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FEASIBILITY OF VERTIPORT SITING AND LAND USE PLANNING: A GUIDE FOR THE PROCESS OF PLANNING UAV/UAM VERTIPORT LOCATIONS

Prepared For:

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RESEARCH
Keeping Utah Moving
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DISCLAIMER

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16. Abstract

Vertiports represent an innovative approach to integrating aviation into municipal transportation networks. This guidebook is intended to aid communities in strategically planning vertiports by overseeing land planning processes, offering recommendations for incorporating vertiports into land plans, and detailing how to conduct site evaluations, including addressing zoning issues and providing step-by-step guidance for early-stage site analysis. We highlight how land planning can benefit from high-level parcel suitability maps to facilitate spatial planning. The guidebook is targeted toward community planners, local governments, Metropolitan Planning Organizations, state-level policymakers, and companies interested in government land use considerations.

Vertiport development is in the preliminary stages in Utah and there are currently no statewide guidelines. This guidebook provides an overview of federal regulations, as well as additional considerations for planners to address land-use issues. This guidebook does not focus on emerging technologies or legal frameworks but instead helps communities to consider the opportunities, ramifications, and hurdles to be proactive about vertiport integration within their communities. The authors encourage collaboration across communities and consultation with both regional experts and the Utah Department of Transportation's Aeronautics Division.

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LIST OF ACRONYMS & DEFINITIONS

AAM	Advanced Air Mobility
AGL	Above Ground Level
AI	Artificial Intelligence
AIP	Airport Improvement Program
ARTCC	Air Route Traffic Control Center
ASOS	Automated Surface Observing System
ATC	Air Traffic Control
ATM	Air Traffic Management
CBR	Community-Based Rules
CDM	Collaborative Decision Making
EDCUtah	Economic Development Corporation of Utah
ELDT	Estimated Landing Time
EMS	Emergency Medical Services
ETOT	Estimated Takeoff Time
eVTOL	Electric Vertical Takeoff and Landing
FAA	Federal Aviation Administration
FATO	Final Approach and Takeoff
FHWA	Federal Highway Administration
GCS	Ground Control Station
GPS	Global Positioning System
GUFI	Globally Unique Flight Identifier
Heliport	Airport or landing place for helicopters
IFR	Instrument Flight Rule
IMC	Instrument Meteorological Conditions
LUP	Land Use Planning
MPO	Metropolitan Planning Organization
MRO	Maintenance, Repair, Overhaul
MSL	Mean Sea Level
NASA	National Aeronautics and Space Administration

PSU	Provider of Services to Urban Air Mobility Service
STOL	Short Takeoff and Landing
TAC	Technical Advisory Committee
TAZ	Traffic Analysis Zone
UAAMS	Utah Advanced Air Mobility Simulator
UOE	Urban Air Mobility Operations Environment
UAM	Urban Air Mobility
UAS	Unmanned/Uncrewed Aerial Systems
sUAS	Small Unmanned/Uncrewed Aerial Systems
UAV	Uncrewed Aerial Vehicle
UDOT	Utah Department of Transportation
UGRC	Utah Geospatial Resource Center
UTM	Unmanned/Uncrewed Traffic Management
Vertiport	Location designated for the takeoff and landing of UAS
VTOL	Vertical Takeoff and Landing
WFRC	Wasatch Front Regional Council

EXECUTIVE SUMMARY

Vertiports offer a new land use that integrates aviation within existing municipal transportation systems. As resources for planning vertiports rapidly emerge, this guidebook provides a structured approach to help communities navigate the integration process. First, we outline the fundamentals of land use planning relevant to vertiports. Second, we offer specific recommendations on how vertiports can be incorporated into municipal and regional planning efforts. Third, we provide guidance on conducting site evaluations, including zoning challenges, early-stage site analysis, and strategic planning tools. For those within the Wasatch Front Regional Council area, we highlight a spatial planning tool that provides parcel suitability scores for vertiport development. While specific datasets may not yet be available for other regions, the principles outlined in this guidebook remain applicable statewide.

This resource is intended for community planners, local governments, Metropolitan Planning Organizations (MPOs), and state policymakers. As part of its development, we consolidated key insights from a multi-sector workshop and a vertiport demonstration. These activities reinforced the critical need for clear governance structures, regulatory coordination, and proactive community engagement. While this guidebook is not a resource for emerging UAM technologies nor a legal framework, it helps municipalities develop policies and processes for vertiport integration and fosters collaboration among communities, the private sector, and regulatory agencies.

Currently, Utah lacks formal state requirements or guidelines for vertiports, creating an opportunity for planners and policymakers to establish best practices. Communities should proactively address zoning limitations, multimodal connectivity, and environmental impacts as they prepare for UAM infrastructure. Testing corridors and demonstration sites should be created to provide real-world case studies and public engagement opportunities. Additionally, a UDOT-led advisory committee of engineers, planners, social scientists, and aviation experts could help guide municipal planning efforts, facilitate regulatory discussions, and support community engagement strategies. By taking a coordinated and data-driven approach, Utah communities can ensure that vertiports are strategically and equitably integrated into the transportation network while addressing public concerns and long-term infrastructure needs.

1.0 FORWARD

The future of Urban Air Mobility (UAM) highlights tremendous economic opportunities and a major shift in the delivery of services and products globally. The future growth of UAM is due to the multiple benefits it provides, including improving emergency and natural disaster response, facilitating commercial package delivery, and, eventually, integration with existing transportation and commuter systems (e.g., air taxis). While these may provide a tremendous opportunity, there is another side to the potential challenges and impacts faced by this new transportation system. Given its recency and novelty, implementation and governance are still emergent, so impacts are not well understood.

This guidebook emerged as an undertaking of Utah State University's (USU) Department of Landscape Architecture and Environmental Planning (LAEP) and the Utah Department of Transportation (UDOT) Division of Aeronautics, and funding for this resource was provided by UDOT's Research and Innovation Division. The collaboration sought the creation of tools and resources to help facilitate UAM planning. The primary outcomes from this collaboration are: 1) the development of a geospatial mapping tool to identify the suitability of parcels for vertiports (which is referenced in the Appendix), and 2) this guidebook to help address key questions from across government and the private sector.

The purpose of this guidebook is to provide an overview of practical resources for facilitating land use planning for vertiports. The guidebook often references urban communities, but the application is still highly relevant to municipalities and rural communities. If you are new to UAM and are unaware of the variety of related acronyms and definitions, we would recommend you skim through Sections 2.2 and 3.0.

2.0 INTRODUCTION

2.1 Introduction and Overview

Uncrewed aircraft systems (UAS) are likely to change how we think about transportation (and land use) systems because they will play an increasing role in parcel delivery, emergency services, and transporting people (Dulia et al., 2022). In addition to enhancing traffic management, the advent of new vehicle types for airborne metropolitan passenger traffic opens significant opportunities for people and cities. Urban Air Mobility (UAM) is an emerging field of UAS that is currently gaining substantial attention from both industry and research, being recognized as a key success factor for socio-technical integration (Mavraj et al., 2022; Straubinger et al., 2020). Moreover, UAS encompasses the vehicles and the necessary infrastructure, including take-off and landing pads, and communication, navigation, and surveillance systems for managing flights and facilitating the exchange of goods and people from ground to air (Bauranov & Rakas, 2021). Significant modifications to existing infrastructure and policies will be required to ensure effective and comprehensive UAS operations (FAA, 2015). However, this can require policy shifts, working through approval processes, and determining locations for the infrastructure.

One of those policy shifts may require communities to rethink existing land use and transportation systems. There are limited precedents for land use decisions around UAS-related land use and heliports, as air-to-ground examples offer limited guidance. The FAA (2022) recommends that Air Transit Port (ATP) stakeholders ensure protection against incompatible land use practices. Thus, rethinking land use for UAS represents a disruptive system (Zeleny, 2012). A key decision will involve platforms for UAS, such as vertiports, and vertihubs (FAA, 2020). These vertiports are crucial for the emerging advanced air mobility (AAM) ecosystem, providing infrastructure for electric vertical takeoff and landing (eVTOL) aircraft, which could transform local and regional transportation (Dulia et al., 2022). These infrastructures are key to safe and reliable systems for exchanging goods and people and maintenance or charging (Brunelli et al., 2023). Recent studies highlight an interest in understanding how vertiports might be distributed throughout communities for efficient and successful integration (Lim & Hwang, 2019; Park et al., 2022). However, there are limited resources that directly appeal to planners, community counselors, and other decision-makers who need to address the multitude of costs and benefits to their communities.

The planning process for UAS will bring about new challenges and questions that have typically not been part of most traditional processes. The convergence of various factors, such as community acceptance, safety, equity, planning, implementation, airspace management, and operations, may pose obstacles to widespread adoption (A.P. Cohen et al., 2021). This complexity arises from the seamless integration of ground and air spaces, where air considerations traditionally do not factor into land use decisions. Further, most transportation operations are centralized through municipal, state, or federal entities – the development of UAS could present new challenges because the variety of use cases, vehicle sizes, and land use demands may differ radically. UAS represents a major and potentially disruptive shift in transportation. It will be important to balance the needs of infrastructure and environmental and social impacts. Hasty decisions could lead to unexpected problems and disproportionate impacts on residents.

Several excellent resources can be used in addition to this guidebook. We have referenced these materials throughout this guidebook and provide a list with links in Section 9.0. Across the literature, there are redundancies as resources have been published simultaneously because these efforts are moving quickly (this guidebook was also being developed simultaneously). We would recommend skimming through planning resources that interest you, then, as able, focus on other publications that provide regulatory guidelines. These documents provide critical insights and frameworks to support communities and planners in navigating UAM-related challenges.

Combined, these resources offer a substantial amount of information about the land-use planning process, considerations for development, and regulatory requirements. Despite the availability of these resources, land use for ground-to-air transportation, specifically vertiports, is nascent. Communities will inevitably face pressures and hurdles that can be tricky to overcome. In this guidebook, we hope to help communities navigate these pressures and consider a more strategic approach toward vertiport and ground-to-air transportation systems. We hope this guidebook will raise key questions for consideration, as well as offer tools and resources to make strategic decisions that will affect your community.

2.2 List of Acronyms

AAM: Advanced Air Mobility

AGL: Above Ground Level

AI: Artificial Intelligence

AIP: Airport Improvement Program

ARTCC: Air Route Traffic Control Center

ASOS: Automated Surface Observing System

ATC: Air Traffic Control

ATM: Air Traffic Management

CBR: Community-Based Rules

CDM: Collaborative Decision Making

EDCUtah: Economic Development Corporation of Utah

ELDT: Estimated Landing Time

EMS: Emergency Medical Services

ETOT: Estimated Takeoff Time

eVTOL: Electric Vertical Takeoff and Landing

FAA: Federal Aviation Administration

FATO: Final Approach and Takeoff

FHWA: Federal Highway Administration

GCS: Ground Control Station

GPS: Global Positioning System

GUFI: Globally Unique Flight Identifier

Heliport: Airport or landing place for helicopters

IFR: Instrument Flight Rule

IMC: Instrument Meteorological Conditions

LUP: Land Use Planning

MPO: Metropolitan Planning Organization

MRO: Maintenance, Repair, Overhaul

MSL: Mean Sea Level

NASA: National Aeronautics and Space Administration

PSU: Provider of Services to Urban Air Mobility Service

STOL: Short Takeoff and Landing

TAC: Technical Advisory Committee

TAZ: Traffic Analysis Zone

UAAMS: Utah Advanced Air Mobility Simulator

UOE: Urban Air Mobility Operations Environment

UAM: Urban Air Mobility

UAS: Unmanned/Uncrewed Aerial Systems

sUAS: Small Unmanned/Uncrewed Aerial Systems

UAV: Uncrewed Aerial Vehicle

UDOT: Utah Department of Transportation

UGRC: Utah Geospatial Resource Center

UTM: Unmanned/Uncrewed Traffic Management

Vertiport: Location designated for the takeoff and landing of UAS

VTOL: Vertical Takeoff and Landing

WFRC: Wasatch Front Regional Council

3.0 DEFINITIONS OF COMMON TERMS

3.1 UAS/sUAS

Uncrewed aircraft systems, commonly known as drones, have a wide range of applications across various fields, impacting our daily lives through practices such as observation, remote sensing, providing site imagery, and LiDAR (Hall, 2023). sUAS, which are small UAS, are commonly used for personal use, small package or food delivery, and photography, ranging from real estate to TV and movie filmography. In agriculture, sUAS have been introduced for tasks such as spreading fertilizer or pesticides, monitoring watering systems, and closely monitoring crops, allowing for precision agriculture (Alcántara et al., 2020; Hassler & Baysal-Gurel, 2019).

3.2 UAM

Urban Air Mobility is an air transportation system that is a subset of AAM. It can be defined as “highly automated, cooperative, passenger or cargo-carrying air transportation services,” focusing on urban and suburban settings (FAA, 2020). UAM vehicles can operate between 500 ft-1,000ft AGL or at higher altitudes by overlapping with a rural area when crossing a rural area with low-altitude airspace and influencing communities (A.P. Cohen et al., 2021; Laugere, 2022). According to Laugere (2022), the UAM flight procedure follows pre-flight, departure, end route, approach, landing, and post-flight. UAM has evolved as autonomous operations can operate by conducting ground-based detect-and-avoid, electronic recharging of their batteries (Laugere, 2022).

UAM or UAVs, known as drones, are flexible and cost-effective air mobility (Mota et al., 2013). The capabilities and applications of UAM have demonstrated versatility in agriculture management, traffic control, environmental monitoring, public security, pollution monitoring, and disaster management (Mohamed et al., 2020). In addition, there have been discussions about utilizing UAM to develop research activity, medical assistance, supplies, city surveillance, package delivery, UAV taxis, etc. Using UAM shows the potential capabilities to improve our lives, but at the same time, it can cause economic, social, and environmental impacts without careful management (Forum, 2021).

3.3 Vertiport

A permanent ground infrastructure is to be used for the landing and takeoff of UAM (Schweiger & Preis, 2022). “UAS and vertiports are becoming an integral part of our current and future transportation infrastructure” (Hall, 2023). Vertiports serve as transportation hubs for exchanging goods and people and as maintenance or charging stations for small UAS (McNabb, 2021). Vertiports require the collaboration of various stakeholders, including city planners, private developers, and state and federal agencies. These groups will need to work together to identify suitable locations for the vertiports and to plan and develop the associated infrastructure (Hall, 2023). The participation of different groups of people and the requirement for obtaining planning consent from them, along with a thorough evaluation process, make it challenging for developers of vertiports to complete the planning of their locations promptly (Laugere, 2022; Lineberger et al., 2019).

4.0 CONSIDERATIONS FOR VERTIPORT LAND-USE PLANNING

When planning for vertiports, addressing specific siting and design requirements is crucial to ensure safety and efficiency. Key factors include the dimensions for touchdown and lift-off areas, necessary airspace for approach and departure paths, and the load-bearing capacity of the facilities. Additionally, integrating vertiports into urban environments requires careful consideration of community impacts such as noise, privacy, visual pollution, infrastructure needs, and multimodal integration. Addressing these aspects through strategic land use planning can enhance the operational effectiveness and social equity of Advanced Air Mobility systems. This section provides an overview of key considerations. First, in Section 4.1 we summarize key findings from a workshop completed in December 2022. Second, this section is expanded to highlight considerations that have been produced from other sources regarding vertiport land use planning, specifically aiming to discuss the shapes, sizes, and types of vertiports and the key challenges and factors involved in their design and implementation. Content for sections 4.2 - 4.4 is summarized here and drawn from (A. Cohen et al., 2024; Mendonca et al., 2022; Yedavalli, 2021). Please see those references for specific details.

