Draft Environmental Assessment for the Denver Metroplex Project

April 22, 2019

Prepared by:

United States Department of Transportation

Federal Aviation Administration

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1 Introduction

The National Environmental Policy Act of 1969 (NEPA) [42 United States Code (U.S.C.) § 4321 et seq.], requires federal agencies to disclose to decision makers a clear, accurate description of the potential environmental impacts that could arise from proposed federal actions. Through NEPA, Congress has directed federal agencies to consider environmental factors in their planning and decision-making processes and to encourage public involvement in decisions that affect the quality of the human environment. As part of the NEPA process, federal agencies are required to consider the environmental effects of a proposed action and reasonable alternatives to the Proposed Action, including a No Action (i.e., analyzing the potential environmental effects of not undertaking the proposed action). The Federal Aviation Administration (FAA) has established a process to ensure compliance with the provisions of NEPA through FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures* (FAA Order 1050.1F).

The Proposed Action, the subject of this Environmental Assessment (EA), is called the Denver Metroplex or "DEN Metroplex" Project.[1] The Air Traffic Control (ATC) procedures ("ATC procedures") designed for the DEN Metroplex Project would be used by arriving and departing aircraft operating under Instrument Flight Rules (IFR) at the study area airports ("the Study Airports").

This EA, prepared in accordance with FAA Order 1050.1F, documents the potential effects to the environment that may result from the optimization of ATC procedures[2] at the Study Airports. These airports, discussed in further detail in Section 1.4, were selected based on whether they would be directly served by a proposed ATC procedure and if so, whether they served the required number of annual Instrument Flight Rules (IFR) filed operations under FAA Order 1050.1F[3]. The Study Airports are:

- Centennial Airport (APA)
- Denver International Airport (DEN)
- Greeley-Weld County Airport (GXY)
- Northern Colorado Regional Airport (FNL)
- Rocky Mountain Metropolitan Airport (BJC)

This EA includes the following chapters and appendices:

- **Chapter 1: Introduction.** Chapter 1 provides basic background information on the air traffic system, the Next Generation Air Transportation System (NextGen) program, Performance-Based Navigation (PBN), the FAA's Metroplex initiative, and information on the Denver Metroplex and the Study Airports.

[1] The Metroplex initiative was formerly referred to as the Optimization of Airspace and Procedures in the Metroplex (OAPM) initiative. A Metroplex is a geographic area covering several airports, serving major metropolitan areas and a diversity of aviation stakeholders.

[2] See Section 1.2 of this EA for a further discussion of air traffic optimization.

[3] Department of Transportation, Federal Aviation Administration, Order 1050.1F, *Environmental Impacts: Policies and Procedures*, Appendix B. Federal Aviation Administration Requirements for Assessing Impacts Related to Noise and Noise-Compatible Land Use and Section 4(f) of the Department of Transportation Act (49 U.S.C. § 303), Para. B-1. Noise and Noise-Compatible Land Use. July 16, 2015.

- **Chapter 2: Purpose and Need.** Chapter 2 discusses the need (i.e., problem) and purpose (i.e., solution) for airspace and procedure optimization in the Denver Metroplex area, and identifies the Proposed Action.
- **Chapter 3: Alternatives.** Chapter 3 discusses the Proposed Action and the No Action analyzed as part of the environmental review process.
- **Chapter 4: Affected Environment.** Chapter 4 discusses existing environmental conditions within the Denver Metroplex area.
- **Chapter 5: Environmental Consequences.** Chapter 5 discusses the potential environmental impacts associated with the Proposed Action and the No Action.
- **Appendix A: Agency Coordination, Community Involvement, and List of Receiving Parties.** Appendix A documents agency and public coordination associated with the EA process and lists the local agencies and parties identified to receive copies of the Draft and Final EA documents.
- **Appendix B: List of Preparers.** Appendix B lists the names and qualifications of the principal persons contributing information to this EA.
- **Appendix C: References.** Appendix C provides references to documents used to prepare this EA document.
- **Appendix D: List of Acronyms and Glossary.** Appendix D lists acronyms and provides a glossary of terms used in this EA.
- **Appendix E: Basics of Noise.** Appendix E presents information on aircraft noise as well as the general methodology used to analyze noise associated with aviation projects.
- **Appendix F: Denver Metroplex Study Team Final Report.** Appendix F contains the conceptual FAA Study Team methodology, findings, and designs used by the FAA Design and Implementation Team to craft Preliminary and Proposed Final Designs.
- **Appendix G: Denver Metroplex Design and Implementation Team Final Report.** Appendix G contains a summary and detailed summaries of the Preliminary Final Designs for proposed air traffic control procedures analyzed in this EA.
- **Appendix H: Denver Metroplex Flight Schedules Technical Report.** Appendix H describes the methodology and inputs used to forecast air traffic for the Study Airports described in this EA.
- **Appendix I: Denver Metroplex Noise Technical Report.** Appendix I presents detailed and technical information on the noise analysis conducted in support of this EA.
- **Appendix J: Reserved.** Appendix J is reserved for Comments on the Draft EA and is not included in this Draft EA.

1.1 Project Background

On January 16, 2009, the FAA asked RTCA[4] to create a joint government-industry task force to make recommendations for implementation of Next Generation Air Transportation System (NextGen) operational improvements for the nation's air transportation system. In response, RTCA assembled the NextGen Mid-Term Implementation Task Force (Task Force 5), which included more than 300 representatives from commercial airlines, general aviation, the military, aerospace manufacturers, and airport stakeholders.[5] Section 1.2.5 discusses the NextGen Program in more detail.[6]

On September 9, 2009, RTCA issued the NextGen Mid-Term Implementation Task Force Report, which provided the Task Force 5 recommendations. One of these recommendations directed the FAA to undertake planning for implementing Performance-Based Navigation (PBN)[7] ATC procedures on a Metroplex basis, including Area Navigation (RNAV) and Required Navigation Performance (RNP), which are discussed further in Sections 1.2.5.1 and 1.2.5.2. Based on this recommendation, the FAA began the Metroplex initiative.

The purpose of the Metroplex initiative is to optimize ATC procedures and airspace on a regional scale. This is accomplished by developing ATC procedures that take advantage of technological advances in navigation, such as RNAV, while ensuring that aircraft not equipped to use RNAV continue to have access to the National Airspace System (NAS). This approach addresses airspace congestion and other factors that reduce airspace efficiency in busy metroplex areas and accounts for key operating airports and airspace in a metroplex. The DEN Metroplex Study Airports are further discussed in Section 1.4. The metroplex initiative also addresses connectivity with other metroplex areas. The overall intent is to use limited airspace as efficiently as possible for congested metroplex areas.[8]

1.2 Air Traffic Control and the National Airspace System

The following sections provide basic background information on air traffic control and the NAS. This information includes a description of the NAS, the role of ATC, the methods air traffic controllers use to provide services within the Air Traffic Control system, and the different phases of aircraft flight within the NAS. Following this discussion, information is provided on the FAA's NextGen program and the Metroplex initiative.

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4 RTCA, Inc. Executive Summary, *NextGen Mid-Term Implementation Task Force Report*, September 9, 2009.

5 RTCA, Inc. is a private, not-for-profit corporation (formerly known as the Radio Technical Commission for Aeronautics and now simply "RTCA") that develops consensus-based recommendations regarding communications, navigation, surveillance (CNS), and air traffic management (ATM) system issues. RTCA functions as a federal advisory committee and includes roughly 400 government, industry, and academic organizations from the United States and around the world. Members represent all facets of the aviation community, including government organizations, airlines, airspace users, airport associations, labor unions, and aviation service and equipment suppliers. More information is available at http://www.rtca.org.

6 RTCA Inc., Executive Summary, *NextGen Mid-Term Implementation Task Force Report*, September 9, 2009.

7 Additional information on Performance-Based Navigation (PBN) is provided on the FAA website at https://www.faa.gov/nextgen/how_nextgen_works/new_technology/pbn/ (accessed February 10, 2019).

8 U.S. Department of Transportation, Federal Aviation Administration, *FAA Response to Recommendations of the RTCA NextGen Mid-Term Implementation Task Force*, January 2010, p. 14.

