

3 Alternatives

The Alternatives analysis was conducted pursuant to Council on Environmental Quality (CEQ) regulations (40 Code of Federal Regulations, parts 1500-1508); and Federal Aviation Administration (FAA) guidance provided in FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures* (FAA Order 1050.1F). This chapter discusses the following topics:

- Alternative Development Process
- Alternatives Overview
- Comparison of Alternatives

The technical terms and concepts discussed in this chapter are explained in Chapter 1, *Introduction*. Footnotes are added to clarify additional technical terms.

3.1 Alternative Development Process

At the earliest phase of design, the Air Traffic Control (ATC) procedures were conceptual in nature and served as broad outlines of function and form for further development. A subsequent phase of robust design and refinement is referred to in this document as a preliminary ATC procedure. Once a preliminary ATC procedure design was completed, those procedures are referred to as Proposed Final Designs (PFDs) and are carried forward for this environmental analysis.

Developing alternatives for the Denver (DEN) Metroplex Project began with the formation of the DEN Metroplex Study Team (Study Team). In a Final Report (**Appendix F**) issued in November of 2014, the Study Team defined operational issues in the DEN Metroplex and recommended conceptual ATC procedure designs that would address these issues.³⁵ The recommended conceptual ATC procedures were then given to the DEN Metroplex Design and Implementation (D&I) Team. The D&I Team designed preliminary ATC procedures based on the Study Team's conceptual recommendations. Each preliminary ATC procedure that the D&I Team designed had to meet several design criteria as well as the project Purpose and Need. As discussed in Chapter 2, the purpose of and need for the Proposed Action is to address existing inefficiencies with DEN Metroplex Standard Instrument Departure (SID) and Standard Terminal Arrival Route (STAR) ATC procedures. The FAA rejected individual preliminary ATC procedures if they did not meet the Purpose and Need.

The Proposed Action that this Environmental Assessment (EA) evaluates is a combined package of interrelated PFD ATC procedures. This group of PFD ATC procedures were considered and evaluated in combination with one another to determine whether the Proposed Action ATC procedures would meet the project's Purpose and Need. The FAA considered multiple versions of each preliminary ATC procedure prior to adopting a PFD. Several versions of preliminary ATC procedures were eliminated from further consideration because they failed to meet the project's Purpose and Need.

The following sections describe the Alternative development process the FAA used to create and evaluate a series of preliminary ATC procedures that, when employed together as PFDs, would add efficiency to the DEN Metroplex airspace.

³⁵ Denver Metroplex Study Team, *Denver Metroplex Study Team Final Report*, November 2014.

3.1.1 DEN Metroplex Study Team

In November 2014, the DEN Metroplex Study Team began work to define operational problems in the DEN Metroplex and identify potential solutions. The Study Team included experts on the ATC system for the DEN Metroplex. The Study Team's work was completed following a process that included identifying and characterizing existing issues, proposing conceptual ATC procedure designs and airspace changes to address these issues, and identifying the expected benefits and risks of the conceptual designs.

The Study Team held a series of outreach meetings with local ATC, pilots, airport representatives, and aviation industry representatives to learn more about the challenges of operating in the DEN Metroplex. These meetings helped identify operational challenges associated with existing ATC procedures and potential solutions that would increase efficiency in the DEN Metroplex airspace. The Study Team identified several performance-based navigation (PBN) solutions that were expected to improve efficiency in the DEN Metroplex airspace. The PBN ATC procedure modifications proposed were conceptual in nature, and did not include a detailed technical assessment to evaluate the feasibility of the ATC procedures, which was reserved for the D&I Team to conduct.³⁶

3.1.2 DEN Metroplex Design and Implementation Team

After the Study Team completed its Final Report in November 2014, the D&I Team began work on the preliminary ATC procedure designs. The D&I Team consisted of participants from FAA ATC facilities, the National Air Traffic Controllers Association (NATCA), ATC subject matter experts (SMEs), aviation industry representatives, representatives from the FAA's Western Service Center and other FAA lines of business, and various support contractors. The first step in the D&I Team process was to prioritize the conceptual Study Team proposals based on complexity, interdependencies with other ATC procedures, and the degree of potential quantitative and qualitative benefits. The D&I Team then divided into workgroups to further develop and refine the conceptual Study Team ATC procedure proposals into preliminary ATC procedure designs. Finally, the preliminary ATC procedure designs were brought to the complete D&I Team for review and, if necessary, modification. Following completion of the preliminary ATC procedure designs, the D&I Team engaged the public (i.e., local residents, the general public, and stakeholders) by holding a series of informational meetings on the DEN Metroplex Project. Feedback received during the community involvement process was considered and incorporated in the ATC procedure PFDs, as appropriate. In developing the ATC procedure PFDs, the D&I Team was responsible for following regulatory and technical guidance as well as meeting criteria and standards in three general categories:

1. **Area Navigation (RNAV) Design Criteria and Air Traffic Control Regulatory Requirements** – The below FAA Orders collectively define the majority of processes, procedures, and methods for PBN flight procedure design, amendment, and implementation. Requirements governing air traffic control procedures, air traffic management, and appropriate technical terminology are additionally considered as integral process components.

³⁶ *Id.* (In this document "*Id.*" is an abbreviation of the Latin term *ibidem*, meaning "in the same place" and always refers to the immediately preceding cited authority, either in the same footnote or the previous footnote.)

- FAA Order 8260.58A, *United States Standard for Performance Based Navigation (PBN) Instrument Procedure Design*;
 - FAA Order 8260.43B, *Flight Procedures Management Program*;
 - FAA Joint Order 7110.65X, *Air Traffic Control*;
 - FAA Order 8260.3D, *United States Standards for Terminal Instrument Procedures (TERPS)*;
 - FAA Order 7100.41A, *Performance Based Navigation Implementation Process and The Guidelines and Updates for Implementing Terminal RNAV Procedures*;
 - FAA Order 8260.19H, *Flight Procedures and Airspace*; and
 - FAA Order 8260.46F, *Departure Procedure (DP) Program*.
2. **Operational Criteria** – Operational criteria needed to be consistent with the Purpose and Need for the DEN Metroplex Project. This includes increasing airspace efficiency and flexibility, and decreasing complexity in air traffic management. These criteria were measured for all preliminary ATC procedures using a full-motion simulator, a stationary simulator, and/or flight training devices. These criteria were also measured for many preliminary ATC procedures using real time Human-In-The-Loop simulations (HITLs).³⁷ These simulations further validated that operations in the DEN Metroplex would not be limited by the preliminary ATC procedures. The D&I Team also evaluated each of the preliminary ATC procedure designs with full-motion aircraft simulators. The simulations helped ensure that aircraft could fly the preliminary ATC procedure without any negative effects on airspace efficiency (e.g., pilot workload).
3. **Safety Factors** – Proposed changes were evaluated using the FAA’s Air Traffic Organization (ATO) Safety Management System (SMS).³⁸ The SMS is the system for assessing and managing the safety of ATC and navigation services in the National Airspace System (NAS). If a proposed change introduced a new hazard or increased the severity and/or likelihood of an existing hazard, the preliminary ATC procedure design was adjusted or mitigated to reduce the hazard to acceptable levels. In compliance with SMS requirements, the proposed changes were evaluated by a Safety Risk Management Panel (SRMP) following a five-step process: (1) system analysis, (2) identify hazards, (3) analyze safety risk, (4) assess safety risk, and (5) control safety risk.³⁹