4.1 Workshop on Feasibility of UAM Vertiport Land Use and Location Planning

A virtual workshop was convened in December 2022 that brought together a dozen participants and experts from various sectors to tackle critical issues and helped inspire this guidebook. By leveraging the collective knowledge of personnel from state, regional, and city governments, industry, and academia, the workshop sought to cover a range of topics to address questions that could arise from planners, policymakers, and practitioners. The 1.5-hour agenda covered an introduction, project objectives, background vocabulary, project background, scenario challenges, discussion, and a plan for next time. Outcomes and key questions from this workshop are aggregated in this section. The discussion was motivated by key questions:

- How might we select sites for UAV/UAM vertiports?
- What is your process for planning UAV/UAM vertiports (e.g., Economic, Land Use, Social Impact, Transit, Environmental Impact, etc.)
- How would you or your community determine where a vertiport would go (or if they would be a part of your community)?
- Specifically, how would you commence a process for planning UAV/UAM?

To explore these questions, we developed three scenarios potentially relevant to Utah. For each scenario, we asked participants to respond to the key research questions, as well as carry on an open conversation about other issues that could be helpful to address in this guidebook. Below are the scenarios that facilitated the conversation.

- **UAV Package Delivery**: We examined how uncrewed aerial vehicles (UAVs) might facilitate customer deliveries. Our goal was to assess the potential challenges if companies wanted to implement this in different communities within Utah.
- **Urban Air Mobility (UAM) Network**: This scenario envisioned a theoretical plan for a new network of aircraft connecting major transportation hubs within the WFRC. It sought challenges and benefits, including the identification of suitable locations.
- **Air Taxi Vertiport**: This scenario focused on a community planning to build a new air taxi vertiport. The task focused on helping planning staff assess potential conflicts between land use regulations and site selection. They were asked to consider concerns a planning board might face.

Notes on responses were taken throughout the workshop. Four major themes emerged from the workshop: 1) key players, 2) procedures for implementation, 3) key challenges and hurdles, and 4) how to determine placement for vertiports. In the following four subsections of this guidebook, we provide a synthesis of the discussion across all responses and scenarios. Throughout this guidebook, we have expanded on these key themes.

4.1.1 Key Players in the Process

The successful implementation of urban air mobility (UAM) will require coordination between public and private entities. Key stakeholders include local governments, UAM providers, law enforcement agencies, power-line utility companies, and community residents, as well as state agencies such as UDOT and metropolitan planning organizations (MPOs) to integrate UAM into the Unified Transportation Plan. The FAA will be crucial in overseeing flight paths and conflict management. Other important contributors include regional and municipal airports, emergency services, the Office of Tourism, and industrial representatives from the private sector. Potential corporate partners such as Amazon, FedEx, UPS, Postmates, Uber, and DoorDash may also play a role in logistics and operations. Additionally, legislative, and legal experts (e.g., Legislative Counsel, Attorney General’s Office) will be needed to assess liability and regulatory frameworks.

4.1.2 Procedure for Implementation

A structured process for UAM development should include pre-development meetings, public hearings, and comprehensive site analyses to ensure compatibility with transportation infrastructure and community needs. Evaluation of transportation hubs and population densities under flight paths will help identify the most viable locations. A conflict assessment should be conducted to prevent interference with existing aerial operations. Stakeholder engagement through interviews and public outreach will be essential to gauge public sentiment, particularly regarding noise and site selection. Additionally, studying best practices from other early adopters can provide insights into successful implementation strategies.

As part of this process, it will be helpful to know how communities can address scale, land use, and layout, with visual aids and diagrams in the guidebook to improve clarity. Noise management will be a significant concern. Municipal noise regulations, conditional use permits, and public concerns must be carefully considered in vertiport placement decisions. It is recommended that noise thresholds be established, along with impact studies to assess the potential effects on surrounding communities.

4.1.3 Key Challenges and Hurdles

One of the major challenges is regulatory fragmentation, as multiple municipal departments may independently draft ordinances without a clear lead agency overseeing the process. Long-range planning and public hearings will be necessary to establish a unified approach. Financial constraints, public acceptance, and perceived risks are also significant hurdles, particularly given Utah's extreme weather conditions (hot summers, snow, and cold winters) and the FAA's evolving certification requirements for new aerial vehicles. Operational density, airspace obstructions (e.g., power lines, trees), liability concerns, and regulatory system development will all require careful planning. Additionally, educating stakeholders sufficiently to obtain informed public input will be a challenge.

4.1.4 Determining Placement of UAM Infrastructure

Site selection should begin with a pre-application or pre-development process, ensuring that all relevant stakeholders are engaged, and that working-level officials contribute through information sharing. Initially, UAM infrastructure should be placed in less populated areas to gather operational data before expanding into higher-density urban locations with greater risks. Co-location with existing infrastructure that already manages traffic and noise (e.g., transportation hubs) could help with public acceptance. Additionally, planners should evaluate existing flight paths to avoid conflicts and consider projected demand.

4.2 Vertiport Shapes and Sizes

4.2.1 UAM Flight Phases and Vertiport Design

The design and layout of the takeoff and landing area within a vertiport include the three main components such as the TLOF (Touchdown and Lift-Off Area), the FATO (Final Approach and Takeoff Area), and the Safety Area. In Figure 4.1, the dimensions for these areas are determined by the controlling dimension (D), which is the diameter of the smallest circle that encloses the projected outline of the VTOL aircraft on a horizontal plane during takeoff or landing, considering the rotation of rotors/propellers, if applicable (FAA, 2021). Figure 4.2 illustrates Air Taxi and Drone examples with their layout.

UAM vehicles are designed to operate within the lower airspace. The specific altitudes of UAM flights are 500 feet and 1,000 feet above ground level (AGL), although they may also operate at higher altitudes. Following the six phases (Figure 4.1), UAM vehicles must coexist and integrate with other airspace users, including helicopters, remotely piloted aircraft systems (RPASs), and fixed-wing aircraft, all operating in the lower airspace.

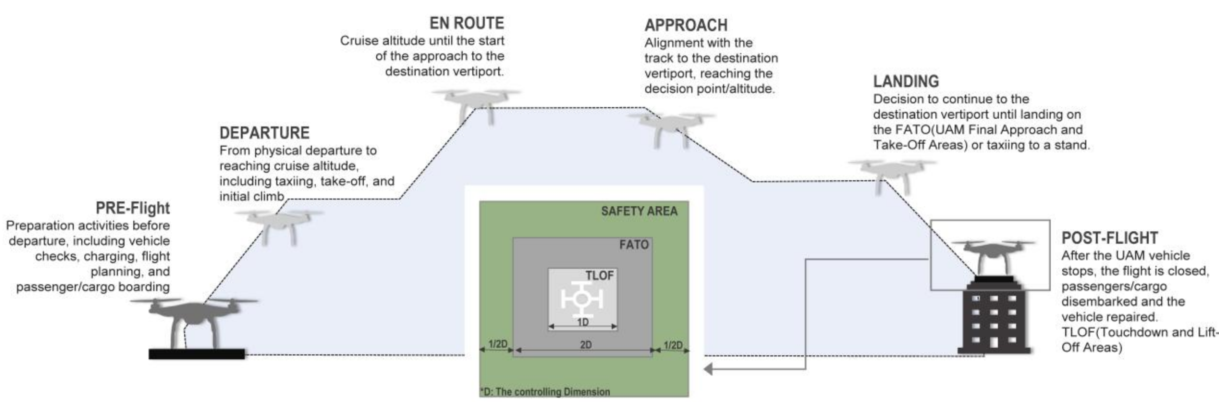

Figure 4.1. The Relationship and Dimensions of Vertipad Components and UAM Flight Phases (Referenced from FAA (2021) and Laugere (2022))

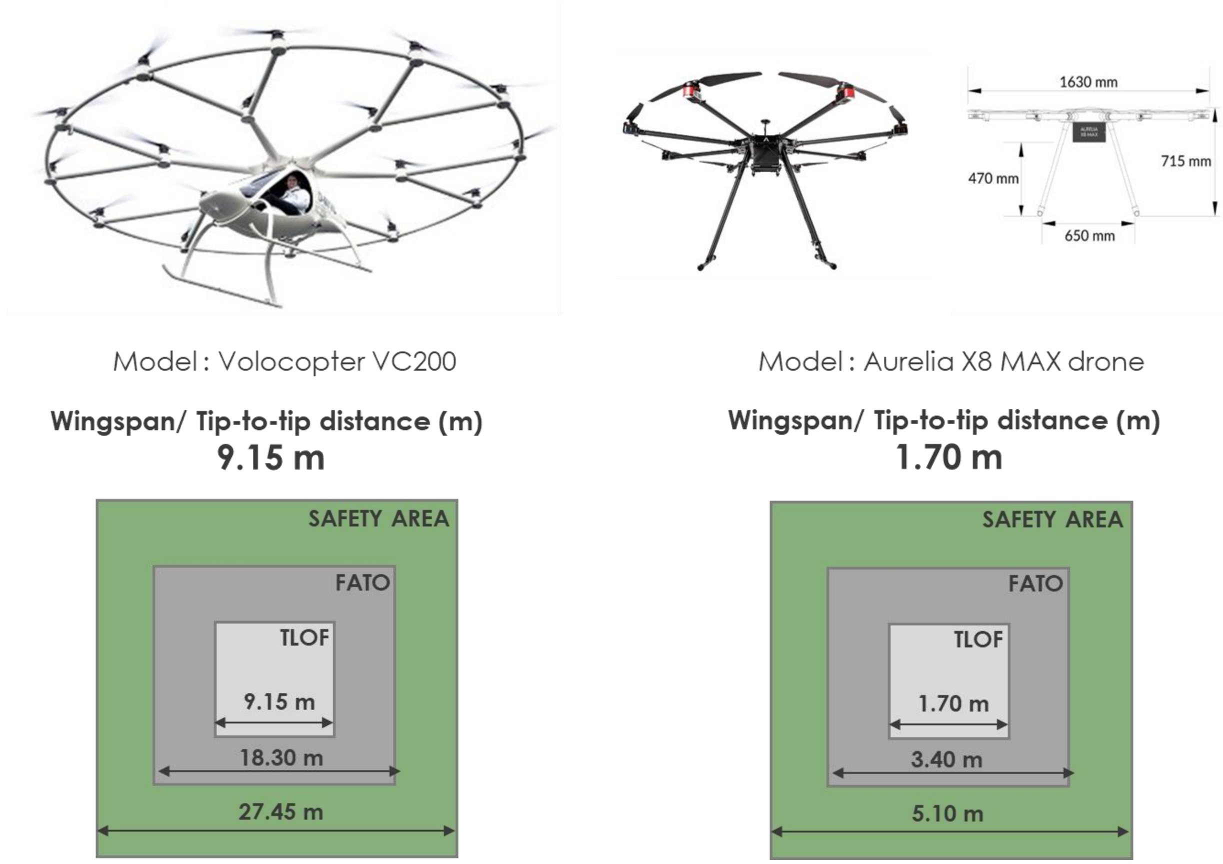

Figure 4.2 Examples of Air Taxi and Drone Layouts
(Left: Air Taxi with its layout; Right: Drone with its layout)

4.2.2 Vertiport Sizes

For current potential vertiport locations, experts debate utilizing existing "residential buildings, highway plazas, parking areas, and rooftops of high-rise buildings" (Lineberger et al., 2019). Along with this, greenfield sites, rooftops, and parking garages are considered potential locations for vertiports (Patterson et al., 2021). With these considerations for UAM landing pad locations, it is crucial to choose feasible types of vertiports. For the scale of the landing pad, the controlling dimension, "the longest distance between two outermost opposite points of the aircraft," is variable depending on the size and type of UAM (Judson et al., 2022).

1) Vertihubs: a location that includes facilities for maintenance, repair, and overhaul operations and a centralized operations control system, like small airports in urban or suburban areas.

2) Vertiports: a designated area on the ground or an elevated platform with associated buildings or facilities. It is in a city and occupies a smaller area than vertihubs.
3) Vertistops: a place to take off and land to drop off or pick up passengers or cargo. They have the smallest area needs which make construction costs lower than other landing pads.

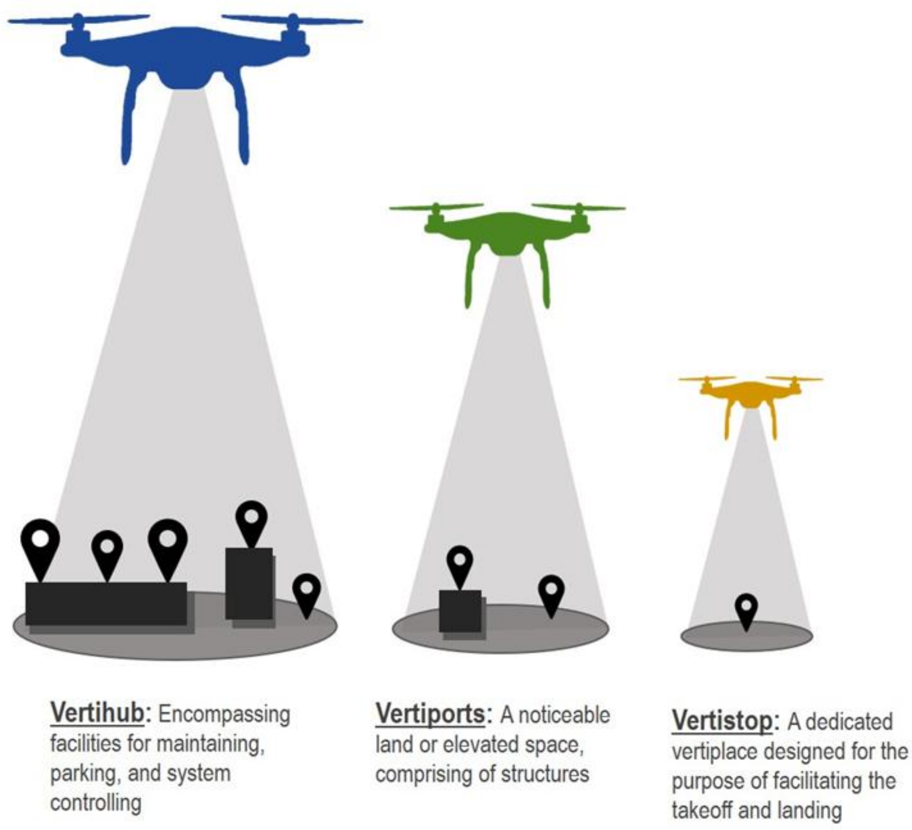

Figure 4.3. Illustration of Shapes and Sizes of Vertiports

4.3 Arrangement of the Possibility

For vertiport design and regulation, the engagement of stakeholders in different fields is indispensable (Laugere, 2022). Representative operational stakeholders include the Federal Aviation Administration (FAA), vertiport manager, fleet operator, flight crew and aircraft, provider of services to urban air mobility network, supplemental data service provider, and state and local government. Several key aspects must be considered to establish a safe, efficient, and robust vertiport operation that provides equal opportunities for all passengers and cargo. These include addressing noise pollution concerns, keeping track of weather conditions, and establishing a well-functioning system supported by a high-speed communication network (Laugere, 2022).

