, Medicine

Integrating Advanced Air Mobility: A Primer for Cities, Urban Movement Labs

An Airport & Vertiport Aircraft Compatibility Approach of Electric Vertical Takeoff & Landing Aircraft Design, Vertical Flight Society

UAM Landing Site Feasibility Analysis Study, Virginia Polytechnic Institute And State University

Integrated Approach to Study Urban Air Mobility (UAM), Virginia Tech

Target True Zero: Delivering the Infrastructure for Battery and Hydrogen-Powered Flight, World Economic Forum

Washington Electric Airport Feasibility Study, WSDOT

UAM Vision Concept of Operations (ConOps) UAM Maturity Level (UML) 4 Version 1.0, NASA

High-Density Automated Vertiport Concept of Operations, NUAIR

Infrastructure to Support Advanced Autonomous Aircraft Technologies in Ohio, The Ohio Department of Transportation

Feasibility Study of Regional Air Mobility Services for High Priority Transportation in the San Joaquin Valley, San Jose State University

FAA UAS Integration Pilot Program, FAA