³⁷ A HITL simulation is conducted to evaluate the feasibility of PFDs. Prior to HITL simulation activities, industry partners used flight simulators to evaluate the PFDs. The HITL simulation creates an interactive environment similar to the operational areas of terminal and en route facilities for controllers to evaluate interactions among procedures and assess their workability.

³⁸ U.S. Department of Transportation, Federal Aviation Administration, Order JO 1000.37A, *Air Traffic Organization Safety Management System*, May 30, 2014.

³⁹ U.S. Department of Transportation, Federal Aviation Administration, Order 8040.4B, *Safety Risk Management Policy*, May 02, 2017.

3.1.2.1 D&I Team Community Involvement

Throughout the post-Study Team recommendations, and in the period spanning from Preliminary Design to Proposed Final Designs, the D&I Team undertook a Community Involvement process that encompassed 23 select official briefings, aviation stakeholder briefings, and public workshops. These Community Involvement activities occurred between November 2015 and December of 2018. A total of 42 meetings and/or briefings were conducted throughout the Study Area during this timeframe. As a result of the public workshops held along the Front Range, 866 email comments and 61 written comments were received and considered in the procedure design process. Design changes were made to preliminary designs and in all cases where appropriate, were carried forward to the Proposed Action for this project as a result of the extensive Community Involvement process.

3.1.2.2 D&I Team Preliminary ATC Procedure Design Efforts

The D&I Team undertook validation exercises that further refined the preliminary ATC procedures to ensure they were viable, taking into account the limitations imposed by mountainous terrain, Class B airspace⁴⁰, and Special Use Airspace⁴¹. (See Section 1.3.2 for further discussion of airspace constraints in the DEN Metroplex). These three factors resulted in restrictions to the preliminary ATC procedure design options for the DEN Metroplex Project. The D&I Team also examined interactions between Denver International Airport (DEN) and satellite airports⁴² including:

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

While the design of an ATC procedure into one airport can be a fairly simple process, the D&I Team was charged with providing a more complete and integrated solution to air traffic complexities and inefficiencies in a large and diverse area. The D&I Team tried to create preliminary ATC procedures that would remain laterally separated from each other to the extent feasible. However, the close proximity of arrival and departure ATC procedures in the DEN Metroplex due to terrain, airspace limitations, and acceptable design criteria results in the complex interaction of aircraft using these ATC procedures.

Preliminary ATC procedure designs for arrivals are most efficient when they allow aircraft to descend at or near idle speed, unaffected by other ATC procedures or terrain elevation. As aircraft arriving or departing the DEN Metroplex enter congested airspace, interaction between these aircraft climbing, descending, leveling, accelerating, and slowing increases substantially. Weather can significantly complicate this interaction and is also considered based on historic norms. These increases in interactions between simulated aircraft operating

⁴⁰ See Federal Aviation Administration. *Aeronautical Information Manual; Chapter 3; Section 2. Controlled Airspace*. October 12, 2017.

⁴¹ *Special Use Airspace* is used to designate airspace in which certain activities must be confined, or where limitations may be imposed on aircraft operations that are not part of those activities. See Federal Aviation Administration. *Aeronautical Information Manual; Chapter 3; Section 4. Special Use Airspace*. October 12, 2017.

⁴² *Satellite airports* are those airports in relatively close proximity the primary air carrier airport and are those that see significant interaction of Instrument Flight Rules (IFR) air traffic needing to be considered in designing ATC procedures.

on different simulated ATC procedures reduces available preliminary ATC procedure design options.

Preliminary ATC procedure designs for departures are most efficient when they allow aircraft to climb unrestricted to cruising altitude, unaffected by other ATC procedures or terrain elevation. Due to the air traffic volume in the DEN Metroplex, departure ATC procedure designs must allow for interactions with departures from surrounding airports while enabling aircraft to join busy en route ATC procedure corridors.

Preliminary arrival and departure PBN ATC procedure designs were developed with lateral routings, crossing points,⁴³ and altitude restrictions that were the most optimal possible considering the constraints inherent in the DEN Metroplex airspace. The D&I Team worked to meet milestones at the 25, 50, 75, 90, and 100 percent preliminary ATC procedure design levels. Each preliminary ATC procedure design was continuously refined based on industry input, design and testing software; aircraft simulator results, HITL controller/pilot simulations, and technical criteria described previously. The combined package of preliminary ATC procedure designs at the 100% design level in this EA are referred to as the FAA's PFD versions and are collectively the Proposed Action. To better illustrate the iterative process that was undertaken, the following sections describe the process that was used for two PFD ATC procedures (SSKII One STAR and SPAZZ SID) that are included in the Proposed Action.⁴⁴

3.1.2.3 SSKII One STAR

The Study Team identified generalized issues influencing PFD ATC procedure development of the SSKII One STAR. These high-level issues are:

- Change the DEN STARs from a 16 ATC procedure system (four ATC procedures crossing each compass corner post of northeast [NE], northwest [NW], southeast [SE], and southwest [SW]) to an eight ATC procedure system (two ATC procedures crossing each compass corner post of NE, NW, SE, and SW) to reduce pilot and controller task complexity and increase efficiency for north/south runway configurations due to multiple and frequent configuration changes at DEN;
- No dedicated RNAV runway transitions to Runways 7 or 26, which creates additional pilot and controller task complexity; and,
- Actual flight tracks do not follow current arrival ATC procedures.

At a more finite level, the Study Team made five recommendations to address these more generalized issues identified with the SW corner post arrivals:

- RNAV Optimized Profile Descent (OPD) STAR created with runway transitions for north, south, and combined flows resulting in optimized lateral paths to reduce flight track miles.

⁴³ *Crossing points* are three dimensional locations laterally defined by latitude/longitude coordinates and vertically defined by an altitude or range of altitudes.