1.2.1 National Airspace System

Under the Federal Aviation Act of 1958 (49 USC § 40101 *et seq.*), the FAA is delegated control over use of the nation's navigable airspace and regulation of domestic civil and military aircraft operations in the interest of maintaining safety and efficiency. To help fulfill this mandate, the FAA established the NAS. Within the NAS, the FAA provides air traffic services for aircraft takeoffs, landings, and the flow of aircraft between airports through a system of infrastructure (e.g., air traffic control facilities), people (e.g., air traffic controllers, maintenance, and support personnel), and technology (e.g., radar, communications equipment, ground-based navigational aids [NAVAIDs],[9] etc.) The NAS is governed by various FAA rules and regulations.

The NAS comprises one of the most complex aviation networks in the world. The FAA continuously reviews the design of all NAS resources to ensure they are effectively and efficiently managed. The FAA Air Traffic Organization (ATO) is the primary organization responsible for managing airspace and flight ATC procedures in the NAS. When changes are proposed to the NAS, the FAA works to ensure that the changes maintain or enhance system safety and improve efficiency. One way to accomplish this mission is to employ air navigation technologies to increase system flexibility and predictability.

1.2.2 Air Traffic Control within the National Airspace System

The combination of infrastructure, people, and technology used to monitor and guide (or direct) aircraft within the NAS is referred to collectively as ATC. One of ATC's responsibilities is to maintain safety and expedite the flow of traffic in the NAS by applying defined minimum distances or altitude between aircraft (referred to as "separation"). This is accomplished through required communications between air traffic controllers and pilots and the use of navigational technologies.

Air traffic controllers and pilots use specific phraseology to refer to various altitudes. Below 18,000 feet above mean sea level (MSL), altitudes are referred numerically in MSL (e.g. 13,000 MSL is spoken "thirteen thousand feet") and referenced by localized altimeter settings. From 18,000 feet MSL and above, altitudes are referred to as flight level (FL)[10] to denote a common altimeter setting. Pilots operate aircraft under two distinct categories of flight rules: Visual Flight Rules (VFR) and Instrument Flight Rules (IFR).[11] Under VFR[12], pilots are responsible to "see and avoid" other aircraft and obstacles such as terrain to maintain safe separation. Under IFR[13], aircraft operators are required to file flight plans and use navigational

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[9] NAVAIDs are facilities that transmit signals that define key points or routes.

[10] Federal Aviation Administration. *Aeronautical Information Manual; Chapter 7, Section 2. Altimeter Setting Procedures*. October 12, 2017.

[11] 14 Code of Federal Regulations (C.F.R.), Part 91.

[12] VFR only available below 18,000 feet MSL unless otherwise approved by air traffic control. See Federal Aviation Administration. *Aeronautical Information Manual; Chapter 3, Airspace*. October 12, 2017.

[13] IFR available at all altitudes below 18,000 feet MSL and required for operation at or above 18,000 feet MSL unless otherwise approved by air traffic control. See Federal Aviation Administration. *Aeronautical Information Manual; Chapter 3, Airspace*. October 12, 2017.

instruments to operate within the NAS. The majority of commercial air traffic operates under IFR.

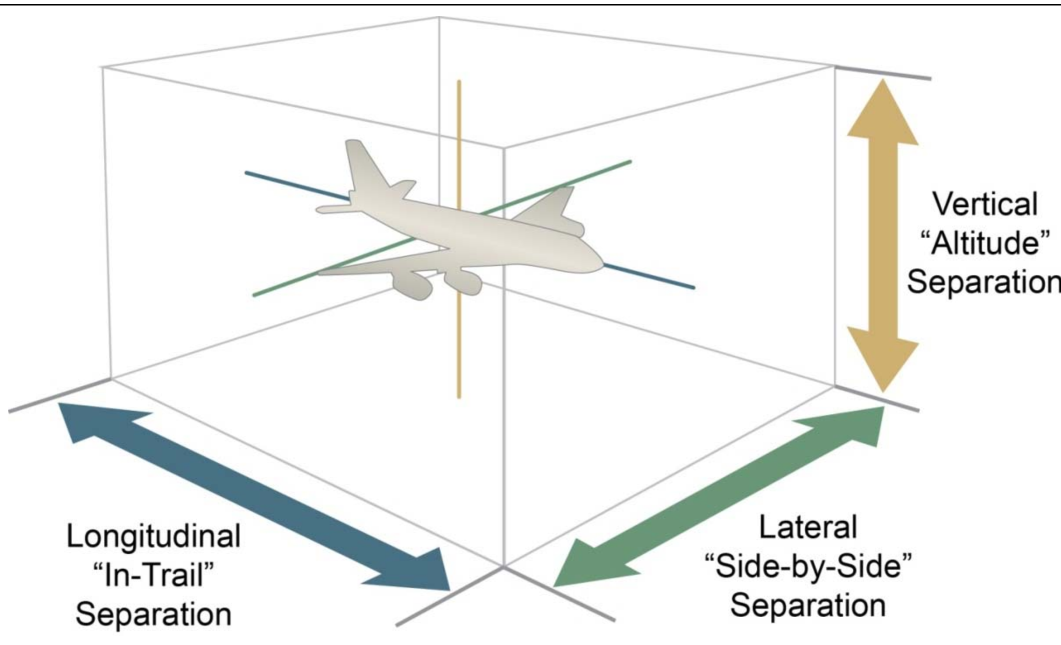
Depending on whether aircraft are operating under IFR or VFR, air traffic controllers apply various techniques to maintain separation between aircraft,[14] including the following:

- **Vertical or "Altitude" Separation:** separation between aircraft operating at different altitudes;
- **Longitudinal or "In-Trail" Separation:** separation between two aircraft operating along the same flight route, referring to the distance between a lead and a following aircraft; and,
- **Lateral or "Side-by-Side" Separation:** separation between aircraft (left or right side) operating along two separate but nearby flight routes.

Exhibit 1-1 depicts the three dimensions around an aircraft used to determine separation.

Air traffic controllers use radar to monitor aircraft and provide services that ensure separation. Published instrument ATC procedures provide predictable, efficient routes that move aircraft through the NAS in a safe and orderly manner. These ATC procedures reduce verbal communication between air traffic controllers and pilots. Published instrument ATC procedures are described as "conventional" ATC procedures when they use ground-based NAVAIDs.

Exhibit 1-1 Three Dimensions Around an Aircraft



Source: ATAC Corporation, December 2012.
Prepared by: ATAC Corporation, January 2019.

In its effort to modernize the NAS, the FAA is developing instrument ATC procedures that use advanced technologies. A primary technology in this effort is RNAV. RNAV uses technology,

[14] Defined in FAA Order JO 7110.65X, *Air Traffic Control*.

including Global Positioning System (GPS), to allow an RNAV-equipped aircraft to fly a more efficient route. This route is based on instrument guidance that references an aircraft's position relative to ground-based NAVAIDs or satellites.

ATC uses a variety of methods and coordination techniques to maintain safety within the NAS, including:

- **Vectors:** Directional headings issued to aircraft to provide navigational guidance and to maintain separation between aircraft and/or obstacles.
- **Speed Control:** Instructions issued to aircraft to reduce or increase aircraft speed to maintain separation between aircraft.
- **Reroute:** Controllers may change an aircraft's route for a variety of reasons, such as avoidance of inclement weather, to maintain separation between aircraft, and/or to protect airspace.
- **Point-out:** Notification issued by one controller when an aircraft might pass through or affects another controller's airspace and radio communications will not be transferred.
- **Holding Pattern/Ground Hold:** Controllers assign aircraft to a holding pattern in the air or hold aircraft on the ground before departure to maintain separation between aircraft and to manage arrival/departure volume.
- **Altitude Assignment/Level-off:** Controllers assign altitudes to maintain separation between aircraft and/or to protect airspace. This may result in aircraft "leveling off" during ascent or descent.

As an aircraft moves from origin to destination, ATC personnel function as a team and transfer control of the aircraft from one controller to the next and from one ATC facility to the next.