4.4 Considerations for Implementing Vertiports

Implementing vertiports faces a significant challenge due to the scarcity of suitable open land with appropriate land use designations and safety clearances. Urban lands, known for their high land prices and dense building structures, make it difficult to find ideal vertiport locations. This challenge is prevalent in many densely populated cities where factors such as land cost, land use planning, zoning regulations, local political support, and community acceptance impede the conversion of existing built-up areas into vertiport facilities. In particular, the acceptance of the community is important for vertiport operations. Their concerns regarding safety, toxic drainage, emissions, light pollution, invasion of privacy, and noise, which remain the primary reasons for resistance, should be considered. To gain trust, vertiport planners must provide realistic, accessible, and trustworthy data to community members, ensuring it aligns with their experiences (M. Cohen, 1996). Additionally, Hall's research findings (Hall, 2023) indicate that security concerns, particularly privacy-related, were identified as significant factors when considering the establishment of vertiports. The research also revealed that residential communities favor locating vertiports near community centers. Residents identified fire stations as the most suitable location, followed by police stations, retail centers, and grocery stores. This emphasizes the importance of considering community preferences when implementing vertiports.

5.0 OVERVIEW OF THE LAND-USE PLANNING PROCESS

5.1 Land Use Planning

Land Use Planning involves designating and utilizing the land for various purposes, such as residential, commercial, industrial, and recreational activities while considering environmental and community impacts (DePasquale et al., 2018). This process introduces unique challenges for UAV vertiports, including integrating ground-to-air operations, managing airspace, and addressing quality-of-life issues like Noise, Safety, and Equity (Meader, 2007). This guidebook emphasizes strategies to align planning decisions with community goals, prioritizing public health, safety, and welfare (Campbell et al., 2017).

5.1.1 General Planning Steps

Vertiports' land-use planning process comprises four key stages: preparation, planning, implementation, and monitoring (FAO, 2020). While these align with traditional land use processes, vertiport planning must address specific considerations like Airspace Constraints, Transportation Integration, and Environmental Impacts.

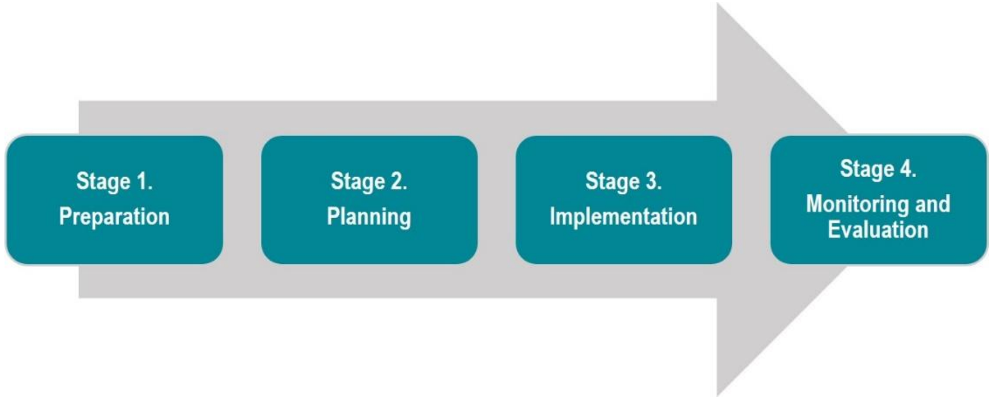

Figure 5.1. Land-Use Planning Steps (Referenced in FAO, 2020)

5.1.1.1 Preparation Stage

- Define Scope and Objectives: Establish terms of reference (TORs) through collaboration with stakeholders, such as local governments, transportation agencies, and aviation experts (Haines et al., 2005).

- Stakeholder Analysis: Engage key stakeholders early to foster ownership and build synergies (FAO, 2020). A participatory approach ensures alignment with community needs and priorities.
- Inventory Resources: Identify available land, transportation infrastructure, and equipment needs. Prepare tools like GIS software, aerial imagery, and safety equipment to facilitate informed decision-making (FAO, 2020).

5.1.1.2 Land-Use Planning Stage

- Data Collection and Analysis: Use participatory mapping and GIS tools to analyze natural resources, transportation networks, and potential environmental impacts (FAO, 2020). Include input from community representatives to ensure inclusive planning.
- Formulate the Land Use Plan: Develop plans emphasizing connectivity, minimizing environmental harm, and ensuring community accessibility. Stakeholder consensus on the proposed land use map is essential (Shepard, 2005).
- Problem Analysis and Solutions: Address site-specific challenges, including noise, safety, and equity, through collaborative discussions and scenario planning (Haines et al., 2005).

5.1.1.3 Implementation Stage

- Define Governance Frameworks: Establish clear roles and responsibilities for plan implementation, ensuring coordination between aviation authorities and local governments (FAO, 2020).
- Resource Allocation: Identify funding sources and provide incentives to encourage community support and participation (FAO, 2020).

5.1.1.4 Monitoring and Evaluation Stage

- Track Progress: Monitor the implementation of land use plans and their effectiveness in addressing identified goals and challenges (Shepard, 2005).
- Evaluate Impact: Conduct regular evaluations (at least every five years) to assess plan effectiveness, adapt to emerging needs, and identify opportunities for revisions or amendments (Haines et al., 2005).

5.2 Land-Use Planning Issues

When planning for a UAV vertiport, it is important to consider the land-use planning issues that may arise. While local codes will offer guidelines, the codes were typically not created for ongoing Ground-to-Air activities. Some important considerations are Noise Restriction Areas, Height Restriction Areas, Safety Restriction Areas, and Overflight Restriction Areas. Heliports offer a precedent from which to draw; this work is adapted from Reynolds et al. (Reynolds et al., 2021). Additionally, Mendoca et al. (2022) provide an exhaustive list of other critical issues to consider, such as operational constraints, community acceptance, and environmental sustainability, which are equally important in the planning process.

1) **The Noise Restriction Area** is defined as the 60 dBA SEL contour, within which an acoustic analysis is required to demonstrate how low-density, single-family, multi-family, and mobile-home dwelling units and schools have been designed to meet an interior noise level of 50 dBA SEL.
2) **The Height Restriction Area** is meant to protect the airspace around the heliport and is defined as the lowest of the Approach Surfaces plus the Sideline.
3) **The Safety Restriction Area** is intended to ensure the safety of people and property on the ground and helicopter occupants.
4) **The Overflight Restriction Area** is a composite of the areas affected by noise, height, and safety considerations around the heliport.

5.3 Land Use Analysis

To help prepare the Land Use elements and the overall Comprehensive Plan, eleven different analytical techniques could be considered. Several techniques depend on bringing together data your community may have collected on other elements (Haines et al., 2005).

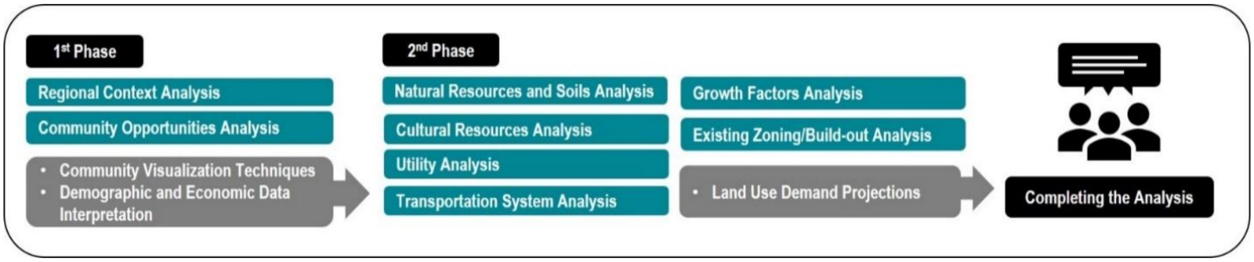

Figure 5.2. Land-Use Analysis Techniques (Referenced in Haines et al., 2005)

5.3.1 Regional Context Analysis

Understanding the regional context is crucial in planning land use, which examines the study area with the border sub-regional areas. This involves analyzing statewide Natural Features, Economic Development efforts, Transportation locations, and the plans of neighboring communities and agencies (Haines et al., 2005). By mapping the Regional Context (as listed below), planners can identify opportunities based on the community's regional position and consider them when making land use decisions in public forums or Comprehensive Plans.

- Understanding topographic, physical, natural features, and hydrological relationships that could impact the strategic development of Vertiport Networks.
- Identifying important habitats and endangered species to conserve biodiversity and ecosystems.
- Identifying regional economic growth and major investments by state.
- Ensuring regional connectivity by identifying major Transportation Corridors.
- Reviewing Comprehensive Plans, Zoning Regulations, and Development Guidelines of neighboring areas/communities.

5.3.2 Community Opportunities Analysis

Community Opportunities Analysis aids in determining the impact of unique opportunities on future land use and assists in planning. Each community has its unique attributes and areas of interest, leading to specific opportunities such as capitalizing on Community Resources, Revitalization Efforts, enhancing Economic Viability, exploring new directions in Economic Development, protecting Natural Resources, and preserving Community

Identity. The land use element should align with these opportunities, resulting in a future Land Use Pattern and Map that reflects the identified opportunities.

- Identifying important characteristics of the community for preservation, especially considering the potential disruptions from regular air traffic and take-offs and landings.
- Focusing on redeveloping and revitalizing underutilized or deteriorating urban areas to enhance livability and economic activity.
- Identifying and attracting new industries that align with the community's strengths and future economic goals.
- Ensuring sustainable water and land, and other natural resources management to prevent depletion and degradation.

5.3.3 Community Visualization Techniques

Visualization techniques help translate community land use preferences into easily understandable visuals. They utilize graphics, such as photographs and illustrations. The visual preference survey and future land use map are relevant. However, traditional means of communicating land use may not provide enough of a story to represent the integration of air traffic within traditional communities used to ground-based transportation. We recommend using illustrations with perspective, orthographic, and sectional representations.

5.3.4 Demographic and Economic Data Interpretation

Analyzing Demographic and Economic Data is essential for understanding the future impacts of population and job trends on land use. Collecting and analyzing data on population growth, age levels, workforce size and skills, and economic activity can inform decisions regarding housing, emergency services, industrial park locations, and commercial and industrial areas. Utilizing and analyzing demographic and economic data in conjunction with other elements helps shape the land use element of planning. Be judicious in economic forecasting, since unexpected outcomes can negatively impact communities or neighborhoods.

5.3.5 Natural Resources and Soils Analysis

Vertiport Planning will involve more emphasis on specific natural systems and elements. This includes understanding topography and physical systems that could impact operations (e.g., wind patterns and vegetation). Topography is important because it can help with initial siting opportunities. Not only is the slope of specific sites important for infrastructure development, but take-offs and landings can also be impacted by surrounding topography that impacts air movement. Vegetation is important to map, especially tree canopy. Through this process, it is important to collaborate with an expert who can offer long-term projections about how vegetation may change over time, as this can affect local conditions and clearances.

5.3.6 Cultural Resources Analysis

Cultural Resources Analysis helps identify a significant community's history and characteristics. This involves consulting the cultural resource element and considering the preservation of historic areas, farmsteads, and other important cultural resources. National and local sources should be consulted to determine their significance in preservation.

5.3.7 Utility Analysis

Utility Analysis assists in aligning future land uses with the capabilities of utility systems. This analysis (see below) ensures that public utilities efficiently serve land use locations and types. Collaboration with utility managers and municipal engineers helps gain insight into system capacities, constraints, and cost-effective growth locations.

- Integrating utility analysis into comprehensive planning documents to guide long-term land use decisions and infrastructure investments.
- Creating detailed maps of existing utility infrastructure to identify areas with sufficient service and glimpses of the area.
- Gaining detailed insights into utility systems' current capacities, limitations, and future expansion plans.

- Working with utility managers to align land use plans with projected population and economic growth.

5.3.8 Transportation System Analysis

Transportation System Analysis allows for a realistic assessment of the connections between land uses and transportation, including access control. Understanding the locations, conditions, and capacity of roads, as well as relevant programs for buses, rail, bicycles, and pedestrians, is necessary. Community planners must consider planned and potential changes to the transportation system to shape the land use element effectively.

- Provides a detailed understanding of the transportation system's capacity and limitations, guiding land use decisions that promote efficient and sustainable development.
- Mapping and evaluating the current inventory/state of roads, including surface quality, missing links, and connectivity.
- Assessing the capacity of roads to handle current and projected traffic volumes, identifying bottlenecks and areas of congestion.
- Analyzing access points to ensure safe and efficient ingress and egress to various land uses and minimizing conflict points.

5.3.9 Growth Factors and Zoning Analysis

Growth Factors Analysis compiles factors influencing suitable areas for community growth, considering past patterns, environmental corridors, productive farmlands, and planned transportation projects. It guides decisions on community growth, prioritizing areas with high potential, low costs, and minimal impacts. Understanding historical growth areas or future or proposed Zoning Changes can help facilitate future Vertiport Planning efforts.

5.3.10 Zoning and Land Use Demands

Zoning is a key leverage point for vertiports' consideration. Current Zoning Laws in most communities do not directly establish zones for vertiports. These would constitute commercial zones or fall under special zoning provisions based on the kinds of activities. It would be advised that communities develop formal policies around conditional use or Zoning Laws that reflect the boundaries and functions of these infrastructures within a zone.

5.3.11 Land Use Demand Projections

Zoning planning and forecasting may be critical in strategically developing areas intended for vertiports or identifying new zoning or conditional use policies. It is advised to work with local jurisdictions and agencies that operate at the state level to identify if there may be long-term plans for transportation systems (that could impact zoning changes). Further, conducting a build-out analysis based on existing zones can give insights by reviewing the current zoning map and aiming to align community interests.

6.0 INTEGRATING VERTIPORTS INTO THE LAND-USE PLANNING PROCESS

This chapter aims to provide specific ideas and considerations for adapting land-use planning processes for UAS and AAM. Numerous formal processes can be used or adapted for this purpose (A. Cohen et al., 2024; J. Coliton et al., 2024) In this section, we introduce multiple steps that generally follow common processes. Communities can certainly use their process, but we want to emphasize a crucial point: The integration of 3D planning of airspace fundamentally differs from traditional 2D ground-based planning processes. We hope to clarify some key elements of this difference in the following subsections.

6.1 Background Information

Some planners may be aware of heliports or have these operations within their communities. Vertiports typically require larger areas than traditional heliports due to the increased capabilities of tiltrotor technology. However, for drone delivery purposes, Vertiports are likely to be smaller than heliports. The business case and future business activities will play a role in determining the total area needed for operations. All space requirements will depend upon the size of the facility, regulations, conditions, expected operations (FAA, 2012 and 2022; Patterson et al., 2021), and forecasting.

Densely populated urban cores, high land prices, and existing buildings occupy much of the available space, making it challenging to identify optimal sites for vertiports if they are intended to be at ground level (building tops are also reasonable locations). Open land, regulatory limitations, and safety clearances (Vázquez, 2021) are very important to this process. We also want to stress that a community should carefully evaluate possible *long-term* negative effects on communities (e.g., social impacts, development, visual pollution, land values). We emphasize the importance of a systematic process to identify and evaluate community criteria and regulatory guidelines. This can help distinguish between site locations but also consider how multiple vertiports could be integrated into a broader system. We have developed a geospatial process to produce parcel-level suitability that can be used to conduct this kind of integrated strategic planning.