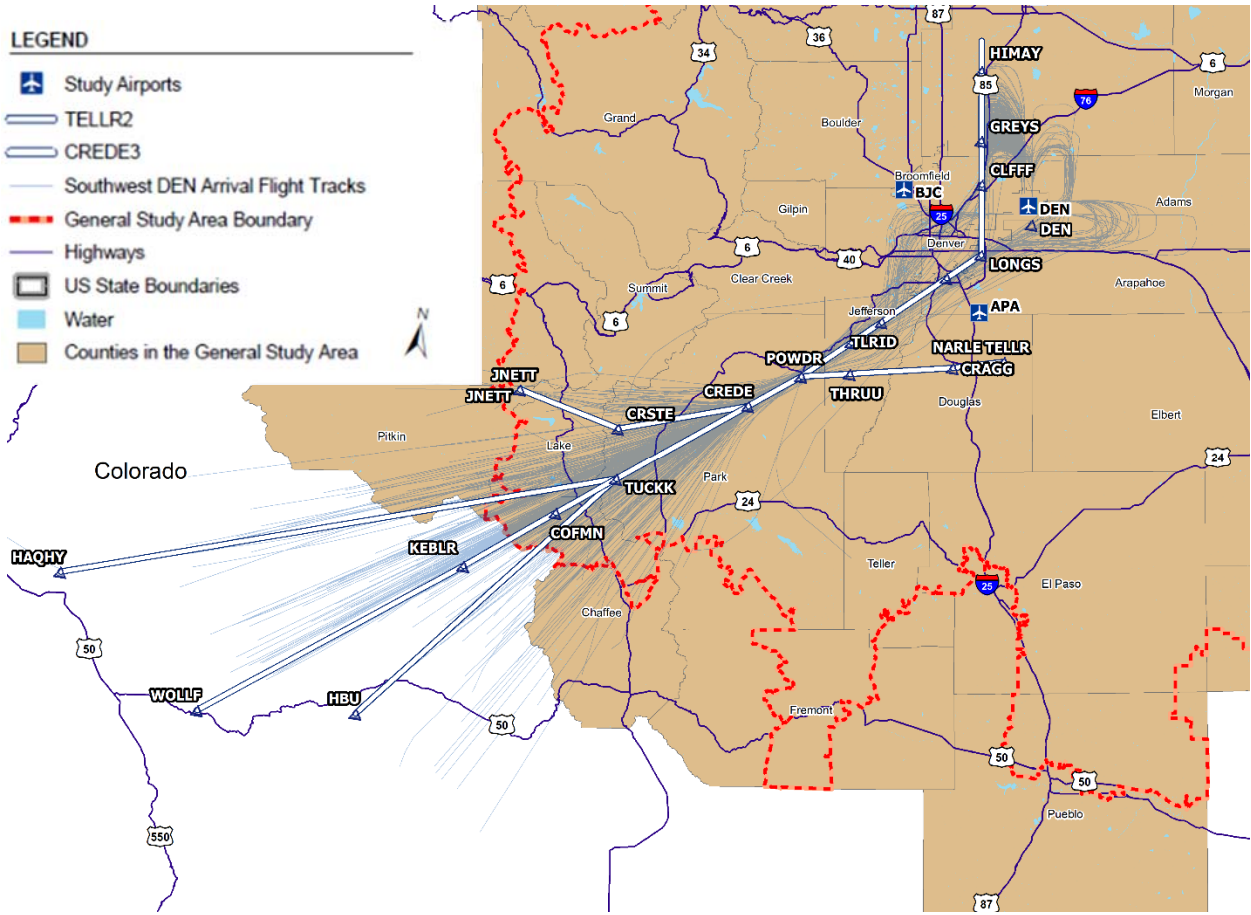
⁴⁴ For a complete explanation of the process, methods, and consideration given to all PFDs in the Proposed Action, please refer to Appendix F: *Denver Metroplex Study Team Final Report* and Appendix G: *Denver Metroplex Design and Implementation Team Final Report* that are supplemental to this EA.

- STAR was shortened for operational flexibility, unused en route ATC procedure transitions were removed, and an en route ATC procedure crossover transition was created, which will be ATC assigned only.
- Modified en route and terminal ATC procedure merge points for increased sequencing time where feasible and created runway transitions which merge with RNP and ILS/RNP ATC procedures.
- Created an altitude window of 17,000 feet above mean sea level MSL to flight level (FL) 230 at the beginning of the common route.
- The proposed JNETT (A052), HAQHY (A050) and HBU (A104) transitions are for mountainous ski-tourist airports and are restricted to at or below FL260.

The existing CREDE and TELLR STARs are two of the four primary arrival routes to the SW corner post in the DEN Metroplex. These two arrivals serve to bring en route traffic into the DEN Metroplex terminal airspace while descending from a cruise altitude and a cruise airspeed to a lower altitude and slower airspeed in the DEN Metroplex terminal airspace. As depicted on **Exhibit 3-1**, the interaction between the existing CREDE and TELLR STARs at the SW corner post creates air crew and controller task complexity. This results in excessive vectoring⁴⁵, air traffic management restrictions (e.g. altitude and/or speed restrictions), reduced airspace efficiency, and increased controller/pilot workload and complexity.

⁴⁵ *Vectoring* is an ATC term used to describe the process of an air traffic controller manually directing an aircraft crew to fly a specific heading, speed, and/or altitude separate from a defined ATC procedure such as the CREDE or TELLR STARs.