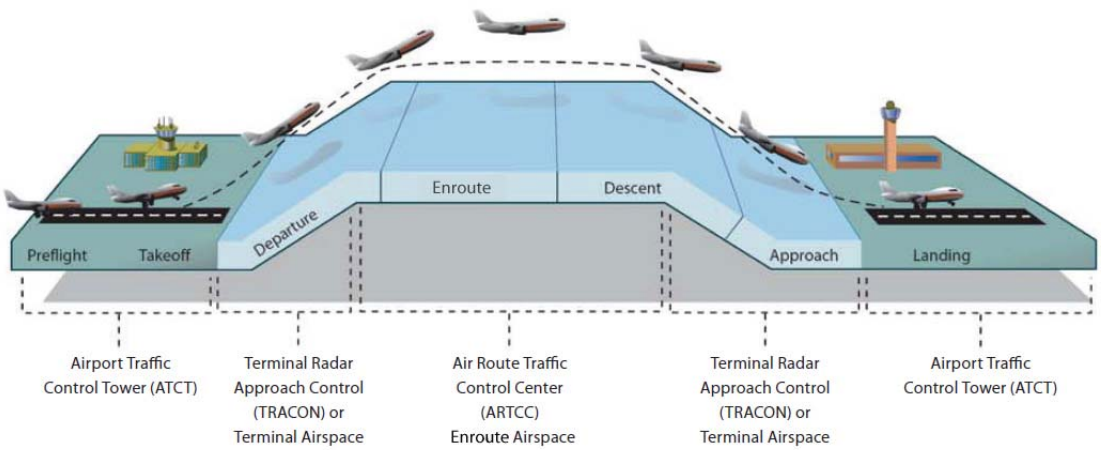
1.2.3 Aircraft Flow within the National Airspace System

An aircraft traveling from airport to airport typically operates through six phases of flight (plus a "preflight" phase.) **Exhibit 1-2** depicts the typical phases of flight for a commercial aircraft. These phases include:

- **Preflight (Flight Planning):** The preflight route planning and flight checks performed in preparation for takeoff.
- **Push Back/Taxi/Takeoff:** The aircraft's transition across the airfield from push-back at the gate, taxiing to an assigned runway, and takeoff from the runway.
- **Departure:** The aircraft's in-flight transition from takeoff to the en route phase of flight, during which it climbs to the assigned cruising altitude.
- **Enroute:** Generally, the level segment of flight (i.e., cruising altitude) between the departure and destination airports.
- **Descent:** The aircraft's in-flight transition from an assigned cruising altitude to the point at which the pilot initiates the approach to a runway at the destination airport.
- **Approach:** The segment of flight during which an aircraft follows a standard ATC procedure that guides the aircraft to the landing runway.

- **Landing:** Touch-down of the aircraft at the destination airport and taxiing from the runway to the gate or parking position.

Exhibit 1-2 Typical Phases of a Commercial Aircraft Flight



Source: U.S. Department of Transportation, Federal Aviation Administration, Houston Area Air Traffic System (HAATS), Airspace Redesign, Final Environmental Assessment, Figure 1.1.1-1, March 2008.

Prepared by: ATAC Corporation, January 2019.

1.2.4 Air Traffic Control Facilities

The NAS is organized into three-dimensional areas of navigable airspace that are defined by a floor, a ceiling, and a lateral boundary. Each is controlled by different types of ATC facilities including:

- **Airport Traffic Control Tower:** Controllers at an Airport Traffic Control Tower (ATCT) located at an airport provide air traffic services for phases of flight associated with aircraft takeoff and landing. The ATCT typically controls airspace extending from the airport to a distance of many miles in all directions. Three of the five airports shown (APA, BJC, DEN) on **Exhibit 1-3** are airport facilities with an ATCT. One airport (FNL) is in the testing phase of a FAA approved Virtual Air Traffic Control Tower installation.[15] The remaining airport (GXY), has neither an ATCT nor any local controller presence.
- **Terminal Radar Approach Control (TRACON):** Controllers at a TRACON provide air traffic service to aircraft as they transition between an airport and the en route phase of flight, and from the en route phase of flight to an airport. This includes the departure, climb, descent, and approach phases of flights. The TRACON airspace is broken down into sectors. As an aircraft moves between sectors, responsibility for it transfers from controller to controller. Controllers maintain separation between aircraft that operate within their sectors. The Primary TRACON facility in the Denver Metroplex is the Denver TRACON (which holds the FAA name code of "D01") located approximately 1.8 statute miles south of the Denver International Airport (DEN) terminal. The terminal airspace in the Denver Metroplex is shown on **Exhibit 1-3**.
- **Air Route Traffic Control Centers (ARTCCs or "Centers"):** Controllers at ARTCCs provide air traffic services during the en route phase of flight. Similar to TRACON airspace, the Center airspace is broken down into sectors. As shown on **Exhibit 1-3**, the Denver Metroplex is comprised of airspace delegated to the Denver ARTCC (ZDV) located in Longmont, Colorado. A small portion of southeastern Colorado airspace is controlled by the Kansas City ARTCC (ZKC), but is beyond the Study Area for this EA.

The following sections discuss how air traffic controllers at these ATC facilities control the phases of flight for aircraft operating under IFR.

1.2.4.1 Departure Flow

As an aircraft operating under IFR, also known as an "IFR aircraft", departs a runway and follows its assigned heading, it moves from the ATCT airspace, through the terminal airspace, and into en route airspace where it proceeds on a specific route to its destination airport.

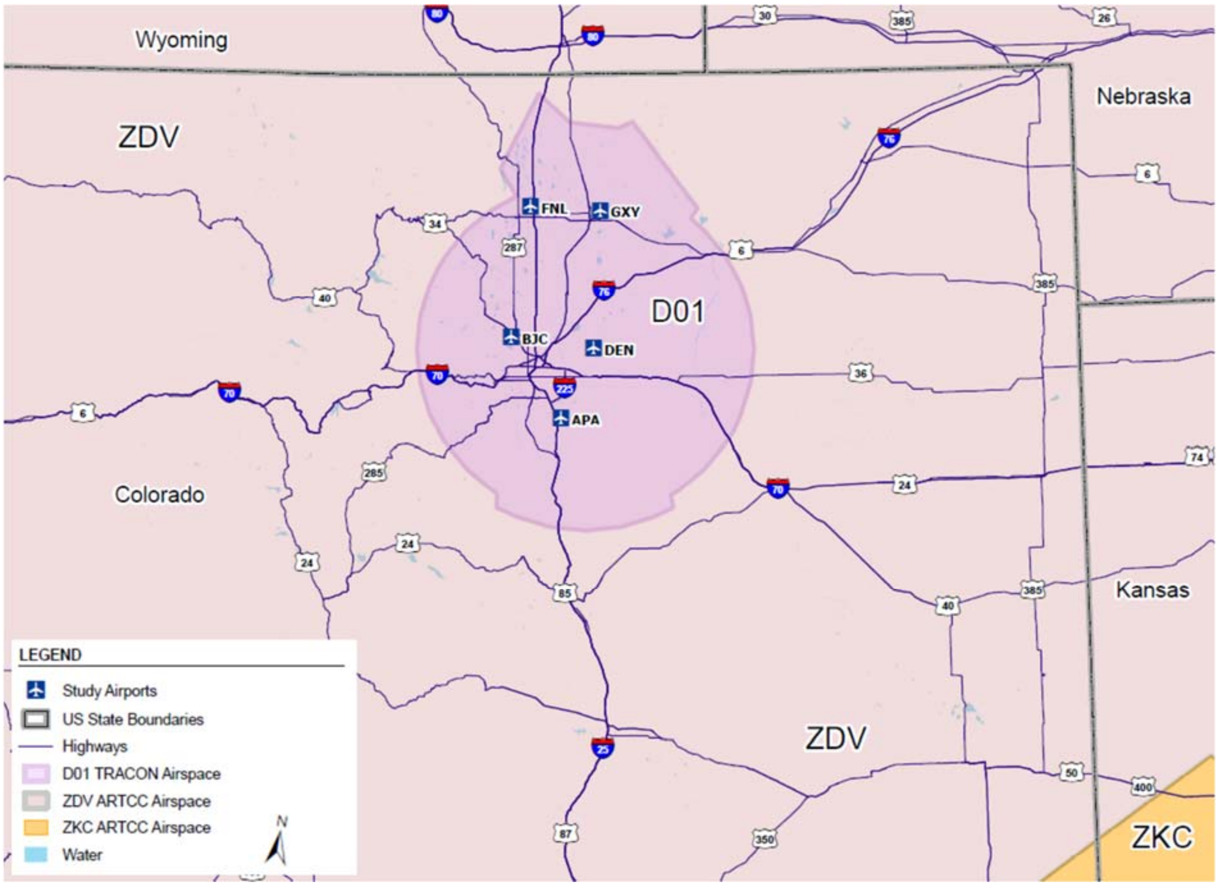
Within the terminal airspace, TRACON controllers provide services to aircraft departing from the ATCT airspace to departure transfer control points referred to as "exit points." An exit point represents an area along the boundary between terminal airspace and en route airspace. Exit points are generally established near commonly used routes to efficiently transfer aircraft between terminal and en route airspace. When aircraft pass through the exit point, control transfers from TRACON to ARTCC controllers as the aircraft joins a specific route.