The purpose of our initiative is to develop a structured framework to identify ideal vertiport locations by considering legal, infrastructural, and logistical aspects and to create a geospatial tool and maps to aid planners in evaluating suitability, implications, opportunities, and challenges associated with implementing vertiports. What is provided in this section was inspired by a previous geospatial mapping project developed for the Wasatch Front, specifically Davis, Salt Lake, Weber, and partially Box Elder (Brigham City area) counties, which are managed by the Wasatch Front Regional Council (WFRC) Metropolitan Planning Organization (MPO). Details of the geospatial process are provided in Hall (2023).

6.2 Inventory Data and Information Collection

One of the most important aspects of the land planning process is to gather and represent important spatial data (Geographical Information Data). We have included an overview of the

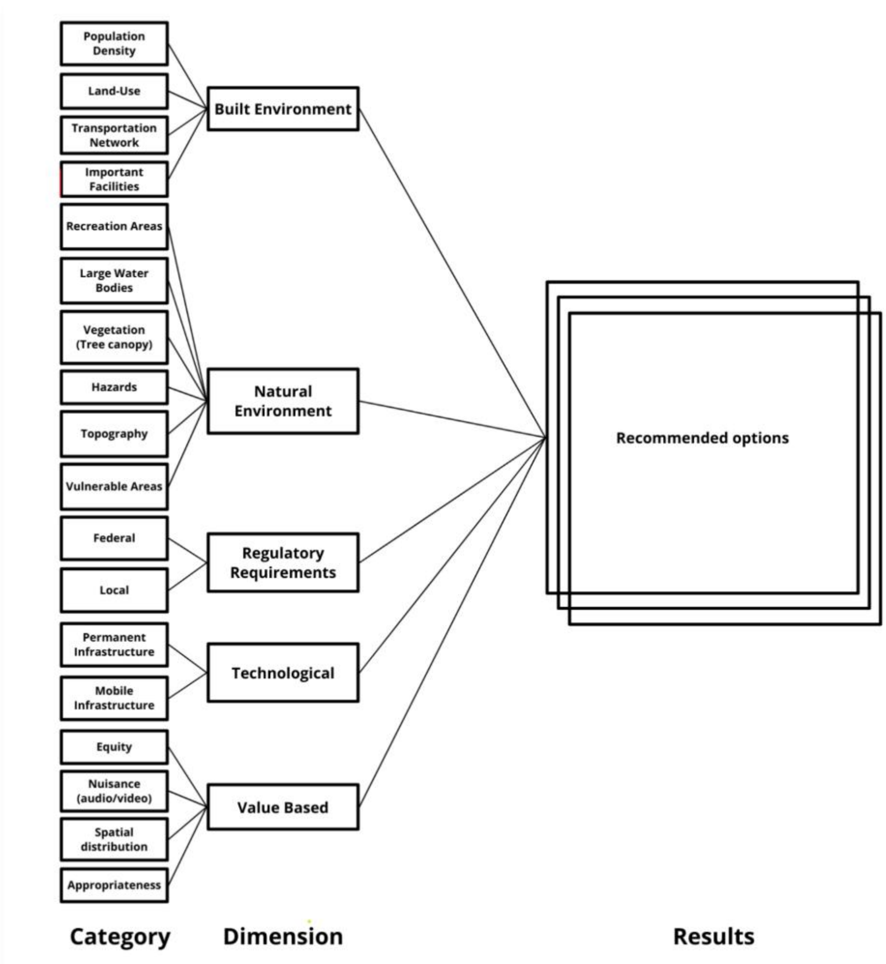

Figure 6.1. Conceptual Framework Diagram (Hall et al., 2022)

different data we believe are important for consideration, as shown in Figure 6.1. These dimensions provide a foundation for organizing research tasks and goals, guiding the development process, and drawing insights from established conceptual frameworks, such as those discussed by Jabareen (2009). This framework is adaptable to a range of different vehicle use cases. Five dimensions summarize a range of different categorical data. Dimensions are built environment, natural environment, regulatory requirements, technology, and value-based considerations. For a full list of these features, see Hall et al. (2022).

Built Environment: This dimension examines the physical elements constructed for societal use within the project area. It includes Land Use (Zoning Maps), Transportation Networks, Important Facilities, and Population Density. Land Use includes the current use of land, such as commercial and residential areas, and municipal parks. It also considers buffers around sensitive areas. Transportation networks involve existing or planned roadways, sidewalks, air traffic patterns, and similar factors. Important Facilities, such as community centers, schools, libraries, and prisons, are encouraged or excluded. Population density can play a role in determining the size of proposed vertiports. We also advise collecting data about the power grid and delivery systems, as well as electrical light poles or other pole or tower infrastructure.

Natural Environment: This dimension focuses on natural features that could pose risks to flight or ground-based operations. These include recreational areas, large water bodies, vegetation, environmental hazards, topography, and vulnerable areas. Extreme topography can introduce unnecessary difficulty and longer flight times that are not ideal for our use case. Dense vegetation makes piloting and landing challenging because of debris and micro variations in wind patterns. Large water bodies present sinking hazards.

Regulatory Requirements: This dimension addresses the various regulatory or legal bodies that control or limit UAS within the project area. For this study, Regulatory Requirements are divided into air, land, and water-based regulations. These may include federal bodies such as the FAA, local government controls, nearby military bases, or airports. The study encompasses all potential ground or air operations regulations, focusing on ensuring compliance with legal requirements.

Technological: This dimension encompasses the needs and limitations of UAS based on current technological conditions and established infrastructure. Factors such as flight range, speed, and time are subject to change through innovation or external factors. Power grid structures are also important as they will play a role in the capacity of vehicular recharge should this be important for the kinds of operations proposed.

Value-Based: This dimension incorporates normative values and includes social acceptance, equity, audible and visual nuisance potential, prioritization, and safety. Some neighborhoods may face disproportionate impacts from vertiport development due to systemic inequities. Marginalized areas often bear greater burdens, including noise, visual pollution, safety risks, and reduced walkability, while wealthier neighborhoods tend to receive more benefits. Zoning and Land Use policies and limited community engagement can exacerbate these disparities, leaving underserved areas with fewer resources and less access to infrastructure benefits. Equitable planning is essential to address these challenges. It is important to consider how historical zoning practices lower community advocacy and resources to resist unfavorable developments, making them more vulnerable to inequitable siting decisions. Lower land costs and perceptions of reduced resistance further drive infrastructure projects into these areas, perpetuating cycles of disadvantage. Therefore, collaborating with these communities and understanding the potential burden or opportunity trade-offs is critical.

6.3 Organizing a Community Participation Group

As part of the Vertiport Land-Use Planning process, organizing a community participation group could be beneficial to gathering input about how community members may perceive benefits and impacts (Hall et al., 2022), especially when vertiports are such a new concept for the public. The group's responsibilities may include:

- Facilitating communication between the project team and stakeholders (residents, businesses, local authorities, and community organizations).
- Promoting transparency and ensuring relevant information is shared with the public.
- Providing a platform for community input to shape initial planning and decisions.

The EPA also provides a good resource for considering how this group might function and partner (EPA, 2020). These participation groups could be formalized into an advisory committee as well. However, given the nascency of this type of infrastructure, an advisory board should not serve just to approve proposals but rather to help form foundational dialogue and plans. By organizing a community participation group, the vertiport planning process can benefit from local knowledge, perspectives, and support. This collaborative approach fosters a sense of ownership and inclusiveness, leading to a more successful and sustainable vertiport infrastructure in the designated areas (EPA, 2020).

Figure 6.2. Examples of a Community Participation Group

6.4 Analysis and Evaluation

The analysis and evaluation phase are critical in identifying suitable locations for vertiport infrastructure. While this process shares elements with traditional land use evaluation, Vertiport Planning introduces distinct considerations that reflect the complexity of integrating ground and airspace systems. This section outlines the key criteria and tools for conducting a comprehensive and vertiport-specific evaluation. Examples of guidelines for conducting a site evaluation are provided in 7.4.

6.5 Key Evaluation Criteria for Vertiports

- **Multimodal Integration and Accessibility:** Vertiport sites can be leveraged when they are part of seamless ground and aerial transportation systems. For use cases where moving people is a priority, consider how vertiports may be integrated with other transit hubs such as large (and limited-use) parking lots, park-n-ride, public transit hubs, major roadways, or active transportation networks. Note that distractions are likely to be present, so it will be important to consider how safety is part of this integration. Note, that balancing connectivity also requires minimizing airspace congestion and conflicts with existing flight paths. The same conditions may apply for cargo transportation but may take on a slightly different role depending upon the business purpose. In this case, connectivity may be more related to a shared site amongst several businesses, rather than a single site for each business. Again, planners need to consider how the ground-to-air transition could influence the existing ground transportation system (e.g., flows of traffic within parking lots).

- **Land Use Compatibility:** Land use evaluation for vertiports must address traditional zoning considerations and factors unique to vertical operations, such as noise mitigation, flight safety corridors, and privacy concerns for nearby properties. Incorporating vertical dimensions and airspace compatibility into land use decisions is different in 2D ground-based planning.
- **Technological Infrastructure:** Vertiport locations must support the technological demands of these vehicles, including charging and maintenance stations for electric Vertical Takeoff and Landing (eVTOL) aircraft. Additionally, sites should be developed in a way to accommodate evolving technologies (e.g., power requirements, vehicle sizes, automation) and operational safety standards. Designs should conider future scalability and adaptability to rapidly changing technologies. The power grid plays a critical role. Not only will it be important to ensure adequate power, but also minimize overhead power lines due to the safety of vehicles and visual obstructions.
- **Environmental and Community Impacts:** Vertiports' environmental footprint and social acceptance are central to their successful integration. Evaluations should consider noise pollution, visual impact, and potential community disruptions. Engaging stakeholders early in the process is essential to addressing these concerns. Managing aerial noise and visual impacts are unique challenges in vertiport development.

- **Economic Feasibility and Operational Viability:** Cost considerations include initial construction, ongoing maintenance, and potential economic benefits, such as increased mobility and impacts to road congestion (it is unlikely vertiports will initially make any meaningful difference in traffic congestion but could increase congestion in the proximal location of a vertiport). Scalability should also be factored into the evaluation to ensure long-term viability. Immediate cost-effectiveness should be balanced with the ability to scale operations as AAM demand grows.

6.6 Tools and Techniques for Evaluation

The evaluation process for vertiports leverages methodologies that extend beyond traditional land-use planning tools:

- **Spatial Analysis with GIS, Google Street View Images, and Google Earth Pro:** Combines spatial data with street-level and satellite imagery to assess land use, connectivity, and visual context of potential vertiport sites.
- **3D Modeling of the site and obstacle analysis:** Visualizes the site in three dimensions to evaluate vertical clearance, airspace integration, and potential obstructions affecting operational safety.
- **Noise Mapping:** Models acoustic impacts of aerial operations, ensuring compliance with local noise regulations and alignment with sustainability goals.
- **Environmental Factors Analysis:** Assesses wind patterns, snow loads, temperature variations, and other climatic conditions to ensure the site's resilience and year-round operability for vertiport operations.

6.7 Air Traffic Controls and Indirect Management

Airspace is federally controlled so communities cannot directly control their airspace. However, communities can influence these routes by leveraging their authority over the land that vertiports occupy. This authority could include a range of different policies, fees, taxes, etc. Of course, these will need to be vetted by legal processes. These approaches would be very new.

Regardless, it is important to consider how contracts and policies can be developed to provide flexibility for a community to influence how air traffic management can be conducted in the future. Predominant routes should be established to manage noise, visual impacts, and safety concerns while also considering FAA regulations and guidelines. For communities expecting a high volume of aerial traffic, it may be useful to study optimal route planning to manage the flow of traffic, as well as designating ideal pathways for this traffic (e.g., above existing roadways or more distant areas that avoid direct flights over residential communities). Key considerations include:

- **Noise Mitigation:**
    - Identify flight corridors that minimize noise exposure to residential areas, schools, hospitals, and other civic areas where noise could create distractions (e.g., driving distractions).
    - Implement buffer zones or noise contour mapping to guide aerial routing decisions.
- **Visual Impact Management:**
    - Avoid flight paths over culturally or aesthetically sensitive areas to preserve community character.
    - Use height and flight direction controls to reduce the visual prominence of aerial operations.
- **Safety Enhancements:**
    - Design routes that avoid high-density urban zones to mitigate risks in case of operational failure.
    - Coordinate with FAA guidelines to ensure compliance with safety standards while considering local land use constraints.
- **Community Mechanisms for Control:**
    - Collaborate with local governments and community stakeholders to establish preferred flight corridors and operational limits.
    - Use local policies to guide vertiport siting and access routes, ensuring alignment with community values and land use priorities.

7.0 ANALYSIS FRAMEWORK FOR VERTIPORT SITE SELECTION

In this section, we offer a more mechanistic approach toward vertiport siting, which aligns with the broader land-use planning process. The approach provides a high-level, first-pass assessment that can help consider how to evaluate site options, consider zoning implications, produce a list of alternatives (spatially), and then conduct site assessments. We adopt standards from the FAA (2022), other vertical take-off and landing zones (heliport, emergency landings), and some basic architectural site assessment processes and couple these with graphics to provide a picture of how the ground-to-air planning can be conducted. We have also completed a companion report that details assessments of several parking lots in the Wasatch Front Regional Council area that was part of another UDOT project. Together, this chapter and that future report offer a more mechanistic, step-by-step guide for conducting site evaluations.

Broadly, when planning a UAV vertiport, it is important to consider factors such as location, site design, zoning regulations, and safety requirements. In addition, according to Reynolds et al. (Reynolds et al., 2021), land-use policy considerations for UAV vertiports also emphasize vertiport safety, site-specific noise issues, and clearance surfaces for vertiports serving UAV or UAM. Thus, examining potential impacts on the community to ensure the safe operation of the vertiport is essential. In the next section, we highlight a subset of criteria we think are critical for vertiport spatial planning. Of course, each community will need to undertake its prioritization of criteria, but these offer a start.

In addition to spatial and regulatory considerations, this section also includes an overview of a demonstration conducted at the 2024 Utah Aeronautics Conference, which provided a firsthand opportunity to evaluate key operational and public acceptance factors for vertiports. The demonstration simulated an urban vertiport environment, with a particular focus on noise management and safety concerns—two major considerations in vertiport site selection and community integration. Participants were able to observe the effects of aircraft noise at varying distances, assess the potential for operational disruptions, and engage in discussions on how to effectively plan for vertiport noise mitigation and public engagement strategies. The insights gained from this demonstration reinforce the importance of public perception, regulatory adaptability, and proactive planning measures in the successful deployment of vertiport infrastructure.

7.1 Vertiport Land-Use Planning Evaluation Criteria

This section outlines the criteria for evaluating potential sites for vertiport development, focusing on spatial analysis and site feasibility to ensure optimal placement and functionality. The evaluation criteria provide a framework for planners to assess and compare various locations. This framework aims to identify operationally efficient sites, minimize environmental and social impacts, and support long-term mobility goals.

7.1.1 Accessibility and Network Integration

It is important to evaluate existing transportation networks, including roads, pedestrian infrastructure, public transit, railways, hubs, and airports, to enhance multimodal accessibility and connectivity. Consider locations that can leverage proximity to existing networks. This will be dependent on the use case. In some cases, a vertiport may be targeted toward a single company, whereas others may serve small or larger hubs to move goods or people. Consider the ramifications for these different use cases and the potential for integration of multiple sites to minimize redundancy and inefficiency in the entire system. Further, assess the potential for locating vertiports near existing formal or informal community centers, such as shopping districts, business parks, or civic hubs. These locations can optimize accessibility while supporting community needs and fostering economic activity in areas with existing foot traffic and infrastructure.