Exhibit 3-1 Existing CREDE Three and TELLR Two STARs

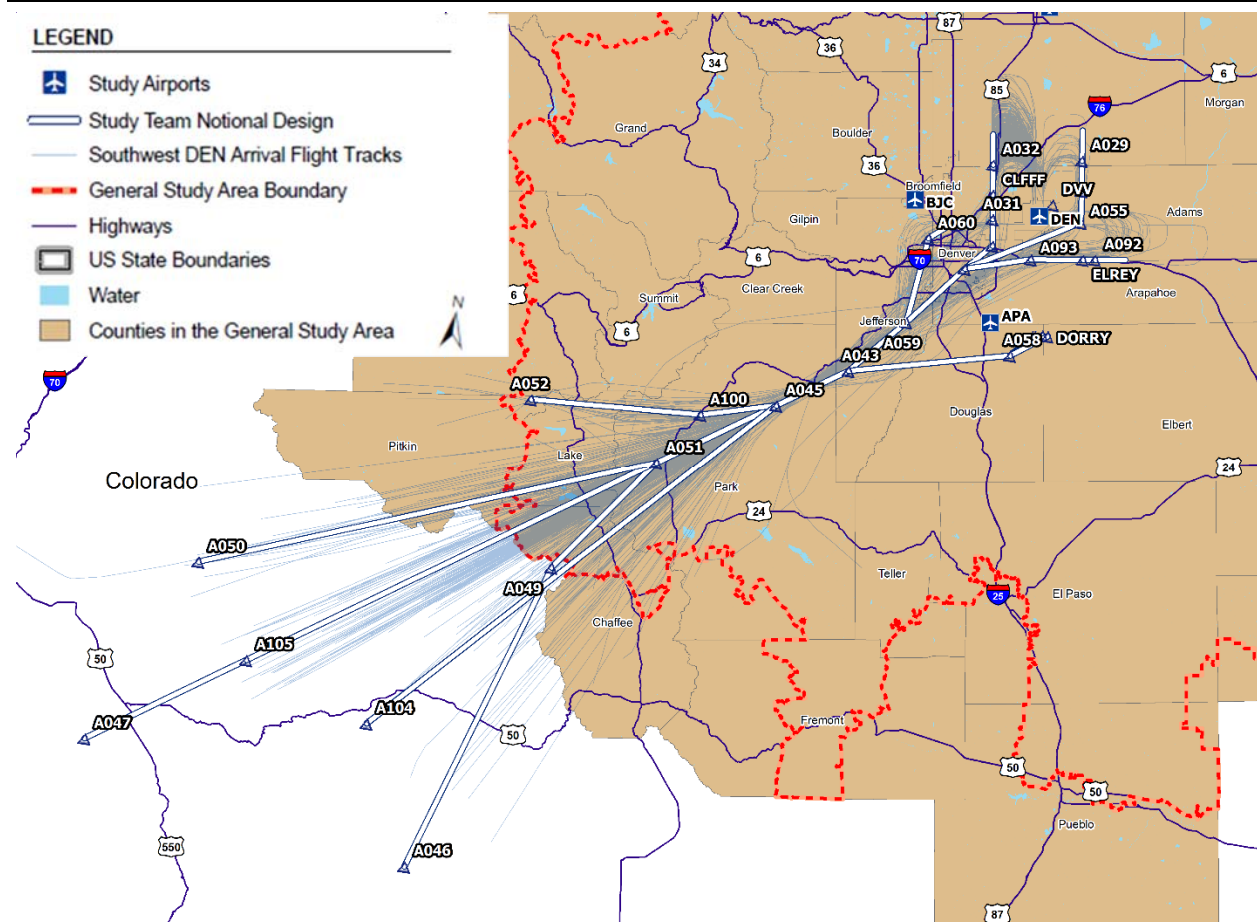


Sources: National Atlas of the United States of America (U.S. County and State Boundaries, Water Bodies); Bureau of Transportation Statistics, National Transportation Atlas Database (U.S. and Interstate Highways); ATAC Corporation (Flight Track Data); DEN Metroplex Study Team, *Study Team Final Report*, November 2014.

Prepared by: ATAC Corporation, February 2019.

In order to address the Study Team recommendations, the D&I team iteratively combined the existing CREDE and TELLR STARs at the SW corner post into a single PFD ATC procedure to create the SSKII One STAR. In the same manner, the existing PEEKK and LDORA STARs that serve as the other half of the four total arrivals to the SW corner post were iteratively combined by the D&I Team to create the TBARR STAR at the SW corner post. The combination of the SSKII One and TBARR PFD STARs achieved the need to reduce the SW corner post from four ATC procedures to two ATC procedures and supported the larger goal of reducing 16 STARs to an 8 STAR corner post system in the DEN Metroplex airspace. This reduction in PFD ATC procedures also met the purpose of the DEN Metroplex project. **Exhibit 3-2** illustrates the Study Team’s conceptual ATC Procedure recommendations compared to the existing ATC procedures.

Exhibit 3-2 Study Team Recommendation – SSKII One STAR

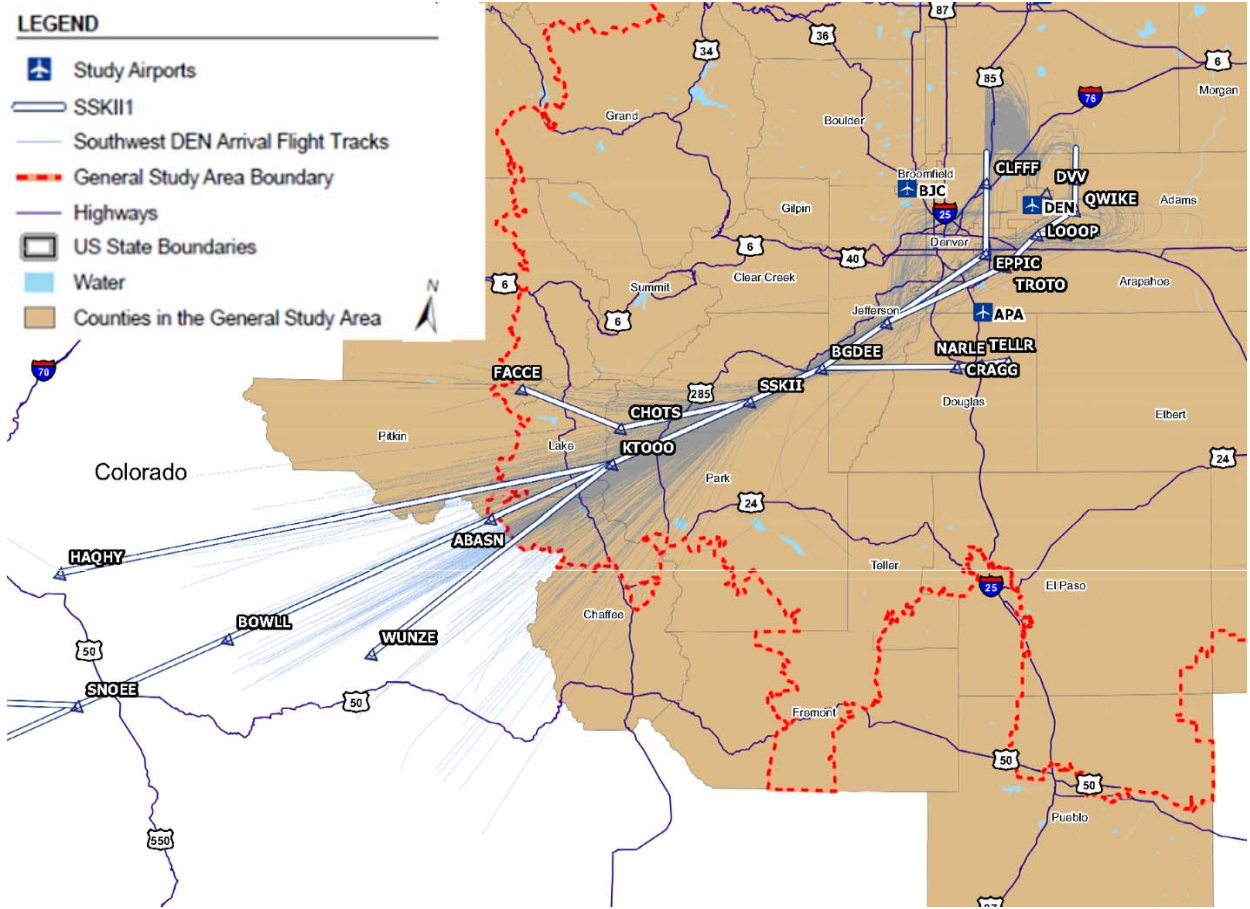


Sources: National Atlas of the United States of America (U.S. County and State Boundaries, Water Bodies); Bureau of Transportation Statistics, National Transportation Atlas Database (U.S. and Interstate Highways); ATAC Corporation (Flight Track Data); DEN Metroplex Study Team, *Study Team Final Report*, November 2014.