[15] For more information on the FNL remote tower, see https://www.flynoco.com/faqs/remote-tower-faq/, Accessed February 24, 2019.

Standard Instrument Departures

Departing IFR aircraft use an ATC procedure called a Standard Instrument Departure (SID). A SID provides pilots with defined lateral and vertical guidance to facilitate safe and predictable navigation from an airport through the terminal airspace to a specific route in the en route airspace.

Exhibit 1-3 Airspace in the Denver Metroplex Area



Notes:

FNL – Northern Colorado Regional Airport	*APA – Centennial Airport*	*BJC – Rocky Mountain Metropolitan Airport*	*DEN – Denver International Airport*
GXY – Greeley-Weld County Airport	*D01 – Denver TRACON*	*ZDV – Denver Center (ARTCC)*	*ZKC – Kansas City Center (ARTCC)*

Sources: U.S. Department of Transportation, Federal Aviation Administration, National Flight Data Center, National Airspace System Resources, Airport, and Runway databases, accessed January 2019 (airspace boundaries); National Atlas of the United States of America (U.S. County and State Boundaries, Water Bodies); Bureau of Transportation Statistics, National Transportation Atlas Database (U.S. and Interstate Highways).

Prepared by: ATAC Corporation, February 2019.

A “conventional” SID follows a route defined by ground-based NAVAIDs, may be based on vectoring, or both. Because of the increased precision inherent in RNAV technology, an RNAV SID defines a more predictable route through the airspace than a conventional SID. Some RNAV SIDs may be designed to include paths called “runway transitions” that serve particular runways at airports. Transitions are a series of fixes leading to/from a common route. They serve as the entry and exit points into terminal and en route airspace. A SID may have several runway transitions serving one or more runways at one or more airports. From the runway transition, aircraft may follow a common path before being directed along one or several diverging routes referred to as "en route transitions." Enroute transitions may terminate at exit fixes or continue into en route airspace where aircraft join a specific route.

1.2.4.2 Arrival Flow

An aircraft begins the descent phase of flight within the en route airspace in order to transition to lower altitudes for less restrictive maneuvering and speed reduction. During descent, the aircraft transitions into the terminal airspace through an "entry point," bound for the destination airport. The entry point represents a physical location in the airspace along the boundary between terminal airspace and en route airspace where control of the aircraft transfers from ARTCC to TRACON controllers.

Standard Terminal Arrival Routes

Aircraft that arrive in the terminal airspace normally follow an instrument ATC procedure called a Standard Terminal Arrival Route (STAR). Aircraft leaving en route airspace and entering terminal airspace may follow an en route transition from an entry fix to the STAR's common route in the terminal airspace. From the common route segment, aircraft may follow a runway transition before making an approach to the airport.

1.2.4.3 Required Aircraft Separation

As controllers manage the flow of aircraft into, out of, and within the NAS, they maintain some of the following separation distances between aircraft[16]:

- **Altitude Separation (vertical):** When operating below 41,000 feet above mean sea level (MSL), two aircraft must be at least 1,000 feet above/below each other until or unless lateral separation is ensured.
- **In-Trail Separation (longitudinal):** Within a radar controlled area, the minimum distance between two aircraft on the same route (i.e., in-trail) can be between 2.5 to 10 nautical miles[17], depending on factors such as aircraft class, weight, and type of airspace.
- **Side-by-Side Separation (lateral):** Similar to in-trail separation, the minimum side-by-side separation must be at least three nautical miles between aircraft in terminal airspace and at least five nautical miles in en route airspace.
- **Visual Separation:** Aircraft may be separated by visual means when other approved separation is assured before and after the application of visual separation.

1.2.5 Next Generation Air Transportation System

The NextGen program is the FAA's long-term plan to modernize the NAS from a ground-based system of air traffic control to a GPS-based system of air traffic management that

[16] For a detailed explanation of separation standards, see FAA Order 7110.65X.

[17] A nautical mile is equivalent to 1.15 statute miles, 1,852 meters, or 6,076.118 feet

allows for the development of PBN ATC procedures.[18] The Metroplex initiative is a key step in the overall process of transitioning to the NextGen system. Achieving the NextGen system requires implementing RNAV and RNP PBN ATC procedures, and aircraft "auto-pilot" and Flight Management System (FMS) capabilities.[19] RNAV and RNP capabilities are now readily available and PBN can serve as the primary means aircraft use to navigate along a route. More than 90 percent of U.S. scheduled air carriers are equipped for some level of RNAV. The following sections describe PBN ATC procedures in greater detail.

1.2.5.1 RNAV

Exhibit 1-4 compares conventional, RNAV and RNP routes. RNAV uses technology, including GPS, to allow an RNAV-equipped aircraft to fly a more efficient route. This route is based on instrument guidance that references an aircraft's position relative to ground-based NAVAIDs or satellites. RNAV enables aircraft traveling through terminal and en route airspace to follow more accurate and better-defined routes. This results in more predictable routes and altitudes that can be pre-planned by the pilot and air traffic control. Predictable routes improve the ability to ensure vertical, longitudinal, and lateral separation between aircraft.

Routes based on ground-based NAVAIDs rely on the aircraft equipment directly communicating with the NAVAID radio signal and are often limited by issues such as line-of-sight and signal reception accuracy. NAVAIDs such as Very High Frequency (VHF) Omnidirectional Ranges (collectively VORs) are affected by variable terrain and other obstructions that can limit their signal accuracy. Consequently, a route that is dependent upon ground-based NAVAIDS requires at least six nautical mile of clearance on either side of its main path to ensure accurate signal reception. As demonstrated by the dashed lines on **Exhibit 1-4**, this clearance requirement increases the farther an aircraft is from the VOR. In comparison, RNAV signal accuracy requires only two nautical miles of clearance on either side of a route's main path.

RNAV routes can mirror conventional routes or, by using satellite technology, provide paths within the airspace that were not previously possible with ground-based NAVAIDs.

1.2.5.2 RNP

RNP is an RNAV ATC procedure with signal accuracy that is increased through the use of onboard performance monitoring and alerting systems. An RNP is an RNAV ATC procedure that requires greater accuracy of on-board performance monitoring and alerting equipment, as well as special pilot training. A defining characteristic of an RNP operation is the ability for an RNP-capable aircraft navigation system to monitor the accuracy of its navigation (based on the number of GPS satellite signals available to pinpoint the aircraft location) and inform the crew if the required data becomes unavailable.

Exhibit 1-4 compares conventional, RNAV, and RNP ATC procedures. It shows how an RNP-capable aircraft navigation system provides a more accurate and seamless horizontal and vertical location (down to less than one nautical mile from the intended path) and will follow a highly predictable path. The enhanced accuracy and predictability makes it possible to