7.1.2 Land Use Compatibility

Vertiport development faces a significant challenge compared to traditional infrastructure projects due to the **absence of established zoning laws or regulations explicitly tailored for this type of activity**. However, we do note, that there has been precedent for this work before (Mendonca et al., 2022). The overall lack of precedence means vertiports could, theoretically, be sited in various locations ranging from residential, commercial, and industrial zones. Developing new zoning frameworks or adapting existing regulations to accommodate vertiports will be important to help navigate development pressures and opportunities, as well as minimize conflicts with surrounding land uses.

Zoning considerations should include anticipating environmental impacts as well. In areas of existing development, it is important to consider how zoning laws may need to consider mechanisms to mitigate noise for humans and wildlife, address air quality issues (e.g., additional dust dispersion), or visual intrusion. Noise maps are examples of ways to represent impacts from existing transportation systems and could be used in developing strategic planning, as well as assessing local impacts (See Figure 7.1). Pay attention to important habitat ranges for animals, consider proximity to sensitive areas such as schools, hospitals, ecological sites, or protected areas, and incorporate strategies to address these concerns proactively. These assessments can also serve as a foundation for shaping future vertiport zoning and regulatory standards.

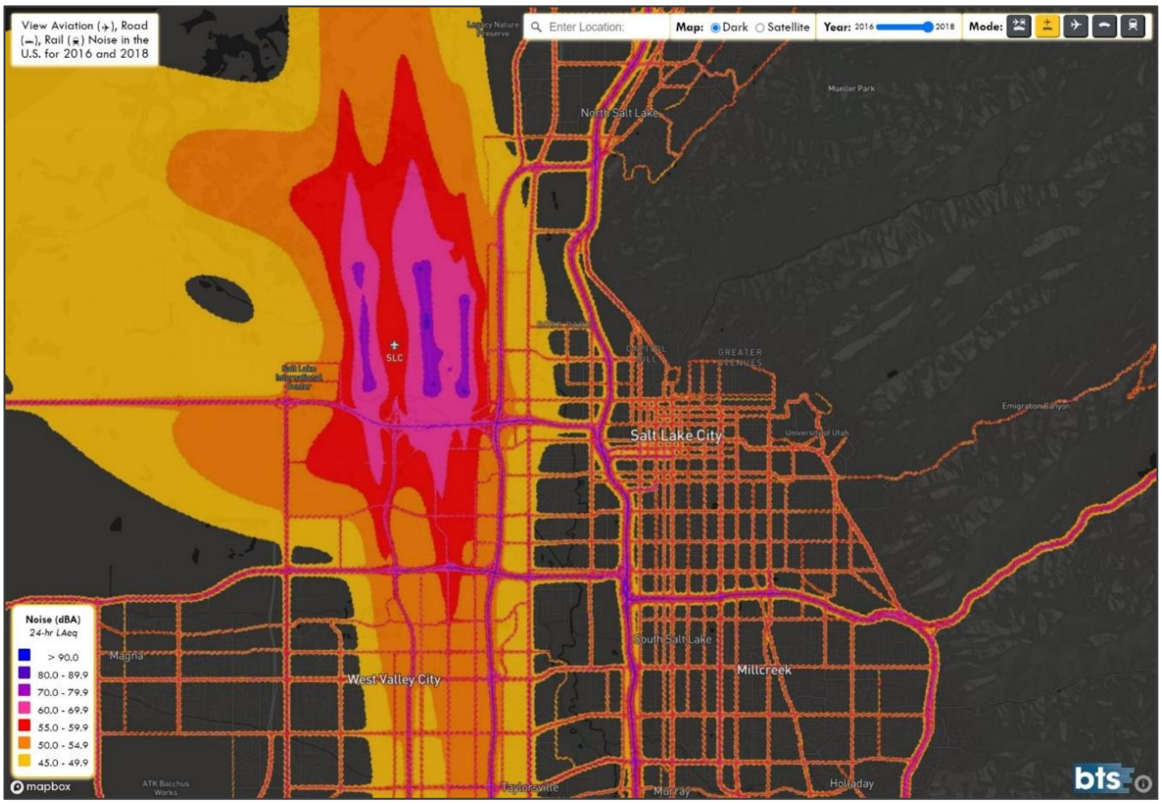

Figure 7.1. Noise Map Example. This map was created by the Office of Spatial Analysis and Visualization at the Bureau of Transportation Statistics, U.S. Department of Transportation (this was not created for a vertiport, but is used for illustrative purposes). A noise map could be useful to model impacts from vertiports.

7.1.3 Physical Space Requirements

The site must accommodate the necessary infrastructure, including the Touchdown and Lift-Off Area (TLOF), Final Approach and Takeoff Area (FATO), and Safety Area, as specified in FAA Engineering Brief No. 105 (FAA, 2022). Proper site sizing and layout are critical for ensuring operational safety and efficiency. Note that there are many different configurations given use cases, and future capacity planning will be important during conversations (especially since these operations are very new). Gather data about infrastructure (on-site evaluations and remotely) on and near any site that could restrict the physical space requirements for flights and ground operations. In addition to datasets about above-ground infrastructure, also consider data that provides the site's topography as grading (and slope) impacts safe operations.

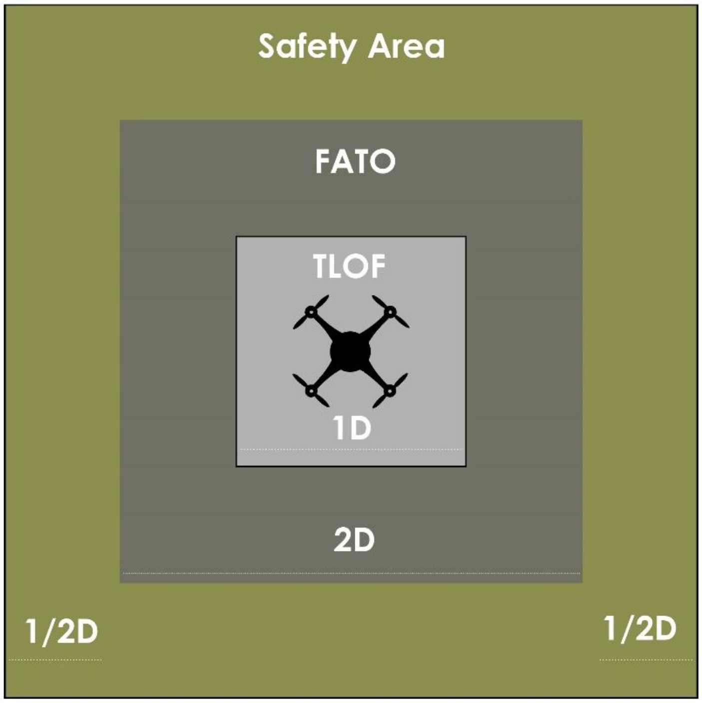

Figure 7.2 Relationship and Dimensions of TLOF, FATO, and Safety Area, Based on FAA Guidelines

7.1.4 Airspace Considerations

When planning a new vertiport site in the city, understanding its impact on the surrounding airspace is crucial. This involves a thorough assessment of how the proposed site might affect current air traffic flows. Additionally, considering all potential obstacles—from urban infrastructures to natural features—is vital for ensuring safe takeoff and landing procedures. It is also important to identify the airspace classification in which the vertiport will operate. Here are three essential points to address:

- **Air Traffic Management:** Evaluate the site's impact on existing air traffic patterns to ensure it does not disrupt nearby airports or heliports.

- **Approach and Departure Paths:** Maintain clear and safe approach and departure paths by adhering to FAA guidelines, avoiding obstructions, and minimizing potential hazards.
- **Airspace Classification:** Identify the airspace classification in which the vertiport will operate. Different classes of airspace have varying regulations and requirements which can impact vertiport design and operation.

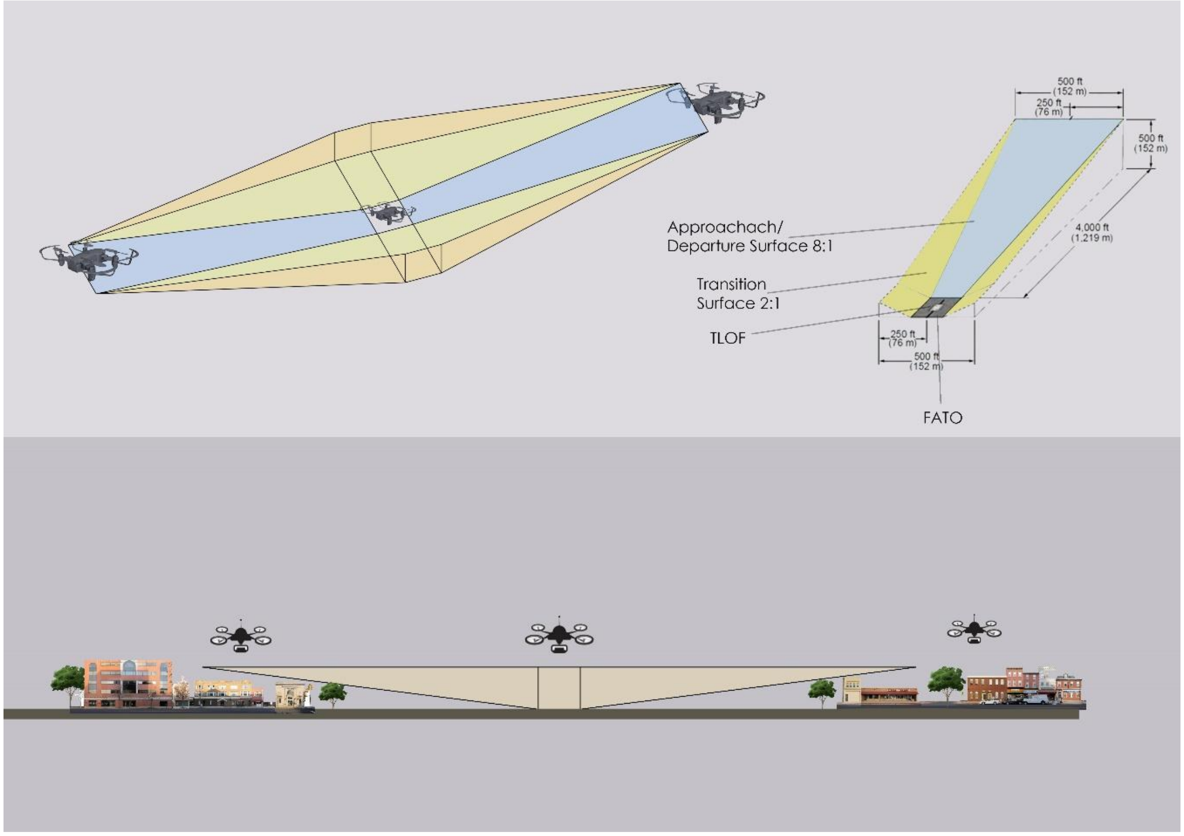

Figure 7.3 Visual Flight Rules Based on FAA Guidelines

7.1.5 Infrastructure and Utilities

- **Availability of Utilities:** Confirm the availability of essential utilities, including electricity, water, and telecommunications, to support vertiport operations. These will be used to determine risks (power lines and poles) and to expand to meet electrical requirements.
- **Future Expansion:** Consider the potential for future expansion and scalability of the vertiport to accommodate increasing demand and technological advancements. Ask if this is primarily to serve for moving people, goods, or both. Also, consider any comprehensive planning or strategic planning goals that may change future zoning laws.

7.2 Land Zoning

This section outlines the general rules, regulations, and restrictions related to land use in specific zones that would affect the siting of a vertiport. As of December 2024, our team is aware of no explicit zoning classification for Urban Air Mobility (UAM) within Utah. Traditional aeronautical infrastructure has been primarily designed to accommodate larger aircraft, focusing on extensive industrial and commercial requirements. However, the diversity of different eVTOLs means that vertical takeoff and landings reduce the necessary space for these operations. As communities explore how vertiports may integrate within their existing communities, there is a pressing need to adapt and develop zoning regulations. Insights into the necessary planning steps, collaboration between government, communities, and private sector partners, and considerations for integrating AAM technologies can be drawn from Urban Movement Labs (Ly, 2024). The World Economic Forum's report, "Advanced Air Mobility: Shaping the Future of Aviation," discusses key enabling factors and sectors pioneering AAM, offering insights into necessary actions for urban communities, operators, and regulators to incorporate AAM into existing frameworks effectively (World Economic Forum, 2024), which emphasizes the importance of aligning urban policies with emerging aviation trends.

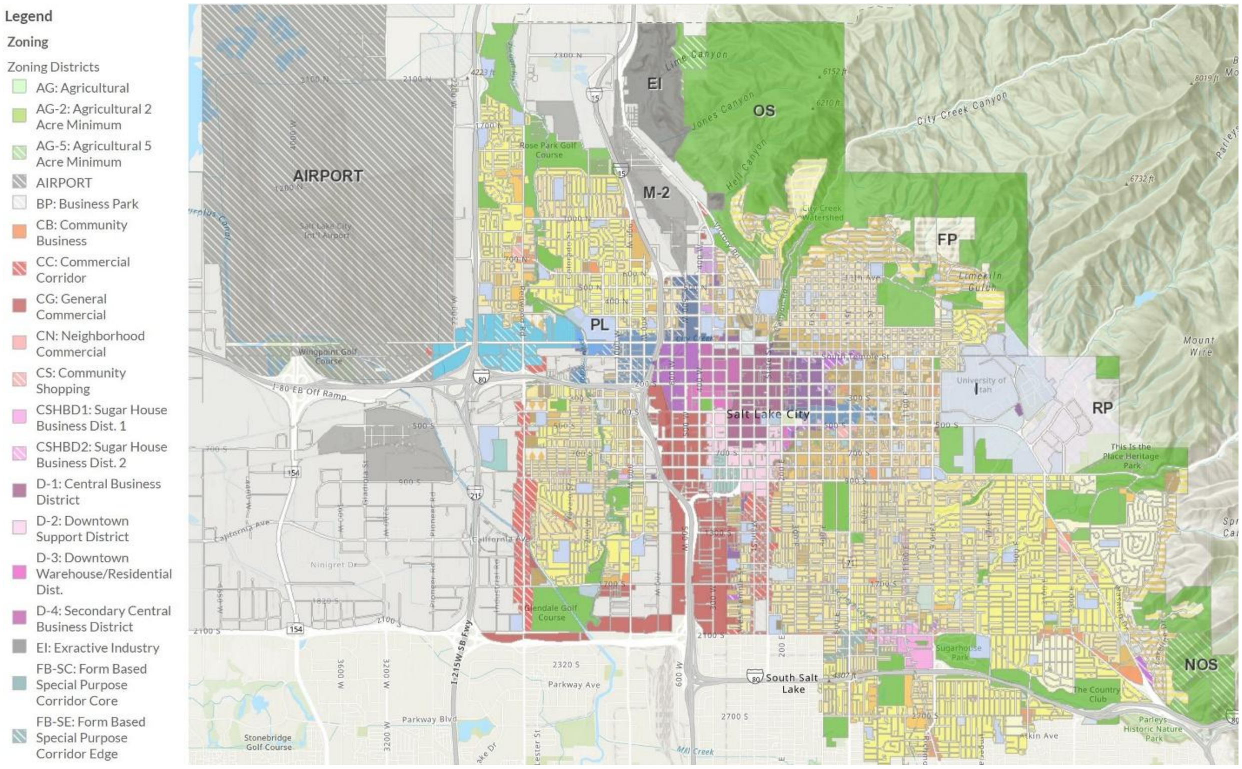

Figure 7.4. SLC Zoning Lookup Map as an Example of Land Use Designations

We identified earlier that vertiports may need to be considered for their unique land use designation, but planners could adopt existing aviation designations as part of this process (Mendonca et al., 2022; Reed, 2022). State policies currently do not have specific guidelines for vertiports and land use, so each municipality must determine the appropriate zoning. To integrate vertiports into existing zoning frameworks, municipalities may need to create new zoning categories or overlay districts specifically for vertiports. Vertiports can operate within existing residential, commercial, and industrial zoning laws in distinct ways, which we touch on briefly below. As these are discussed, it is also important to consider the use case for operations because these could range from small community delivery sites to larger air taxi operations. The former may be more reasonable within a lower-density residential zone, while the latter for higher-density zoning.