Prepared by: ATAC Corporation, February 2019.

In developing the SSKII One RNAV STAR PFD ATC Procedure, the D&I Team considered interactions between the Study Team designated SW STAR 1 and SW STAR 2 traffic for DEN and traffic into and out of the satellite airports, as well as certain terrain and airspace restrictions. The D&I Team modified the Study Team recommendations to improve the vertical profile and address the issues identified by the Study Team. **Exhibit 3-3** depicts the PFD for the SSKII One STAR.

Exhibit 3-3 D&I Team PFD – SSKII One STAR



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); ATAC Corporation (Flight Track Data); DEN Metroplex D&I Team *DEN SSKII One STAR Proposed Final Design Sheet*, April 2019.

Prepared by: ATAC Corporation, April 2019.

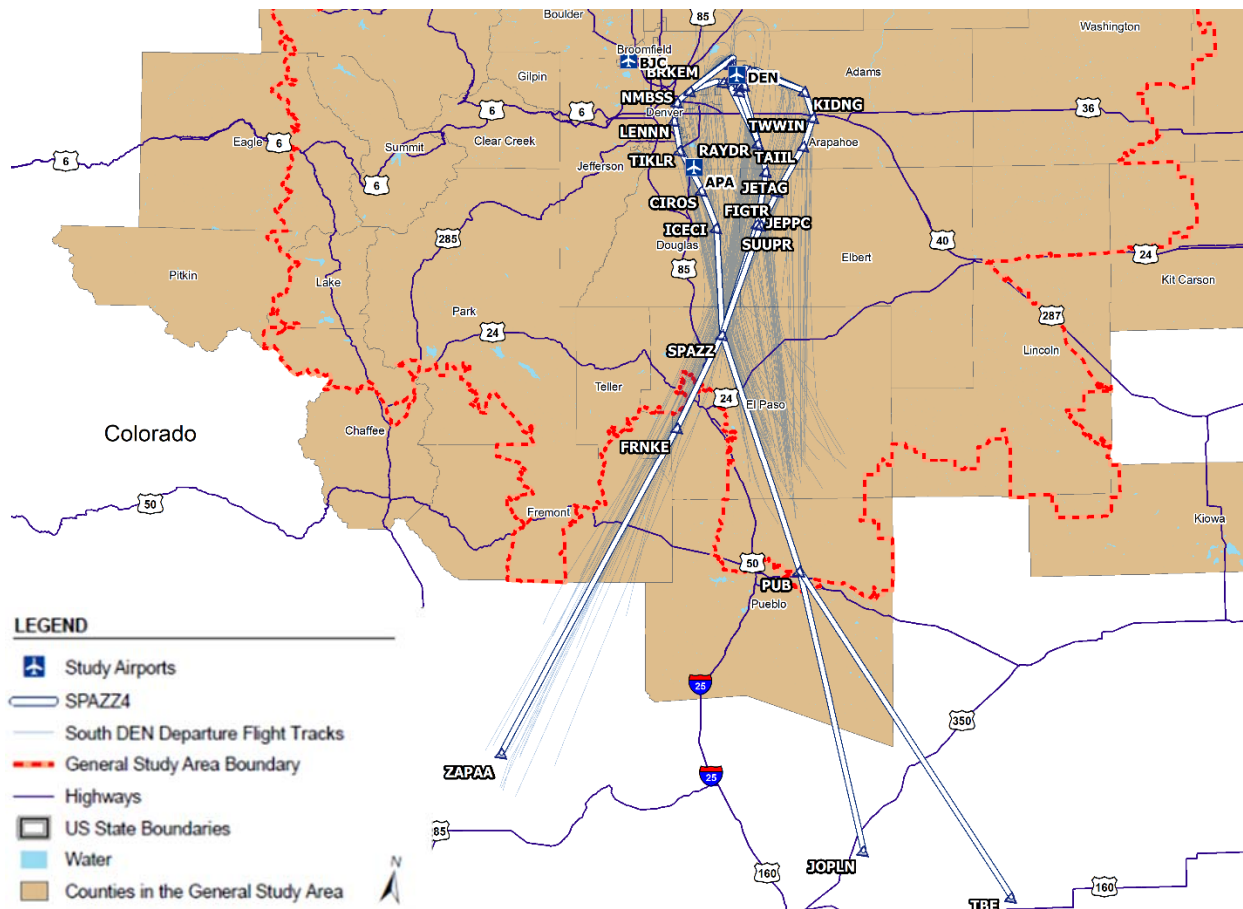
3.1.2.4 SPAZZ SID

Exhibit 3-4 provides the current ATC procedure depiction of the SPAZZ SID to illustrate the starting point for the design revisions. All of the revised SIDs for DEN shared a number of prescribed Study Team design criteria:

- Optimization of lateral paths to reduce flight track miles
- Segregation of RNAV SIDs from arrivals where practical
- Elimination of unused en route transition(s)
- Minimum of eight nautical miles between all departure and arrival transfer control points
- RNAV off-the-ground departure ATC procedures
- Combination of initial RNAV ATC procedure segments as appropriate

- Initial altitude assignment of 10,000 feet MSL (all other altitudes are tactically assigned by ATC)
- Shortening of en route transitions for added flexibility

Exhibit 3-4 Existing SPAZZ Four SID



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); ATAC Corporation (Flight Track Data); DEN Metroplex D&I Team *DEN SUDDZ SID Proposed Final Design Sheet*, June 2016.

Prepared by: ATAC Corporation, February 2019.