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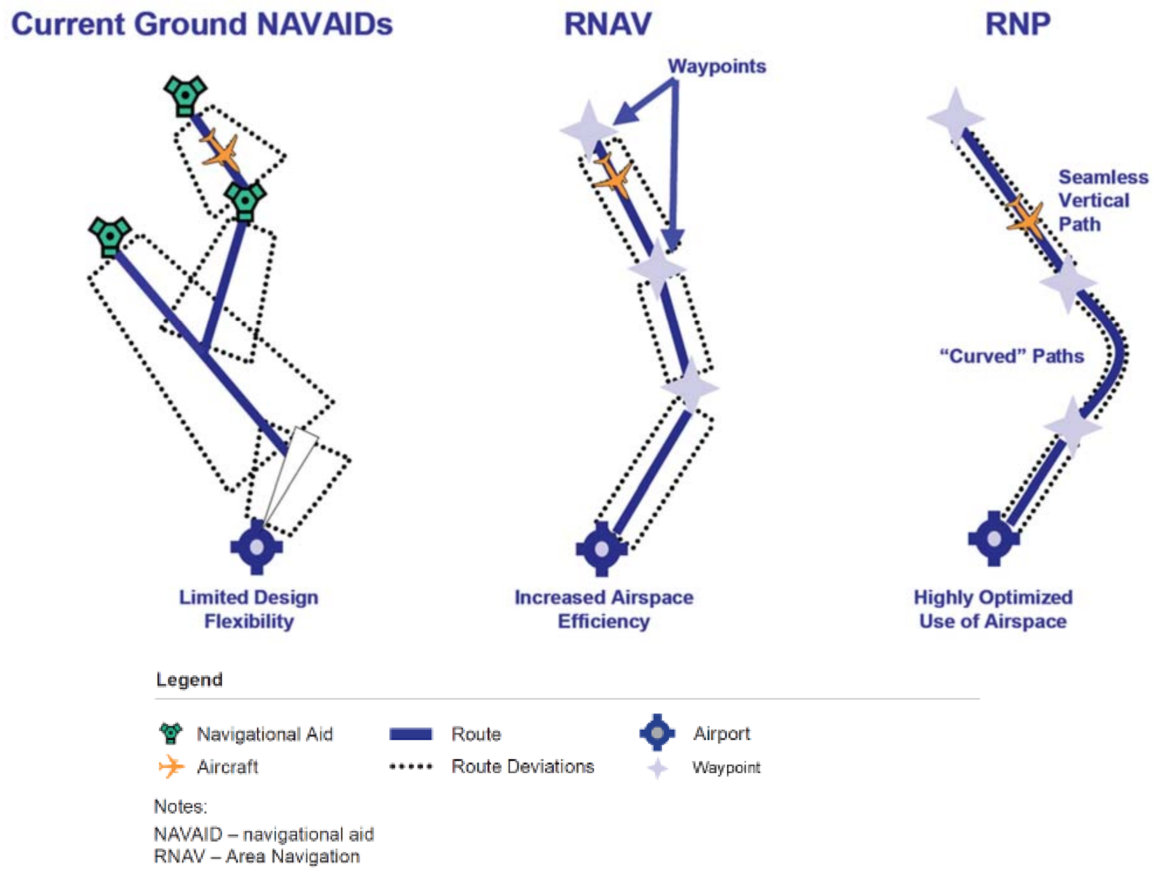
[18] U.S. Department of Transportation, Federal Aviation Administration, https://www.faa.gov/nextgen/how_nextgen_works/nextgen_in_action/ (accessed January 4, 2019).

[19] A Flight Management System (FMS) is an onboard computer that uses inputs from various sensors (e.g., GPS and inertial navigation systems) to determine the geographic position of an aircraft and help guide it along its flight path.

implement ATC procedures within controlled airspace that are not always possible under the current air traffic system.

Exhibit 1-4 Navigational Comparison – Conventional/RNAV/RNP



Source: U.S. Department of Transportation, Federal Aviation Administration, "Performance-Based (PBN) Brochure," October 2009.
Prepared by: ATAC Corporation, January 2019.

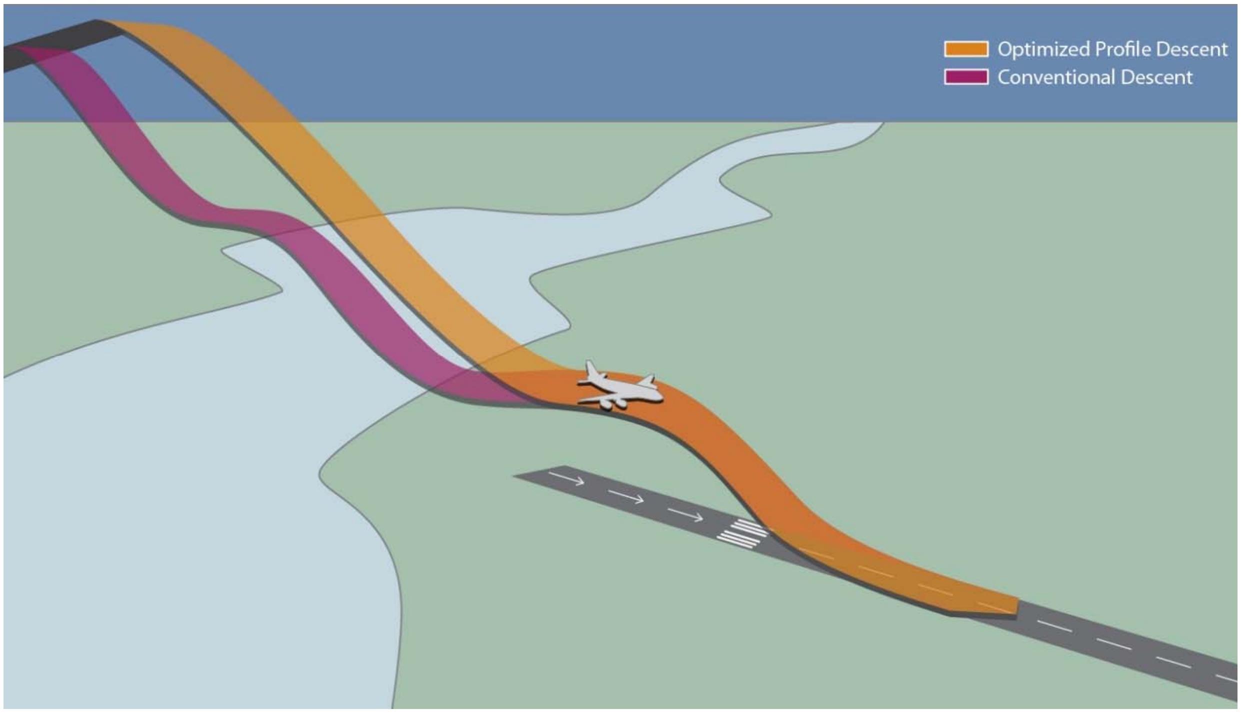
1.2.5.3 Optimized Profile Descent

An Optimized Profile Descent (OPD) is an ATC procedure that allows an aircraft using FMS to fly continuously from the top of descent to landing with minimal level-off segments. **Exhibit 1-5** illustrates an OPD ATC procedure compared to a conventional descent. Aircraft that fly OPDs can maintain higher altitudes and lower thrust for longer periods. As level-off segments are minimized, OPDs reduce the need for communications between controllers and pilots.

1.2.6 The Metroplex Initiative

As part of the Metroplex initiative, the FAA is designing and implementing RNAV ATC procedures that take advantage of the technology available in a majority of commercial service aircraft. The Metroplex initiative specifically addresses congestion, airports in close geographical proximity, and other limiting factors that reduce efficiency in busy metroplex airspace. Efficiency is improved by implementing more RNAV-based standard instrument ATC procedures and connecting the routes defined by the standard instrument ATC procedures to high- and low-altitude RNAV routes. Efficiency is further improved by using RNAV to optimize the use of the limited airspace in congested metroplex environments.

Exhibit 1-5 Optimized Profile Descent Compared to a Conventional Descent



Source: ATAC Corporation, December 2012.
Prepared by: ATAC Corporation, January 2019.

1.3 The Denver Metroplex

The following sections describe the airspace structure and existing standard instrument ATC procedures of the Denver Metroplex that would be affected by the DEN Metroplex Project.

1.3.1 2012 FAA RNAV and RNP Procedures Project

The Denver region was previously an FAA project site for RNAV procedure implementation.[20] The proposed routes and procedures were designed by the FAA to improve the safety and efficiency of the Denver airspace and respond to the growing need for efficiency as the airport operations in the Denver airspace increased. The 2012 FAA RNAV and RNP ATC procedures project was not part of the Metroplex initiative within FAA, but was focused on similar Purpose and Need criteria while adopting a smaller geographic scope.

Following an ATC procedure design process and an Environmental Assessment, the FAA implemented 16 RNAV Directional STARs in late 2012, 16 SIDs in early 2013, and RNP/RNP-AR approaches into DEN in late 2013.