In **residential zones**, noise pollution, privacy concerns, and safety risks are significant hurdles to vertiport development. Residents are particularly sensitive to aircraft noise and may oppose operations that disrupt their neighborhoods. Privacy concerns arise from the perception of aircraft flying at low altitudes, while safety risks, such as potential crashes, contribute to public resistance. However, limited-use vertiports, such as those for emergency services like air ambulances, may find a place in residential areas under strict regulations. Mitigations, including buffer zones, restricted operating hours, and advanced noise abatement technologies, can help address these challenges. Zoning exceptions or conditional use permits may also enable development while ensuring community concerns are addressed.

One of the important challenges stemming from vertiports in residential zones is the little information about how these zones could influence property values. The devaluation of property could impact communities and disproportionately impact lower-income communities. This problem should be well understood, and care should be exercised to ensure these operations do not negatively impact communities. Mitigation of these impacts could come from implementing noise barriers, restricted operating hours, and consideration of rezoning (if it strategically benefits a community).

Commercial zones, on the other hand, may offer more compatibility for a range of vertiport implementations. Commercial zones often serve as transportation, retail, and healthcare hubs, making them well-suited for eVTOL infrastructure. Vertiports in commercial districts can meet high demand from business centers, shopping malls, and entertainment venues (in Utah, this may include outdoor recreation venues). In higher-density commercial zoning, height restrictions may need adjustments to accommodate vertiport infrastructure. In lower-density commercial zoning (and mixed use), it will be important to consider nearby impacts on residential communities, as identified in the previous paragraph. Public perception is likely more favorable in commercial areas due to their established role as centers of activity and transit.

Industrial zones present another viable option for vertiports due to their ample space, existing utility infrastructure, and logistical advantages. These areas often host warehouses, distribution centers, and manufacturing hubs, making them ideal for cargo-focused operations. Industrial zones typically face less public scrutiny. However, existing industrial zoning laws may not anticipate the specific needs of vertiports, such as energy infrastructure for eVTOL charging or hydrogen fuel storage. Environmental impact assessments may still be required to address emissions, noise, and land use changes. Vertiports in industrial zones can also support dual purposes, such as cargo hubs during off-peak passenger hours, improving operational efficiency and economic feasibility.

7.3 Parcel Suitability Map for Vertiport Planning

Given the evolving models of ground-to-air integration and the initial capital costs associated with developing vertiports, it is extremely useful to utilize geospatial models to represent data and for forecasting. One of the approaches we recommend is to develop both capability and suitability maps. The former are areas identified within a community where it would not be possible to develop a vertiport (e.g., for legal or safety reasons). The latter helps to visualize comparisons between different sites. In previous work, we produced both maps across the Wasatch Front; this work is referenced in this section. The images here provide a visual representation of the spatial data and help in understanding the results and insights derived from the analysis. More maps are available in Hall et al. (2022)

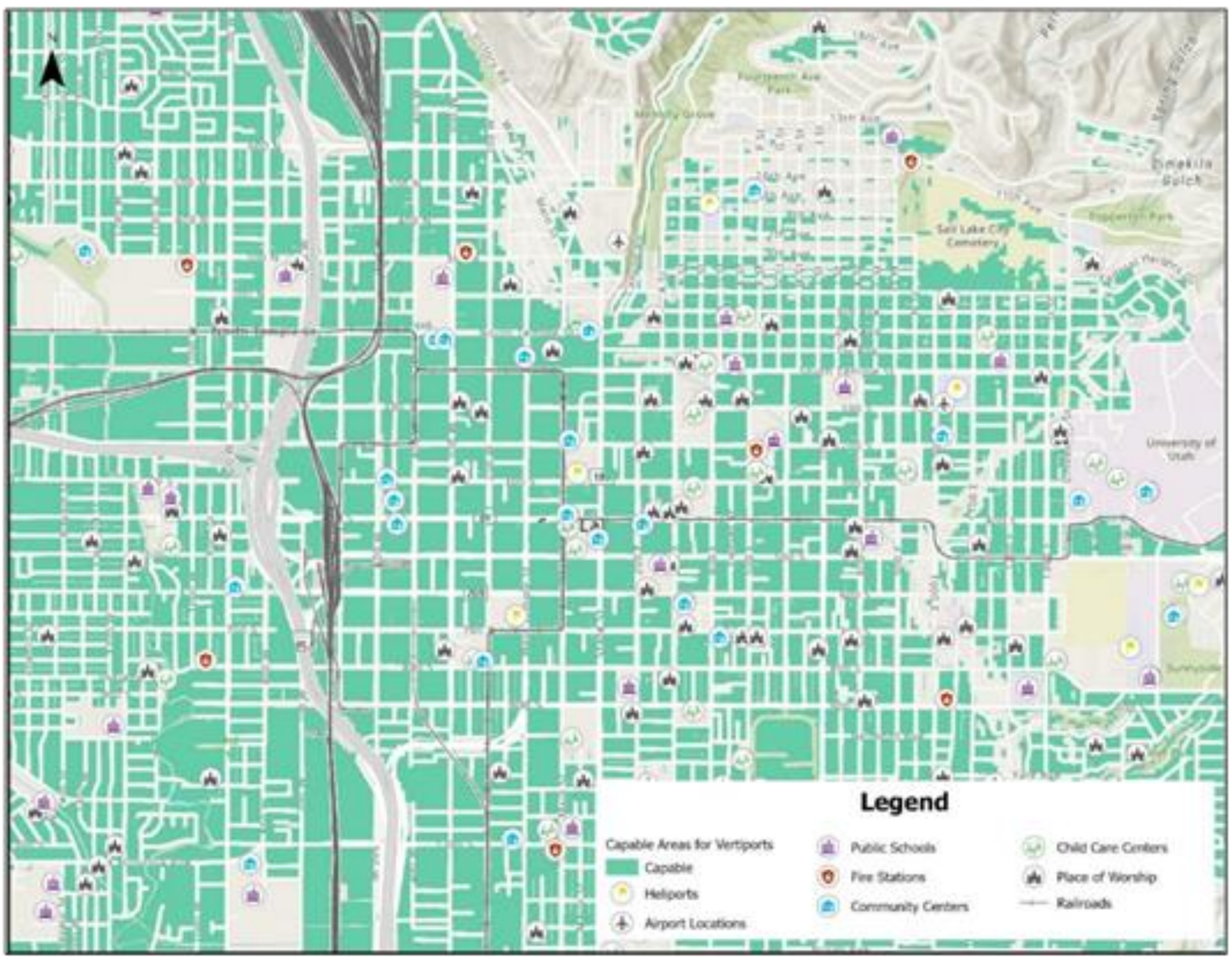

Figure 7.5. Parcel Capability Map. This map provides an example of areas where it would be theoretically possible to develop a vertiport (green). Blank areas are not capable because

of safety concerns, physical constraints, or being too close to police stations, schools, and similar facilities. Roadway buffers have also been added. The buffers might change depending on the specific use case (e.g., larger vehicles need more clearance).

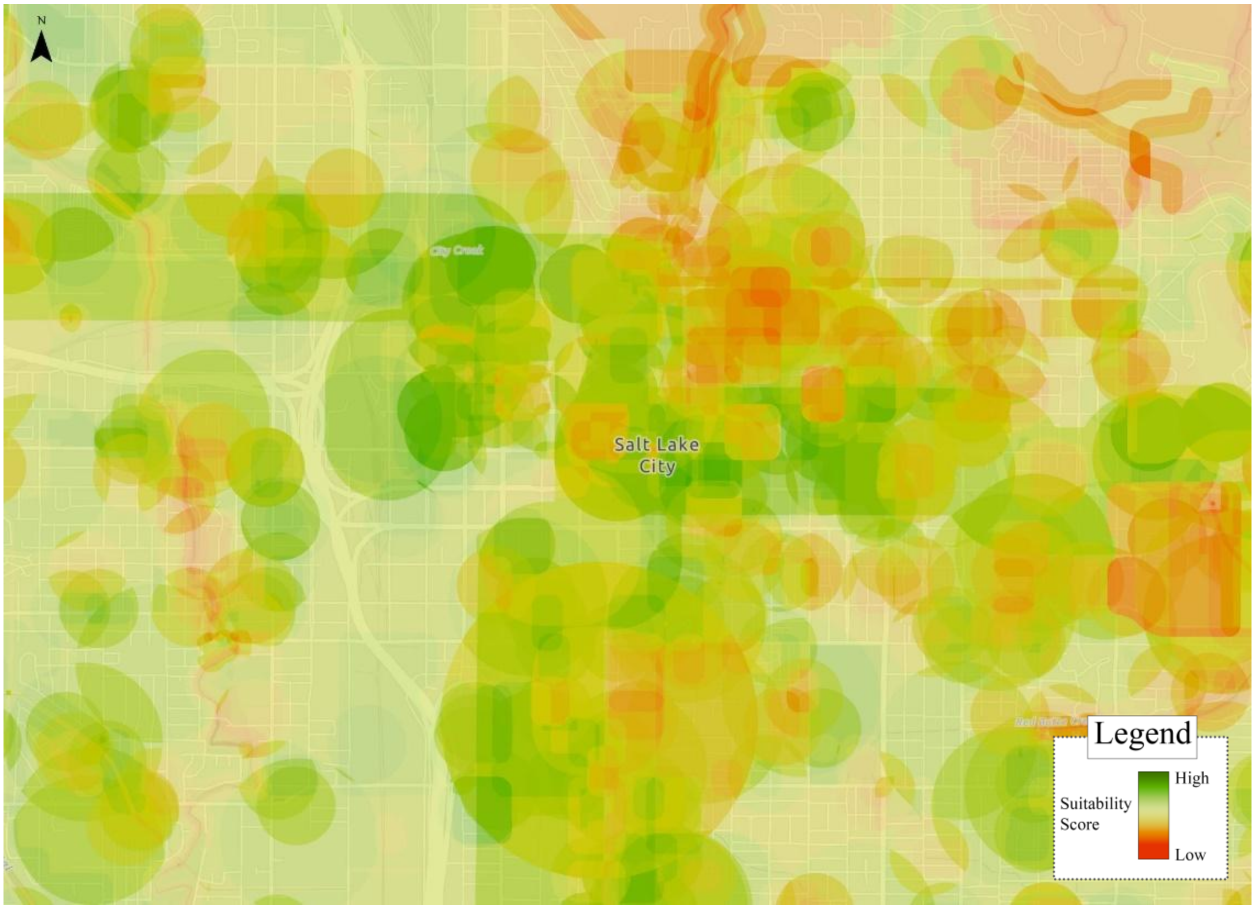

Figure 7.6. A Vertiport Suitability Map is a decision-making tool for identifying vertiport locations. This visualization illustrates a scoring technique for dozens of different spatial rules. Each rule is mathematically combined based on a set of assumptions and priorities. The final calculation represents areas of higher or lower suitability for vertiports.

Figure 7.7. Parcel suitability maps represent the median suitability for vertiports for each parcel. Using Zonal Statistics to analyze final suitability values, enables classification into categories that respect regulatory boundaries and support land acquisition decisions.

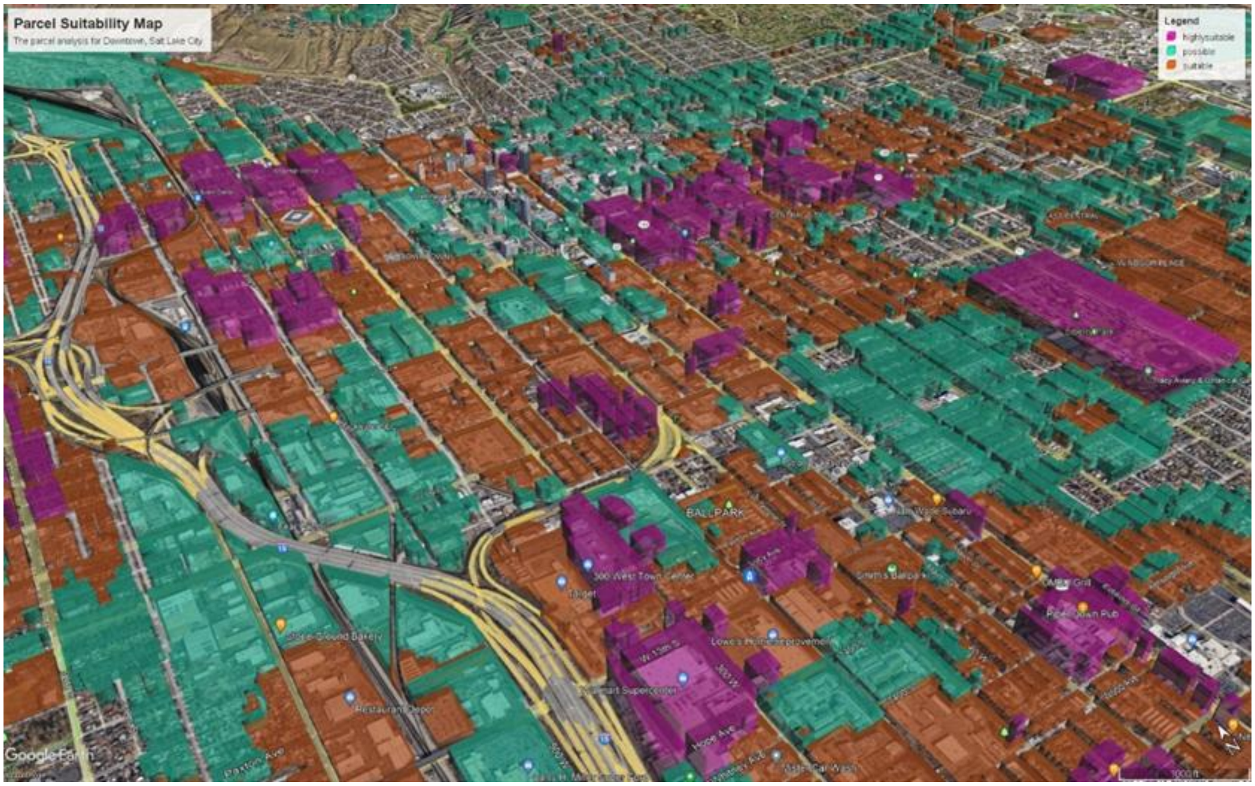

Figure 7.8. Parcel Suitability Map (Version II). Here the distinct colors are overlayed with heights to represent suitability. Purple represents higher suitability, red moderate, and blue has lower suitability, with empty areas and not capable. Visualizations like these can be used to represent suitability. Be aware that extracting heights is not meant to visualize air space, but merely to help facilitate strategic spatial planning.