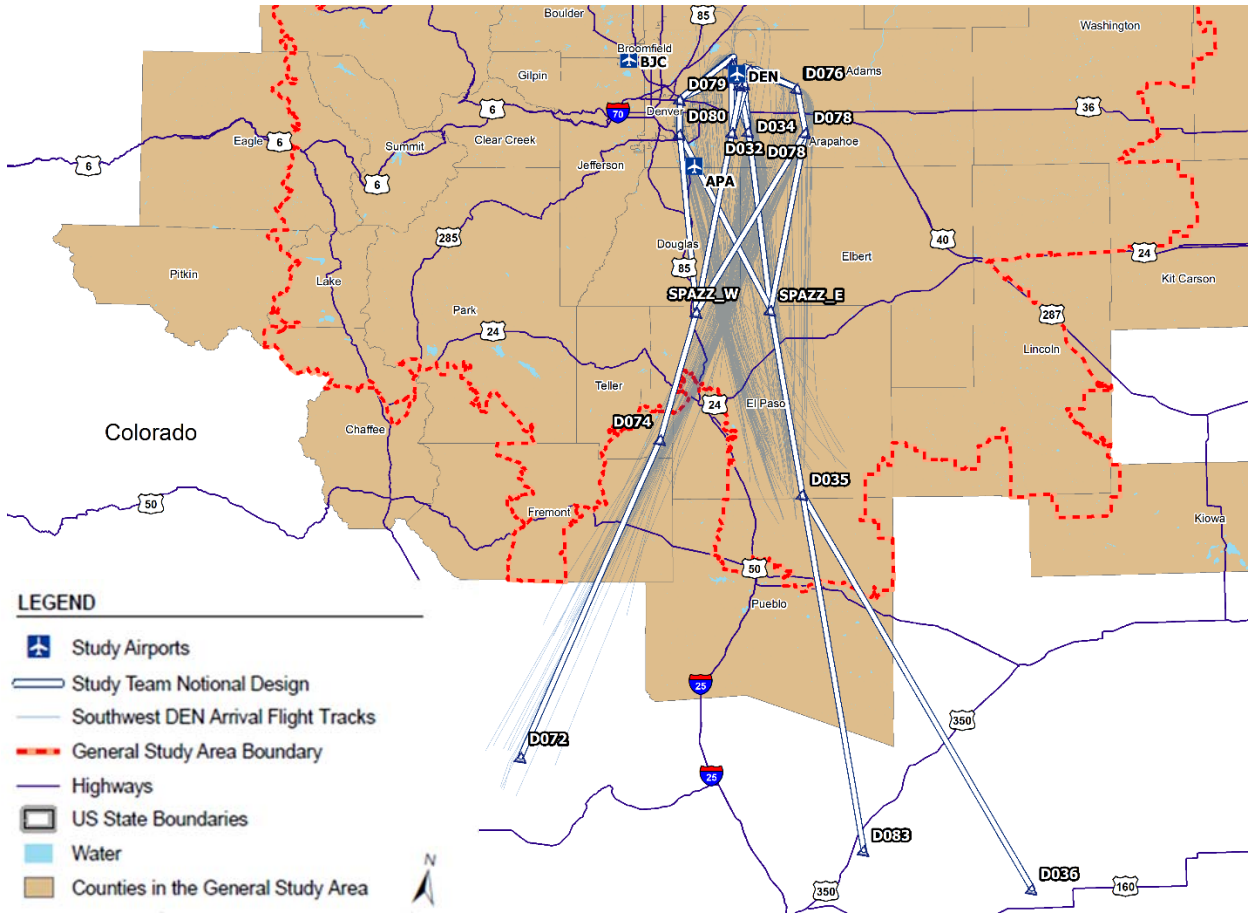
The Study Team made more specific recommendations to address the issues identified with SPAZZ departures:

- Routes were shortened for flight track mile savings.
- Current SPAZZ SID should be split into two ATC procedures (a proposed SPAZZ E and a proposed SPAZZ W) which creates an additional departure gate for increased flexibility.
- A proposed SPAZZ E and a proposed SPAZZ W SIDs would avoid restricted area R-2601 SUA (US Army Fort Carson Live Fire Range).

- A proposed SPAZZ E SID avoids Two Buttes Military Operations Area (MOA) (primarily operated by the Colorado Air National Guard for military air exercises and training)

Exhibit 3-5 illustrates the Study Team’s recommended conceptual ATC procedure design.

Exhibit 3-5 Study Team Recommendation – Conceptual SPAZZ East and SPAZZ West SIDs to replace SPAZZ Four SID



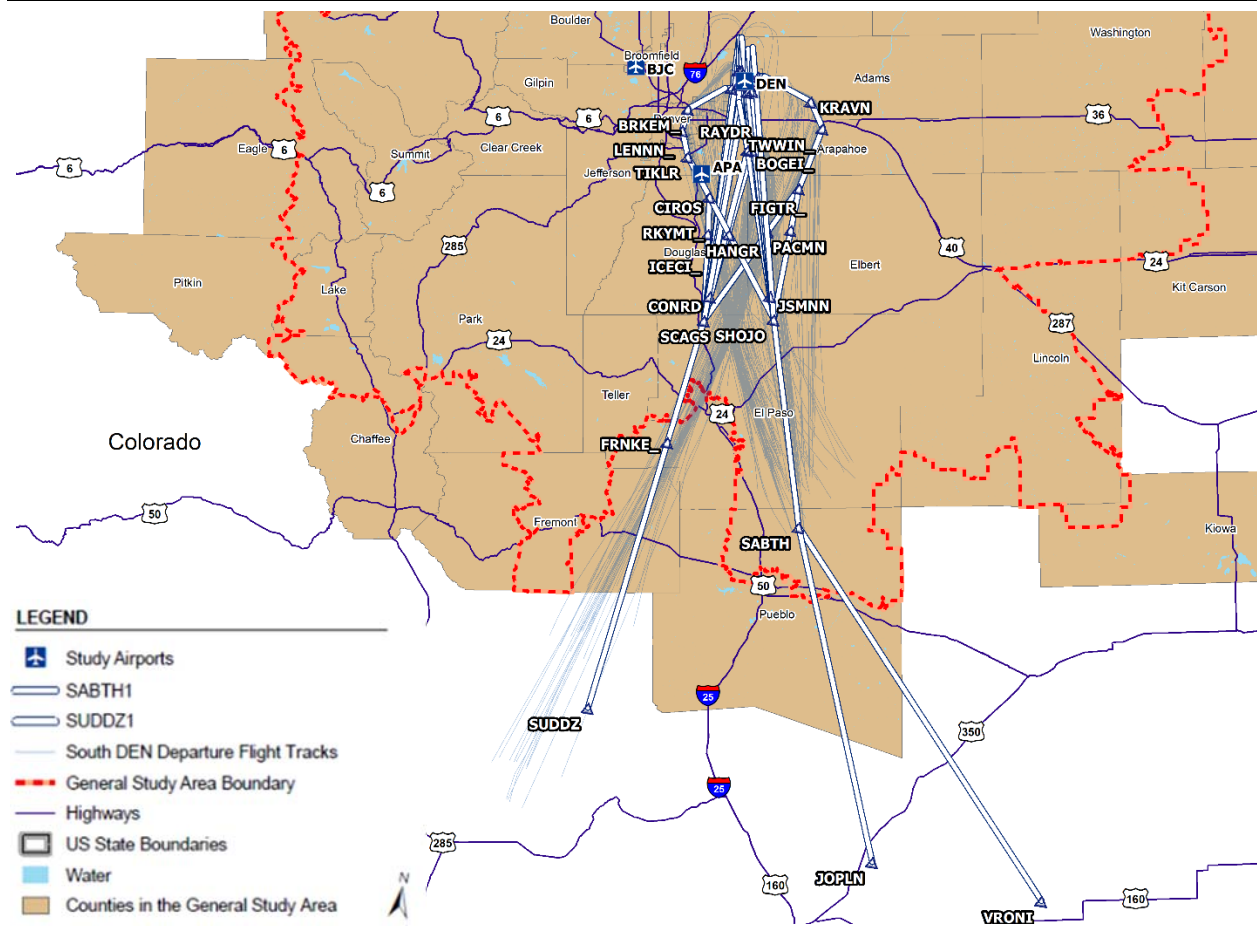
Sources: National Atlas of the United States of America (U.S. County and State Boundaries, Water Bodies); Bureau of Transportation Statistics, National Transportation Atlas Database (U.S. and Interstate Highways); ATAC Corporation (Flight Track Data); DEN Metroplex Study Team, *Study Team Final Report*, November 2014.