Following implementation and operation of ATC procedures designed under this effort, the FAA found that a number of features were hindering the best use and application of RNAV

[20] Department of Transportation, Federal Aviation Administration. *FAA RNAV and RNP Procedures at Denver International Airport, Centennial Airport and Rocky Mountain Metropolitan Airport Environmental Assessment.* August 2012.

procedures in the Denver airspace. These items were generally found to be: procedure complexity; more procedures than needed; more waypoints than needed; more STAR changes enroute than needed; an increased workload for ZDV controllers and pilots of IFR aircraft; excessive track miles to join new STARs; lateral path deviations on SIDs as the result of errant Lateral Navigation instrument[21] engagements; and that the DEN and surrounding satellite airport ATC procedures were not segregated, resulting in a diverse mixture of air carrier and general aviation air traffic. These issues formed the underlying basis for the application of evolving and newer air traffic management strategies, methods, and

1.3.2 Denver Metroplex Airspace

Exhibit 1-3 (prior) depicts the airspace structure in the Denver Metroplex. The Denver Metroplex consists of airspace delegated to Denver ARTCC (ZDV) and Denver TRACON. ZDV provides Air Traffic Services for 285,000 square miles of en route airspace covering portions of nine states including Colorado, Arizona, New Mexico, Utah, Kansas, Nebraska, South Dakota, Wyoming, and Montana. It abuts Minneapolis (ZMP), Salt Lake City (ZLC), Los Angeles (ZLA), Albuquerque (ZAB), and Kansas City (ZKC) ARTCCs in the US. ZDV is responsible for all private and commercial aircraft landing, departing and traversing inside its lateral boundaries when they are operating under Instrument Flight Rules (IFR) and offers select services to aircraft operating under Visual Flight Rules (VFR). ZDV provides air traffic control service to United States, foreign, and military aircraft operating both IFR and VFR in ZDV airspace. ZDV controllers provide air traffic services in the airspace above and adjacent to the Denver TRACON airspace for facilities noted previously in **Exhibit 1-3**.

Denver TRACON controllers provide air traffic services for terminal airspace from the surface to as high as 23,000 feet MSL, covering 45 square miles of airspace around DEN.[22] The lateral boundaries of the Denver TRACON airspace are surrounded and capped by ZDV ARTCC airspace and extend from the Wyoming border to the Larkspur, Colorado area on a north-south basis and from the Leader, Colorado area to the Empire, Colorado area on an east-west basis.

The Denver TRACON is the final radar facility responsible for separating and sequencing aircraft that are landing at and departing from airports in its airspace. This includes the initial sequencing of DEN departures as well as providing safe and expeditious flows of traffic into and out of six other FAA and contract tower controlled airports (including Pueblo and Grand Junction) and seven public/municipal airports. The Denver TRACON facility provides air traffic control services to IFR-filed aircraft and, when requested or required, VFR aircraft. As with ZDV, the noted TRACON facility also offer these services to military aircraft that are operating in its airspace.

[21] Lateral Navigation (LNAV) approaches are non-precision approaches that provide lateral guidance to aircraft through instrumentation.

[22] The Denver area contains one local approach control facility along with airport traffic control towers located at numerous airports. The responsibilities for airspace in these facilities are generally more localized to individual airports. Additionally one military facility provides air traffic control into and out of a United States Air Force airfield.

1.3.3 Denver Metroplex Airspace Constraints

The following provide a general overview of the constraints related to controlling aircraft within the Denver Metroplex area airspace.

1.3.3.1 Class B Airspace

Class B airspace is regulatory airspace, generally located around and over major airports with operating control towers and TRACON facilities, such as DEN. The rules for flying inside of Class B airspace are more restrictive to pilots and aircraft types than for other classes of airspace. The Class B aircraft equipment and pilot operation rules include but are not limited to the following:[23]

- All aircraft are subject to air traffic clearances to arrive or depart from airports within the Class B limits and/or to enter Class B airspace;
- Aircraft must be equipped with an active transponder beacon that has Mode C (altitude reporting) capability within an identified airspace block generally referred to as a Mode C veil;
- Aircraft operating under VFR, IFR and Special VFR are radar separated;
- Student certificated pilots must have ground and flight instruction with an instructor signoff to operate in specific Class B airspace. A minimum of a private pilot certificate is necessary to land or depart certain airports; and
- Pilots are not to exceed 250 knots unless directed by ATC and to declare "unable" when the aircraft is unable to meet ATC speed requirements.

These rules make for a safer and more orderly flow of traffic within Class B airspace. Class B airspace design has a direct impact on the flow of traffic within the Denver Metroplex area.

Due to Class B airspace design, ZDV delivers arrival flow traffic to TRACON airspace via multiple arrival flows with sequenced aircraft. The multiple arrival flows generally operate in a four corner-post system. The four corner-posts reflect cardinal compass headings for departure flows, and the inter-cardinal compass headings (e.g. northeast, southeast, etc.) for arrival flows. The transfer of control points, where control transfers from the ZDV to the Denver TRACON, are generally located at or near the common lateral boundary of each facility's airspace.

1.3.3.2 Denver Metroplex Special Use Airspace

Exhibit 1-6 depicts the boundaries of Special Use Airspace (SUA)[24] in the Denver Metroplex illustrating the limited available options for entering and exiting the Denver Metroplex airspace. SUA is airspace with defined vertical and lateral boundaries in which certain activities such as military flight training and air-to-ground military exercises must be confined. These areas either restrict other aircraft from entering or limit aircraft activity allowed within the airspace. Four types of SUA are found within the Denver Metroplex:

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[23] FAR 61.95 *Operations in Class B airspace and at airports located within Class B airspace*; FAR 91.131 *Operations in Class B airspace*; FAR 91.117 *Aircraft speed.*

[24] Department of Transportation, Federal Aviation Administration. Joint Order 7400.2M *Procedures for Handling Airspace Matters*, Part 5: Special Use Airspace. February 28, 2019.

- **Alert Areas:** A An alert area is airspace wherein a high volume of pilot training or an unusual type of aeronautical activity is conducted. Alert areas are designated to inform nonparticipating pilots of areas that contain a high volume of pilot training operations, or an unusual type of aeronautical activity, that they might not otherwise expect to encounter. Pilots are advised to be particularly alert when flying in these areas.
- **Restricted Area:** A restricted area is airspace within which the flight of aircraft, while not wholly prohibited, is subject to restriction. Restricted areas are established when determined necessary to confine or segregate activities considered hazardous to nonparticipating aircraft.
- **National Security Area:** A National Security Area (NSA) consists of airspace of defined vertical and lateral dimensions established at locations where there is a requirement for increased security of ground facilities. Pilots are requested to voluntarily avoid flying through an NSA. When it is necessary to provide a greater level of security, flight in an NSA may be temporarily prohibited.
- **Military Operations Area:** A military operations area (MOA) is airspace designated outside of Class A airspace, to separate or segregate certain nonhazardous military activities from IFR traffic and to identify for VFR traffic where these activities are conducted. MOAs are designated to contain nonhazardous, military flight activities including, but not limited to, air combat maneuvers, air intercepts, low altitude tactics, etc.