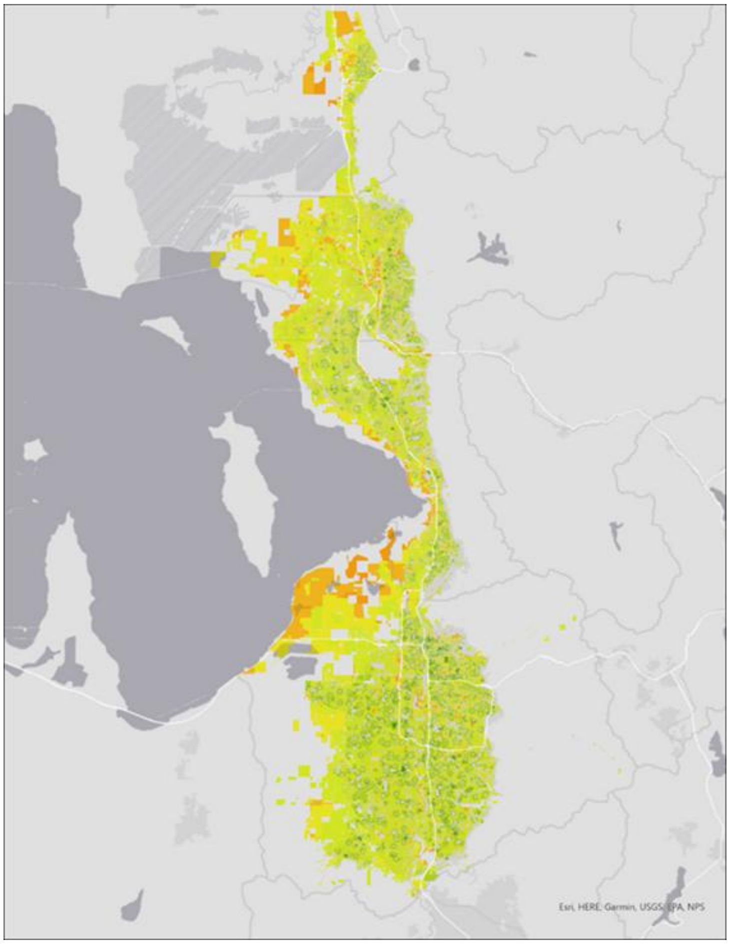

Figure 7.9 Parcel Suitability Map for Wasatch Front.
These data are fully available in Hall et al. (2022).

Whether the entire parcel or areas of parcels are used to implement vertiports, there is a wide range of spatial layouts to consider. For instance, greenfield sites, rooftops, parking garages, and more could be retrofitted to transport people (Patterson et al., 2021), with much smaller spaces that could be retrofitted for goods delivery. Ultimately, choosing the right location for a vertiport requires careful consideration of numerous factors to ensure safe and efficient operations while minimizing the impact on local communities. Since choosing a suitable location is a crucial factor in planning and designing vertiports, we emphasize the value of developing and using spatial planning tools to facilitate community conversations and strategic planning.

Where spatial tools provide a necessary resource in vertiport planning, many data sources may not be available at the parcel level. According to Vázquez (2021), a site investigation should not only include land use information (related to parcel suitability) but also integrate transportation plans. Some other data necessary for parcel suitability would include the use case (type and layout of the vertiports), convenience for users (e.g., business case for a given location), airspace obstructions, direction of prevailing winds, social and environmental factors, turbulence, and visibility. It is unlikely these data are readily available at the parcel level, so we encourage on-site assessments as potential sites are considered feasible.

7.4 Exploring Site Feasibility Using Criteria Evaluation

This section outlines a structured approach for assessing potential vertiport sites using feasibility criteria derived from the **FAA Guidelines** (FAA, 2022), the **Helicopter Design Advisory** (FAA, 2012), and **Emergency Landing Zone Protocols** (Life Flight, 2019; Trauma Life Flight, 2016). These references contribute specific insights that enable planners to evaluate the operational, safety, and environmental aspects of each site. The FAA Guidelines focus on physical and operational requirements, the Helicopter Design Advisory addresses obstacle clearance and safety, and the Emergency Landing Zone Protocols ensure that emergency zones meet safety and environmental standards. Together, these resources support a balanced and comprehensive approach to planning safe, efficient, and community-compatible vertiport infrastructure.

The **FAA Guidelines** (FAA, 2022) establish critical safety and operational standards necessary for vertiport infrastructure. These include the dimensions of Touchdown and Lift-Off Areas (TLOF), Final Approach and Takeoff Areas (FATO), Safety Areas, and adherence to visual flight rules to ensure safe and efficient operations. The guidelines also specify slope limitations, accessibility considerations for disabled users, and strategies for mitigating noise pollution. Additionally, the FAA emphasizes the identification of obstacles—both natural (e.g., trees) and built (e.g., buildings, bridges)—which are categorized by height and proximity to the site. These criteria are applied by using FAA standards as a baseline for assessing physical suitability, with spatial data such as topographic and parcel maps overlaid to verify compliance with requirements. This process ensures a detailed understanding of a site’s operational capacity.

The **Helicopter Design Advisory** (FAA, 2012) provides essential guidance on managing obstacles and ensuring safe operations. It highlights criteria for addressing electromagnetic interference from nearby electrical devices or structures, which can disrupt navigational instruments, as well as the importance of assessing air turbulence at ground level and elevated locations. The advisory also focuses on noise pollution as a critical factor in urban integration. These criteria are implemented through obstacle surveys and spatial analyses conducted with GIS tools. Field inspections complement this data, categorizing obstacles by impact levels and proximity, which aids in developing strategies to meet operational clearance and safety standards.

The **Emergency Landing Zone Protocols** (Life Flight, 2019; Trauma Life Flight, 2016) offer detailed criteria for evaluating emergency landing zones as part of the vertiport site. This includes requirements for landing zone size and surface suitability, and differentiating between daytime and nighttime operations. Key aspects such as ensuring the clearance of people and obstacles, maintaining a maximum slope limit, and keeping spectators and moving vehicles at least 200 feet from the touchdown area are emphasized. Wind direction and prevailing patterns are also assessed to enhance operational safety. These protocols guide planners in evaluating the suitability of emergency landing zones, ensuring that safety and accessibility are prioritized for vertiport sites.

Below we provide specific examples of important criteria derived from these three sources that need to be considered when conducting site assessments at the parcel level:

- **Operational Area**:
  - **Criteria**: Size, accessibility, slope, and emergency landing zones.
  - **References**: FAA Guidelines (size, access, and slope requirements), Emergency Landing Zone Protocols (safety zones).
  - **Method**: Assess land parcels for size and accessibility using GIS. Overlay emergency landing zone dimensions and slope data for compliance verification.
- **Obstacle Clearance**:
  - **Criteria**: Natural and built obstacles, electromagnetic interference, noise pollution, and air turbulence.
  - **References**: Helicopter Design Advisory (obstacle identification, noise, and air pollution), FAA Guidelines (approach/departure paths, visual flight rule, and noise pollution), Emergency Landing Zone Protocols (noise and turbulence).
  - **Method**: Conduct obstacle surveys and noise analyses using GIS and field inspections. Categorize obstacles by height and type for impact scoring.

- **Environmental Factors**:
    - **Criteria**: Weather, microclimate, and wind conditions.
    - **References**: Emergency Landing Zone Protocols and FAA Guidelines (weather and wind considerations).
    - **Method**: Use meteorological and historical weather data to model wind impacts and assess site resilience under variable conditions. Consider collecting additional data at the local site under different conditions.

An important consideration of these criteria is carefully measuring and forecasting changes to the environment, rather than only assessing what exists now. The following images provide examples of how different criteria can be assessed and visualized. The examples below use an existing parking area where there is ongoing development within the parcel area. These highlight both built (Figure 7.10) and natural (Figure 7.11) obstacles. We want to emphasize the importance of modeling the growth and maintenance of natural features. This is important for trees because the growth of trees can impact wind flow, debris, and visibility as they age and grow. We have also included an image rendering the noise boundaries for air taxis as proposed by NASA (Figure 7.12). Noise levels are typically regulated within existing zoning laws, but these laws may not be meant to address some of the vertiport use cases (e.g., constant operations). Further, NASA has recommended the maximum volume levels for eVTOL, but it will be important to understand exactly how noise levels will be impacted by different aircraft and regulations (this is one of the points of leverage communities can have on airspace because ground-noise limits can limit the amount and kind of aircraft).

Figure 7.10 Built-Environment Obstacles. Obstacles are represented in the perspective view but should also be represented in the plan view to identify obstacles and how these interact with TLOF, FATO, and Safety Areas.

Figure 7.11 Natural Obstacles (Future Projection). Comparison of current and future growth provides a means to evaluate future impacts on important criteria.

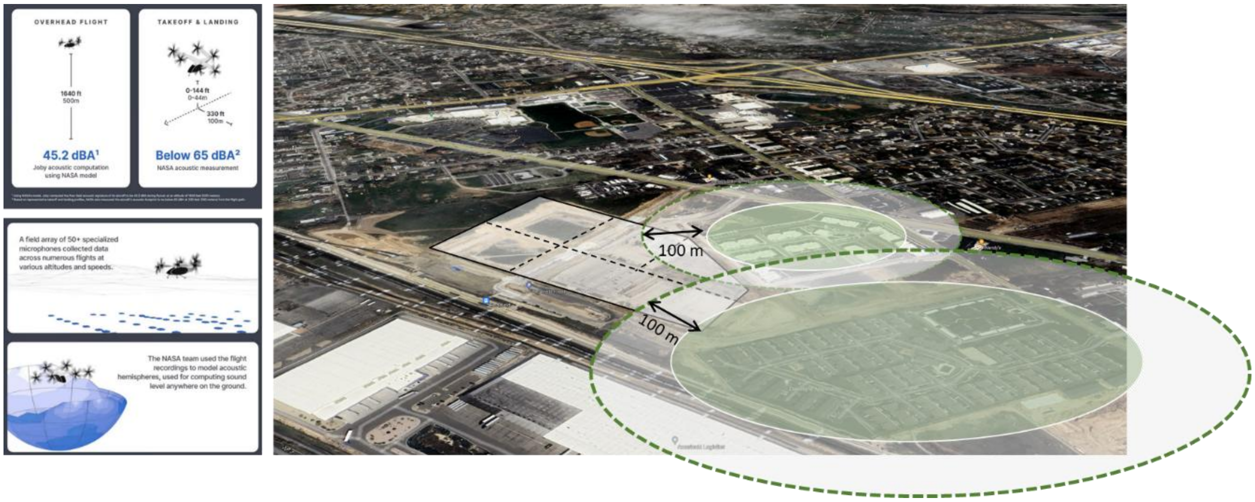

Figure 7.12 Representation of Noise Boundaries. Left side: Photos related to NASA's research on noise pollution in Air Taxis (NASA acoustic testing, 2022); Right side: Noise boundary areas at a sample site.

7.5 Overview of the Planning for Vertiport Land Use

Strategic vertiport planning should involve a comprehensive effort to consider how many parts of the transportation network, logistics, and community integration may unfold. There are numerous elements of urban planning, aviation regulations, community engagement, and environmental considerations. We have touched on many of these throughout this chapter. In this section, we briefly rehash and remind the readers of key steps and elements involved in the planning process to ensure the effective integration of vertiports into existing communities.

1. **Project Scope Definition**:
   - Define the goals and objectives of strategic vertiport planning. This could involve focusing on a single project but within a broader network of vertiports (even if they are not yet planned).
   - Identify key issues and opportunities related to vertiport development in the community.
   - Identify the primary stakeholders, including local authorities, aviation regulators, and community representatives.
2. **Preliminary Site Assessments**:
   - Produce spatial tools and maps to help identify locations for vertiports.

- Conduct initial site surveys to identify potential locations for the vertiport.
- Evaluate the suitability of identified sites based on basic criteria such as accessibility, existing infrastructure, and land use compatibility.

3. **Regulatory Framework Review**:

- Review relevant federal, state, and local regulations governing vertiport development.
- Identify necessary permits and approvals required for the project.
- Analyze the airspace requirements and potential conflicts with existing aviation operations.
- Establish safety zones and protocols by FAA guidelines to protect surrounding areas from operational hazards.

4. **Stakeholder Engagement Plan**:

- Develop a plan for engaging with stakeholders throughout the project.
- Schedule initial meetings with key stakeholders to gather input and address concerns.

5. **Consider Important Community Elements** (Haines et al., 2005)

- Assess the potential impacts on housing (especially land values) and consider the possible impacts on commercial, industrial, and transportation systems.
- Economic Development: Evaluate the potential economic benefits and impacts of the vertiport on local and regional economies.
- Transportation: How well can a vertiport integrate with your existing transportation system?
- Consider how your utility system could be impacted by a network of vertiports.
- Consider how vertiports might impact agricultural, natural, and cultural resources, as well as access to health care (especially for rural communities). Then, develop strategies to mitigate unwanted impacts.
- Environmental Impact Assessment: Assess the effects of vertiport operations on noise levels, air quality (dust and debris can be increased in the local area), and local ecosystems.
- Identify the technological requirements for vertiport operations, including navigation, communication, and safety systems.
- Plan for the vertiport's operational needs, such as staffing, maintenance, and emergency response protocols.

By considering these elements, planners can ensure a comprehensive approach to vertiport land use planning that addresses the needs of all stakeholders and promotes the sustainable development of vertiport infrastructure.

7.6 Workshop Demonstration for Vertiport

A demonstration titled "Simulating Urban Air Mobility Noise and Operation" was held as part of the 2024 Utah Aeronautics Conference at the Davis Conference Center to simulate a vertiport within an existing commercial district. A parking lot next to the center was used (see Figure 7.13). Participants who attended the opening session of the conference were invited to attend the live demonstration. The 90-minute session brought together experts from academia, industry, and government to get the feel of an urban vertiport. The primary objective was to evaluate simulated UAM operations, with a particular emphasis on noise management and operational safety—key factors for the acceptance and integration of UAM systems in urban settings. Participants discussed immediate observations from the demonstration, addressing key concerns and exploring potential strategies for mitigating noise and enhancing safety.

The demonstration commenced with an introduction and a recap of the UAM noise simulation demonstration. Key terms and concepts related to UAM operations and noise simulations were introduced to ensure all participants had a common understanding. The session then delved into scenario-based challenges observed during the demonstration, particularly how distance to the landing zone (TLOF) impacts sound levels. The physical space was marked in the nearby parking lot. As the participants walked from the convention center to the parking lot, they were asked to consider several key questions about vertiport development in the area:

- How might noise concerns shape the future of UAM vertiports in urban areas?
- What best practices can be derived from the noise simulation for planning and operating UAM vertiports?
- How can communities be prepared for the integration of UAM technologies concerning noise and safety?