Prepared by: ATAC Corporation, February 2019.

Based on the Study Team recommendations, the D&I Team developed new preliminary ATC procedure SIDs named SUDDZ and SABTH. The D&I Team considered the Study Team concept that split the SPAZZ SID into two separate SIDs (E and W), which aids operational flexibility and sequencing aircraft departures in advance of departing an airport. The D&I Team added additional runway transitions to increase DEN ATCT flexibility. The waypoints BRKEM and KDING were moved to align with the E and W SIDs. The BOGEI waypoint was added and the RAYDR waypoint was moved on the SUDDZ SID to regain operational flexibility and de-conflict simultaneous runway departures. Finally, restrictions were placed on the ATC procedure segment from the CIROS to RKYMT waypoints to de-conflict departures from the SSKII One and TBARR STARs when the DEN airport runway configuration is landing

north. **Exhibit 3-6** depicts the D&I Team’s PFD ATC procedure for the SUDDZ and SABTH SIDs.

Exhibit 3-6 D&I Team PFD – SUDDZ One and SABTH One SIDs



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); ATAC Corporation (Flight Track Data); DEN Metroplex D&I Team *SUDDZ SID Proposed Final Design Sheet*, June 2016.

Prepared by: ATAC Corporation, February 2019.

3.2 Alternatives Overview

The following sections discuss the No Action and the Proposed Action, which are the Alternatives carried forward for analysis in the EA (refer to Section 3.2). A robust alternatives process was undertaken from the Study Team preliminary designs through the Proposed Final Design process.

3.2.1 No Action

Under the No Action, the FAA would maintain existing arrival/departure ATC procedures. The related routes and air traffic flow in use in the DEN Metroplex as of 2017 (representing Existing Conditions) would remain largely the same. Some ATC procedure modifications independent of those recommended as part of the DEN Metroplex are intended to be implemented prior to the Proposed Action to deal with specific independent utility issues

separate from the DEN Metroplex. These independent ATC procedures are included in the No Action and are taken into account in the analysis of impacts associated with the No Action (see Chapter 5, *Environmental Consequences*).

3.2.1.1 No Action Procedures

The No Action includes 47 ATC procedures: 13 conventional ATC procedures and 34 RNAV ATC procedures.⁴⁶ The JMPRS TWO ATC procedure serving DEN in the Existing Conditions has been retired.

Table 3-1 lists the names of the No Action ATC procedures; the ATC procedure type (i.e., SID or STAR); the basis of design on which the ATC procedures are based (shown as RNAV or conventional [CONV]); and the number of runway and en route transitions for each ATC procedure.

⁴⁶ National Flight Data Center National Airspace System Resources Database, accessed June 2018; Department of Transportation, FAA Operational Procedure Files June 2018.

Table 3-1 No Action SIDs and STARs

No Action Procedure	Procedure Type	Basis of Design	Transitions (en route/ runway)	Airports Served
ANCHR FOUR	STAR	RNAV	5/0	DEN
BAYLR FOUR	SID	RNAV	2/7	DEN, APA, BJC, FNL
BOSSS TWO	STAR	RNAV	2/0	DEN
BRYCC FOUR	SID	RNAV	1/8	DEN, APA, BJC, FNL
CONNR FIVE	SID	RNAV	1/7	DEN, APA, BJC, FNL
COORZ FOUR	SID	RNAV	1/6	DEN, APA, BJC, FNL
CREDE THREE	STAR	RNAV	4/0	DEN
DANDD NINE	STAR	CONV	3/0	DEN, APA, BJC, FNL, GXY
DENVER ONE	SID	CONV	0/0	DEN, APA, BJC, FNL, GXY
DUNNN TWO	STAR	RNAV	1/2	APA, BJC
EEONS SIX	SID	RNAV	1/7	DEN, APA, BJC, FNL
EMMYS SIX	SID	RNAV	1/7	DEN, APA, BJC, FNL
EPKEE FIVE	SID	RNAV	2/5	DEN, APA, BJC, FNL
EXTAN FIVE	SID	RNAV	1/5	DEN, APA, BJC, FNL
FOOT FOUR	SID	RNAV	1/6	DEN, APA, BJC, FNL
FRNCH THREE	STAR	RNAV	3/0	DEN
JAGGR THREE	STAR	RNAV	2/0	DEN
KAILE TWO	STAR	RNAV	3/0	DEN
KIPPR FIVE	STAR	RNAV	5/0	DEN, APA, BJC, FNL, GXY
KOHOE THREE	STAR	RNAV	3/0	DEN
LANDR NINE	STAR	CONV	5/0	DEN, APA, BJC, FNL, GXY
LARKS NINE	STAR	CONV	5/0	DEN, APA, BJC, FNL, GXY
LDORA TWO	STAR	RNAV	3/0	DEN
MOLTN THREE	STAR	RNAV	2/0	DEN
PEEKK THREE	STAR	RNAV	3/0	DEN
PIKES ONE	SID	CONV	3/0	DEN, APA, BJC, FNL, GXY
PLAINS NINE	SID	CONV	10/0	DEN, APA, BJC, FNL, GXY
POWDR NINE	STAR	CONV	3/0	DEN, APA, BJC, FNL, GXY
PUFFR FOUR	STAR	RNAV	1/2	DEN
PURRL TWO	STAR	RNAV	2/0	DEN
QUAIL NINE	STAR	CONV	3/0	DEN, APA, BJC, FNL, GXY
RAMMS SEVEN	STAR	CONV	4/0	DEN, APA, BJC, FNL, GXY
RIKKK FOUR	SID	RNAV	1/8	DEN, APA, BJC, FNL
ROCKIES FOUR	SID	CONV	6/0	DEN, APA, BJC, FNL, GXY
SAYGE ONE	STAR	CONV	4/0	DEN, APA, BJC, FNL, GXY
SOLAR FOUR	SID	RNAV	1/8	DEN, APA, BJC, FNL
SPAZZ FOUR	SID	RNAV	3/8	DEN, APA, BJC, FNL
STAKR FOUR	SID	RNAV	1/8	DEN, APA, BJC, FNL
TELLR TWO	STAR	RNAV	4/0	DEN
TOMSN SEVEN	STAR	CONV	3/0	DEN, APA, BJC, FNL, GXY
TSHNR THREE	STAR	RNAV	2/0	DEN, FNL, GXY