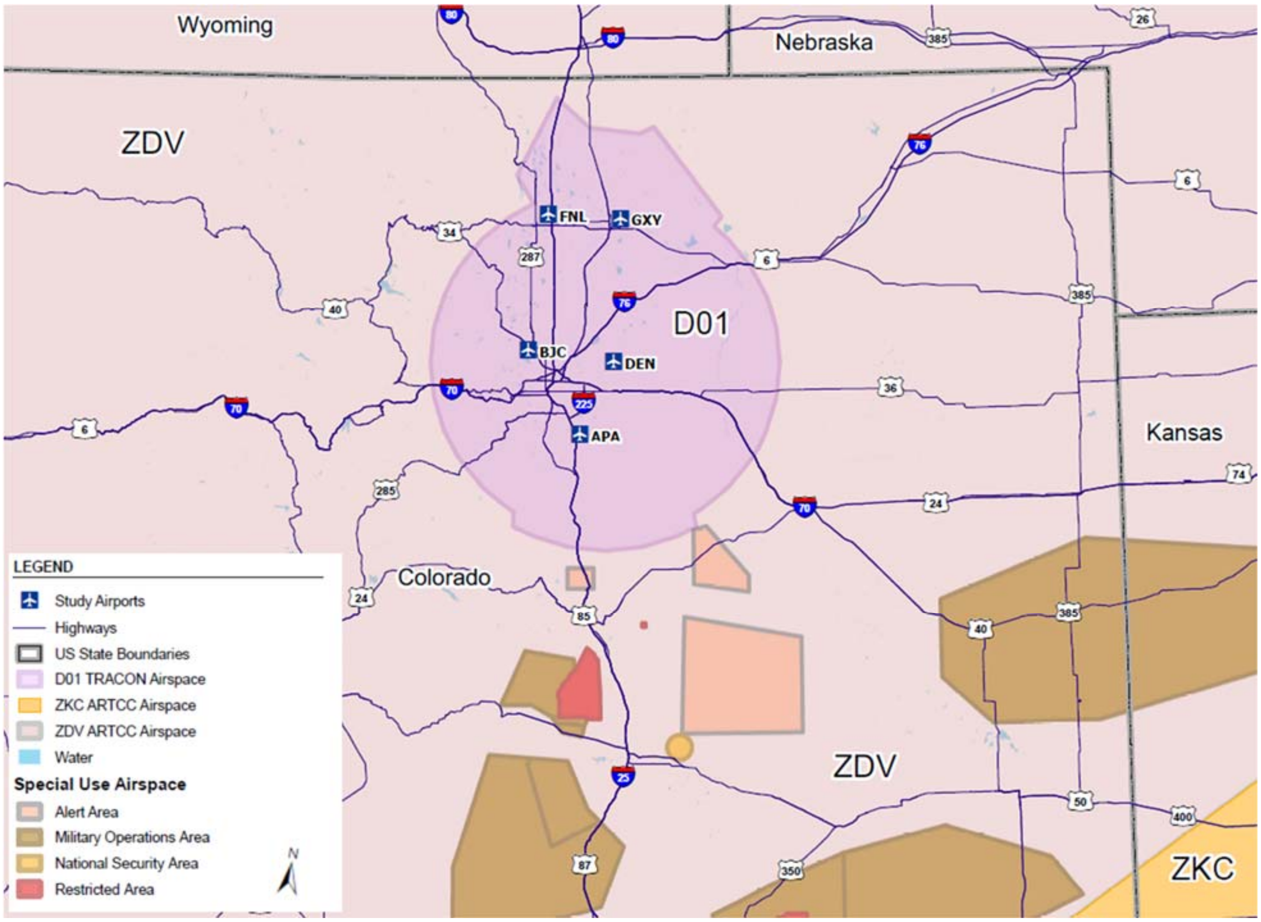
ZDV has 18,505 square miles of special use airspace (SUA), representing 6.9 percent of its total coverage area. ZDV is required to ensure that civilian and military aircraft (not under the authority of the United States Armed Forces)[25] are routed within the remaining 248,068 square miles of airspace.

Due to the location and altitudes SUAs occupy in the ZDV and Denver TRACON control area, there are choke points for departures from the Denver area. This is caused by the funneling of traffic into corridors that are unaffected by airspace restrictions or SUAs.

One such constraint is the need to depart Denver area traffic to the south and southeast while avoiding the Cougar (east) and Two Buttes (south) Military Operations Area (MOA) airspaces. These south and southeast departure routes require additional separation attention for commercial aircraft to be redirected away from, around, or above the proposed and existing MOAs.

[25] Aircraft under the direct control of the military air traffic control facilities are confined to Special Use Areas (SUAs) or departure and arrival patterns near military airfields. These SUAs are specific areas of airspace that are used by military aircraft and are provided air traffic control services by the military. The United States Military branches are specifically charged with management of that airspace when active.

Exhibit 1-6 Special Use Airspace



Notes:

FNL – Northern Colorado Regional Airport	*APA – Centennial Airport*	*BJC – Rocky Mountain Metropolitan Airport*	*DEN – Denver International Airport*
GXY – Greeley-Weld County Airport	*D01 – Denver TRACON*	*ZDV – Denver Center (ARTCC)*	*ZKC – Kansas City Center (ARTCC)*

Sources: U.S. Department of Transportation, Federal Aviation Administration, National Flight Data Center, National Airspace System Resources, Airport, and Runway databases, accessed January 2019 (airspace boundaries); National Atlas of the United States of America (U.S. County and State Boundaries, Water Bodies); Bureau of Transportation Statistics, National Transportation Atlas Database (U.S. and Interstate Highways).

Prepared by: ATAC Corporation, February 2019.

1.3.4 STARs and SIDs Serving Study Airports

As of June 2018, 47 total arrival and departure ATC procedures included 20 published SIDs and 27 STARs serving the Study Airports identified in Section 1.4 within the Denver Metroplex. Of these, 13 are conventional ATC procedures.

1.4 Denver Metroplex Project Study Airports

Exhibit 1-7 shows the locations of the five DEN Metroplex Project Study Airports. The Study Airports were selected based on specific FAA criteria: each airport must have a minimum of 700 annual IFR-filed jet operations or 90,000 or more annual propeller aircraft operations. Airports that did not meet these thresholds were not included as Study Airports because the Proposed Action would result in little or no change to their operations. In addition, airports where the majority of traffic operates under VFR were also excluded from selection as Study Airports because they are not expected to be affected by the Proposed Action. VFR aircraft operating outside controlled airspace are not required to be in contact with ATC. Because these aircraft operate at the discretion of the pilot on a "see and be seen" basis and are not required to file flight plans, FAA generally has very limited information for these operations.

Of the five airports included in the DEN Metroplex Project, the Study Team identified DEN as the Major Study Airport and is the primary focus of the project. DEN is located approximately 25 miles northeast of downtown Denver and is classified as a large hub[26] commercial service airport in the 2019-2023 National Plan of Integrated Airport Systems (NPIAS). DEN has six runways, described in **Table 1-1**. As of June 6, 2018, DEN IFR arrivals may be assigned one of 8 conventional STARs or 16 RNAV STARs. Departing IFR aircraft may be assigned one of 5 conventional SIDs or 15 RNAV SIDs.

Table 1-1 Denver Metroplex Project Major Study Airport

Airport Name	Airport Code	Location	Runways[1/]
Denver International Airport	DEN	Denver, CO	7, 8, 16L, 16R, 17L, 17R, 25, 26, 34L, 34R 35L, 35R

Notes:
1/ A runway can be used in both directions, but are named in each direction separately. Runway number is based on the magnetic direction of the runway, divided by 10 and rounded to the nearest 10 (e.g., Runway 09 points to the compass heading 90 degrees, which is east). The two numbers on either side always differ by 180 degrees. If there is more than one runway pointing in the same direction, each runway number includes an 'L', 'C' or 'R' at the end. This is based on which side a runway is next to another one in the same direction.

Source: Department of Transportation, Federal Aviation Administration. digital-Airport/Facility Directory. January 3, 2019 – February 28, 2019 (http://www.faa.gov/air_traffic/flight_info/aeronav/digital_products/dafd/ January 4, 2019).
Prepared by: ATAC Corporation, January 2019.

As shown in **Table 1-2**, in 2017, approximately 63 percent of all IFR traffic (itinerant[27] and overflight) within the Denver Metroplex operated at the Study Airports for which FAA data was