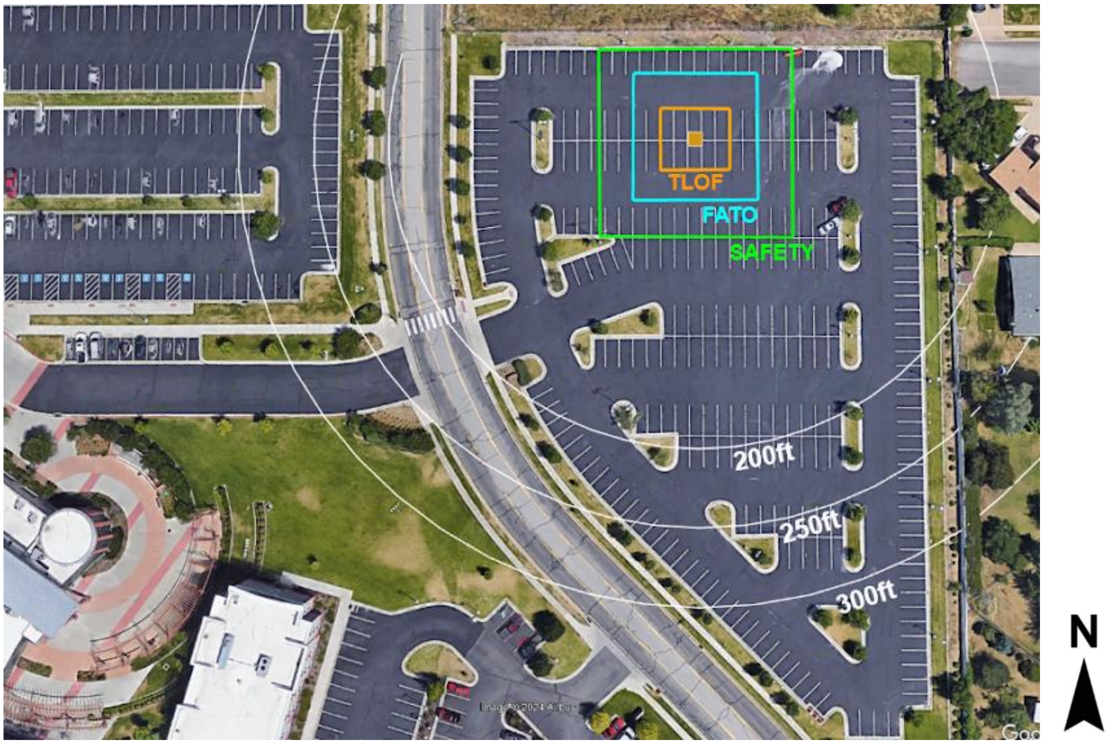

Figure 7.13 Demonstration Zone for Simulated Vertiport. The Davis Conference Center is located in the bottom left. Bounding boxes in colors: TLOF = Touchdown and Liftoff, FATO = Final Approach and Takeoff, Safety = Safety Zone.

The simulation involved participants standing at different distances away from the TLOF area with and without earplugs. Distances included 300’, 250’, 200’, and then right near the Safety Zone. The simulation was produced by a helicopter which would be much louder than an eVTOL. The helicopter performed take-offs and landings, as well as hovering at different elevations above ground. This process engaged participants to consider how these noise levels would influence residential neighborhoods and commercial operations.

While a formal Q&A session was not part of the agenda, the authors received important points of feedback. Participants wanted to know how they might consider and measure eVTOL and the potential change in regulations. They were also interested in the safety protocols, especially since they were able to explore the physical space that was presented in the parking lot. Participants were also interested in practices for noise and safety management. Within this report, we have addressed several of these points. Continuing these discussions will be crucial for developing guidelines that support the development of urban air mobility while addressing public concerns about noise and safety.

8.0 FINDINGS AND RECOMMENDATIONS

The integration of vertiports into urban environments requires a shift in land use planning, regulatory coordination, and community engagement strategies. Unlike traditional infrastructure, vertiports must align ground-based zoning with airspace regulations, balance multimodal transportation needs, and proactively address public concerns regarding noise, safety, and privacy. The following recommendations focus on key challenges, planning considerations, and best practices for planners, policymakers, and decision-makers involved in land use development and vertiport approvals.

8.1 Governance and Implementation Strategies

The successful deployment of vertiports depends on clear governance structures and standardized planning procedures. Cities should establish a lead department to coordinate between local governments, aviation authorities, and private stakeholders. This will streamline regulatory approvals, site selection, and community outreach. Planning processes should include pre-development meetings, stakeholder engagement, and best practices from early adopters to anticipate potential conflicts and minimize risks.

- **Unique Challenge**: Unlike conventional land-use projects, vertiport planning must integrate federal airspace regulations, which requires ongoing coordination with the FAA. Planners must navigate regulatory fragmentation across federal, state, and local levels, ensuring compliance while retaining local control over land use.
- **Planning Consideration**: Establish zoning ordinances and permit frameworks for approval processes.
- **Best Practice**: Develop clear governance structures that clarify responsibilities.

8.2 Site Selection and Land Use Compatibility

Selecting appropriate sites for vertiports can be vastly improved using a data-driven approach that considers airspace constraints, transportation connectivity, environmental impacts, and public acceptance. Initially co-locating with existing transit hubs, commercial districts, or emergency services can enhance accessibility and reduce opposition from residents concerned about noise and privacy.

- **Planning Consideration**: Research suggests that siting vertiports near major public facilities that act like community hubs may be more acceptable due to existing noise levels and transportation activity.
- **Integration Tip**: Developing maps and spatial analysis to assess zoning compatibility, multimodal connections, and environmental constraints facilitate strategic siting.
- **Best Practice**: Develop visual simulations, noise impact models, and public engagement tools to demonstrate site feasibility and address resident concerns early in the process.

8.3 Zoning and Regulatory Considerations

Most zoning codes do not directly account for vertiports which can create regulatory ambiguity and lead to unintended consequences. Zoning overlays or conditional use permits will likely be required to accommodate vertiports within residential, commercial, and industrial districts. These regulations must address noise mitigation, airspace coordination, and safety buffers, ensuring vertiports integrate seamlessly into urban landscapes without disrupting existing land uses.

- **Unique Challenge**: Unlike traditional infrastructure, vertiports require three-dimensional zoning considerations, meaning policies must account for airspace corridors, flight path restrictions, and altitude regulations, not just ground-level land use.
- **Best Practice**: Work with local, state, and federal agencies to develop clear zoning classifications for vertiports, ensuring alignment with FAA regulations while maintaining local control over land use approvals.

8.4 Community Engagement and Public Acceptance

Public concerns about noise, safety, and privacy will heavily influence the success or failure of vertiport projects. Without proactive engagement, resistance from residents could delay or halt approvals. Transparent outreach, impact assessments, and educational initiatives are essential to build trust and gain community buy-in.

- **Best Practice**: Form a Community Participation Group to gather input, ensure transparent decision-making, and address resident concerns early in the planning process.
- **Planning Consideration**: Under-resourced communities should be carefully considered if vertiport siting is within these areas. Planners should carefully assess trade-offs between who benefits and who is impacted.

- **Integration Tip**: Leverage community-preferred locations such as commercial centers, transit hubs, and emergency services facilities to reduce opposition while maximizing accessibility.

8.5 Multimodal Transportation and Infrastructure Integration

Vertiports must be seamlessly integrated into existing transportation systems, ensuring efficient connections between aerial and ground-based mobility networks. Passenger vertiports should be linked to transit hubs, while cargo-focused vertiports should align with logistics centers and freight corridors.

Planning Consideration: Last-mile connectivity must be addressed, ensuring vertiports are accessible via transit, bike paths, and pedestrian networks, and reducing reliance on personal vehicles as this could lead to further congestion.

- **Infrastructure Requirement**: Power and utility infrastructure must be assessed to ensure adequate grid capacity for eVTOL charging stations and to prevent conflicts with existing power lines.
- **Best Practice**: Consider weather and terrain factors, such as micro-scale wind patterns, topography, and extreme temperatures (these data are typically not available from public sources).

8.6 Environmental and Safety Regulations

Unlike traditional infrastructure projects, vertiports introduce unique environmental and safety considerations that must be accounted for in the planning process. Noise contours, flight path restrictions, and emergency response protocols should be established to mitigate risks and ensure compliance with safety regulations.

- **Best Practice**: Conduct comprehensive environmental and safety impact assessments to proactively address noise pollution, stormwater management, particulates from propellors, and microclimate effects before site approvals.
- **Integration Tip**: Preferred flight corridors should be designated to minimize noise and safety concerns, routing aerial traffic over commercial or industrial zones rather than residential neighborhoods.

8.7 Future-Proofing Policies for UAM Growth

Urban air mobility is an emerging and rapidly evolving industry, meaning planning and regulatory frameworks must be flexible enough to accommodate new aircraft types, automation technologies, and shifting FAA guidelines. Policies should allow for modular vertiport expansion, enabling sites to scale as demand increases.

- **Planning Consideration**: Communities should avoid overly rigid zoning and permitting structures, instead opting for adaptive regulatory frameworks that can evolve alongside UAM technology advancements and demand.
- **Best Practice**: Work with UDOT to establish a statewide UAM Advisory Committee to help facilitate planning processes and challenges, as well as ensure communities are aware of new developments across agencies and industries.

9.0 HOW UDOT CAN GUIDE IMPLEMENTATION

As urban air mobility (UAM) advances, the Utah Department of Transportation (UDOT) has a critical role in helping communities overcome planning and policy challenges for vertiport development. Unlike traditional transportation infrastructure, vertiports require airspace integration, multimodal coordination, and new zoning approaches, necessitating state-level leadership and regulatory alignment. Below we provide seven implementation recommendations UDOT can consider as they begin collaborating with communities interested in UAM.

1. **Establish Statewide Governance and a Regulatory Framework**

   Vertiport development requires coordination across local governments, the FAA, MPOs, private operators, and state agencies. UDOT can facilitate this by creating policies that align regulatory requirements, permitting processes, and land use guidelines. Most municipalities lack zoning frameworks for vertiports, so UDOT could facilitate model ordinances.

2. **Support Data-Driven Site Selection and Airspace Management**

   UDOT could develop a statewide suitability map to help communities assess potential locations. While airspace is federally controlled, UDOT can play a role in coordinating with the FAA to establish preferred flight corridors that avoid noise-sensitive areas and integrate vertiports into Utah's aviation planning. Additionally, UDOT can provide technical guidance on noise contours, approach and departure paths, and multimodal access.

3. **Facilitate Community Engagement and Public Acceptance**

   UDOT can support local governments by developing educational resources and engagement templates to proactively address public concerns. Further, encourage siting practices that do not place a disproportionate burden on under-resourced communities. Consider demonstration projects and public outreach efforts to give residents firsthand exposure.

4. **Integrate Vertiports into Utah's Transportation Network**

   For vertiports to be effective, they must be integrated into Utah's broader transportation system. Connecting vertiports with transit hubs, park-and-ride lots, and freight centers will ensure multimodal accessibility and improve efficiency for both passenger and cargo operations. Consider how the future of UAM might drive changes to existing networks.

5. **Establish Testing Corridors and Research Spaces**

   Creating controlled airspace zones for testing and research can help refine vertiport site implementation practices, safety protocols, and integration strategies. UDOT should help identify corridors and sites where experimental flights can take place, providing communities and industry with opportunities. Developing example vertiport sites will offer a firsthand experience for planners and policymakers, allowing them to better understand layout requirements and community impacts. Partnering with public universities can expand innovation and training.

6. **Create a Vertiport Advisory Committee**

   UDOT should establish an advisory committee composed of engineers, urban planners, social scientists, aviation experts, and industry leaders. This multidisciplinary team can provide technical assistance to local governments, helping them address zoning challenges, airspace regulations, and public engagement strategies. The committee can also ensure that as federal policies and UAM technologies evolve, UDOT remains proactive in updating regulatory frameworks and infrastructure planning efforts.

10.0 RESOURCES AND MORE READING

This section is a collection of key resources aimed at helping planners, policymakers, and industry stakeholders effectively navigate vertiport planning and AAM integration. It includes carefully selected planning-specific sources and essential regulatory and technical guidelines critical for understanding and implementing AAM.

Planning-Specific Sources

These resources provide essential insights into the planning aspects of vertiport and AAM infrastructure, emphasizing collaboration, safety, and community engagement:

- **Planning for Advanced Air Mobility:** Guides planners on integrating Advanced Air Mobility (AAM) into local planning and highlights collaboration with the FAA to ensure safety**.** *https://www.planning.org/publications/report/9286262/*
- **Urban Air Mobility Division, NASA Aeronautics Research Institute (NARI) – UAM Ecosystem Working Groups:** Collaborative insights on developing a UAM ecosystem. *https://nari.arc.nasa.gov/sites/default/files/attachments/UAM_ConOps_v1.0.pdf*
- **Advanced Air Mobility Land Use Compatibility and Site Approval Guidebook (Florida Department of Transportation Aviation Office):** Conducts tabletop exercises in Daytona Beach and Miami to explore land use needs and challenges for integrating Advanced Air Mobility into Florida's transportation network and develops a guidebook for vertiport planning. *https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/aviation/fdot-aam-land-use-compatibility-and-site-approval-guidebook---sept-2024-final.pdf?sfvrsn=2cfc5e9f_1*
- **Land Use Analysis on Vertiports Based on a Case Study of the San Francisco Bay Area:** Aims to create a framework for vertiport site selection and regional AAM planning while ensuring consistency and flexibility for local and state-specific considerations. *https://transweb.sjsu.edu/research/2122-Land-Use-Analysis-Vertiports-San-Francisco-Bay-Area*
- **Urban Air Mobility Policy Framework Considerations (Los Angeles Department of Transportation):** Explores how air mobility technology can integrate with public transit, protect the environment, and ensure equitable benefits for all Angelenos. *https://ladot.lacity.gov/sites/default/files/documents/ladot-uam-policy-framework-considerations.pdf*

- **National Association of City Transportation Officials (NACTO) – Blueprint for Autonomous Urbanism:** Guidelines on integrating autonomous systems into urban infrastructure. *https://nacto.org/publication/bau2/*

Regulations and Technical Guidelines

This subsection offers detailed operational frameworks, market studies, and regulatory guidelines essential for the safe and efficient integration of UAM into existing airspaces:

- **FAA Urban Air Mobility Concept of Operations (ConOps) v2.0:** Operational frameworks for integrating UAM into airspace. *https://www.faa.gov/sites/faa.gov/files/Urban%20Air%20Mobility%20%28UAM%29%20Concept%20of%20Operations%202.0_0.pdf*
- **NASA Urban Air Mobility (UAM) Market Study:** Explores market dynamics, potential applications, and adoption pathways for UAM systems. *https://www.nasa.gov/mission/aam/*
- **Uber Elevate Whitepaper:** Industry perspectives on the potential for air taxis and infrastructure requirements. *https://evtol.news/__media/PDFs/UberElevateWhitePaperOct2016.pdf*
- **European Union Aviation Safety Agency (EASA) – Guidelines on the Operation of UAS in the 'Open' and 'Specific' Categories:** Regulatory frameworks for UAS operations in Europe. *https://www.easa.europa.eu/en/downloads/139435/en*
- **Community Air Mobility Initiative (CAMI) – Resources and Research:** Community-driven tools and research for UAM adoption. *https://www.communityairmobility.org/resources*
- **International Civil Aviation Organization (ICAO) – Uncrewed Aircraft Systems (UAS) Toolkit:** Comprehensive resources for UAS integration and safety. *https://www.icao.int/safety/UA/UASToolkit/Pages/default.aspx*

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