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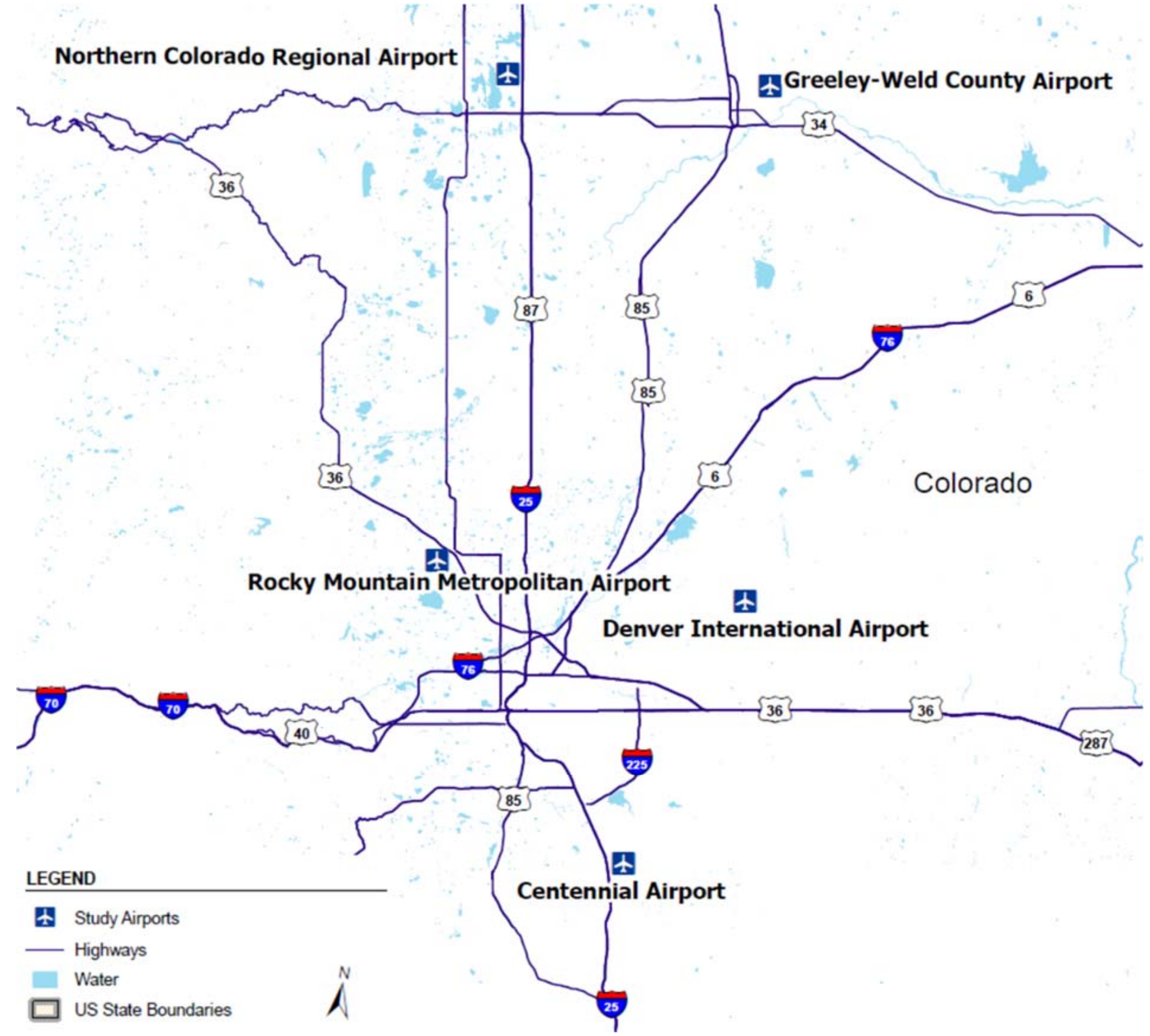
[26] FAA classifies airports in primary and non-primary categories. Within the primary category are small, medium, and large hub airports. Large hubs are those airports that each account for one percent or more of total U.S. passenger enplanements. See the FAA's most current *National Plan of Integrated Airport Systems (NPIAS)* for a complete discussion of airport categories at https://www.faa.gov/airports/planning_capacity/npias/reports/.

[27] Airport Operations are the number of arrivals and departures from the airport at which the airport traffic control tower is located. There are two types of airport operations: local and itinerant. 1.) Local operations are those operations performed by aircraft that remain in the local traffic pattern, execute simulated instrument approaches or low passes at the airport, and the operations to or from the airport and a designated practice area within a 20−mile radius of the tower. 2.) Itinerant operations are operations performed by an aircraft, either IFR, SVFR, or VFR, that lands at an airport, arriving from outside the airport area, or departs an airport and leaves the airport area. Found at https://aspmhelp.faa.gov/index.php/Glossary. Accessed March 2019.

available. This data tracks total operations at FNL (94,896) and GXY (122,500),[28] but not IFR operations due to the lack of an ATCT and associated personnel to track the data.

Exhibit 1-7 Study Airport Locations



Sources:	National Atlas of the United States of America (U.S. County and State Boundaries, Water Bodies); Bureau of Transportation Statistics, National Transportation Atlas Database (U.S. and Interstate Highways); EA Study Airports.
Prepared by:	ATAC Corporation, February 2019.

28 Department of Transportation, Federal Aviation Administration. GXY and FNL *Airport Master Record (FAA Form 5010)* for the period Jan 1, 2017 to December 31, 2017.

Table 1-2 Distribution of 2017 IFR Traffic under FAA Control Among EA Study Airports

Airport	IFR Operations	Percent of Total Airport Operations
Denver International Airport (DEN)	581,443	99%
Centennial Airport (APA)	70,677	21%
Northern Colorado Regional Airport (FNL)*	N/A	N/A
Greeley-Weld County Airport (GXY)	N/A	N/A
Rocky Mountain Metropolitan Airport (BJC)	21,211	13%
Total IFR Operations	673,331	63%

**Note: FNL is a remote tower testbed that is not reporting formal FAA IFR operations. More information about the remote tower program can be found at https://www.codot.gov/programs/remote-tower*

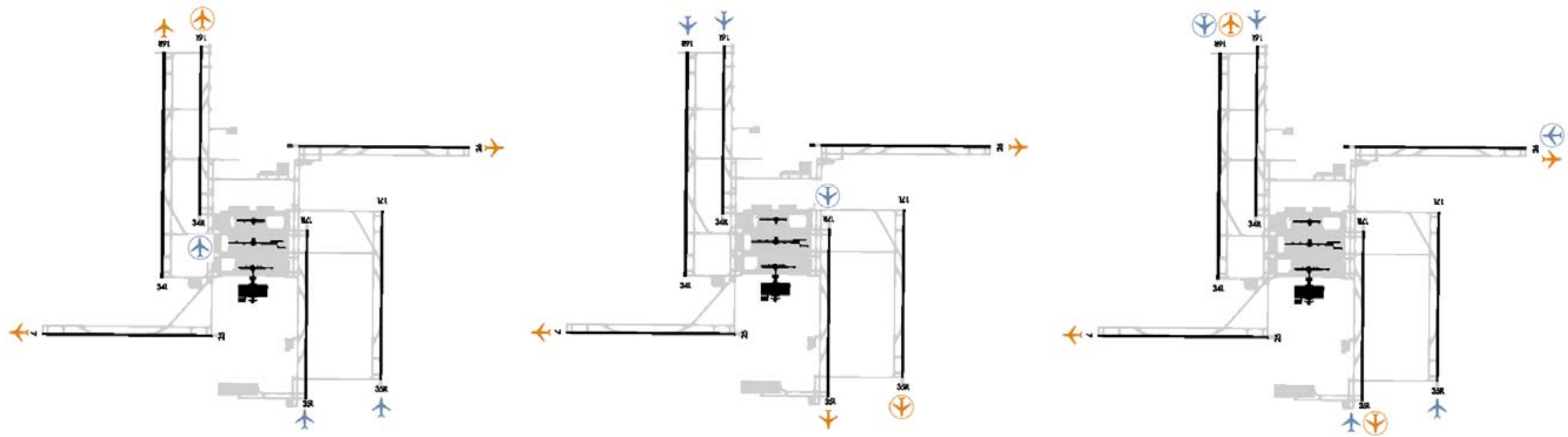
Source: Department of Transportation, Federal Aviation Administration. Operations Network: Tower Counts for DEN, (https://aspm.faa.gov/opsnet/sys/Tower.asp; accessed February 15, 2019).
Prepared by: ATAC Corporation, February 2019.

1.4.1 DEN Runway Operating Configurations

As a Major Study Airport, DEN often operates under several different runway configurations[29] depending on factors such as weather, prevailing wind, and air traffic conditions. As a result, it is possible for the runway ends used for arrivals and departures to change several times throughout a day. Controllers at these airports use different runway operating configurations. **Exhibit 1-8** illustrates the primary runway operating configurations at DEN.

[29] *Runway configuration* is the arrival and departure of aircraft associated with a specified compass direction. Example: A runway oriented north/south has two operational configurations: north and south. In a north runway configuration, aircraft approach the runway from the south landing to the north and aircraft depart from the south end of the runway heading north.

Exhibit 1-8 DEN Runway Operating Configurations



Runways 34R, 35L, 35R | 8, 25, 34L, 34R
Operating Configuration – North
Arrivals 40.7.X% Departures 42.2%

Runways 16L, 16R, 17R | 8, 17L, 17R, 25
Operating Configuration – South
Arrivals 42.9% Departures 43.9%

Runways 16L, 16R, 26, 35L, 35R | 8, 17R, 25, 34L
Operating Configuration – Combined
Arrivals 16.4% Departures 13.8%

Source: U.S. Department of Transportation, Federal Aviation Administration, Airport Diagrams [http://www.faa.gov/airports/runway_safety/diagrams/ (accessed January 2019)]; FAA ASPM (retrieved June 2017).
Prepared By: ATAC Corporation, January 2019.

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