Table 3-1 No Action SIDs and STARs

No Action Procedure	Procedure Type	Basis of Design	Transitions (en route/ runway)	Airports Served
WAHUU TWO	STAR	RNAV	3/0	DEN
YAMMI FOUR	SID	RNAV	1/9	DEN, APA, BJC, FNL
YELLOWSTONE TWO	SID	CONV	7/0	DEN, APA, BJC, FNL, GXY
YOKES SIX	SID	RNAV	2/9	DEN, APA, BJC, FNL
ZOMBZ ONE	STAR	RNAV	1/1	APA
ZPLYN THREE	STAR	RNAV	2/0	DEN

STAR=Standard Terminal Arrival Route
SID=Standard Instrument Departure
RNAV=Area Navigation
CONV=Conventional ground based navaid ATC procedure
DEN – Denver International Airport
APA – Centennial Airport
BJC – Rocky Mountain Metropolitan Airport
FNL – Northern Colorado Regional Airport
GXY – Greeley-Weld County Airport

Sources: National Flight Data Center National Airspace System Resources Database, accessed November 7, 2018; Department of Transportation, FAA Operational Procedure Files, November 7, 2018.
 Prepared by: ATAC Corporation, February 2019.

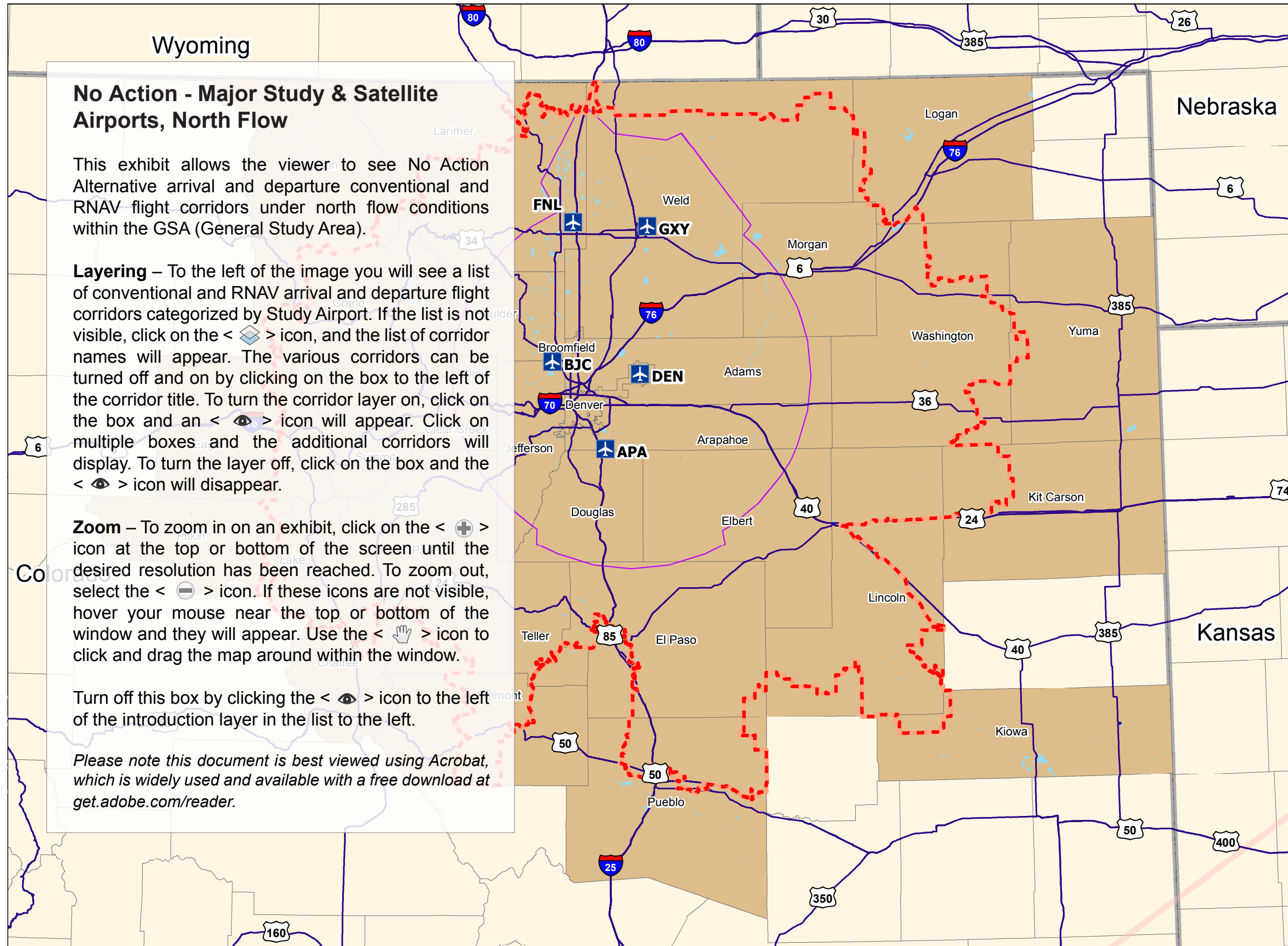
The final approaches to the runways and initial departure flows from the runways remain similar in altitude and lateral width for the No Action compared to Existing Conditions for all of the Study Airports. Small modification in aircraft vertical and lateral tracks were necessary to connect the No Action ATC procedures to the final approaches and initial departure flows. An aircraft on final approach is generally indicated by the last flight segment where an aircraft has lined up with the landing runway and established a stable flight configuration with the intent of landing. An aircraft on an initial departure flow is generally defined as an aircraft that has left the departing runway, is climbing normally and at a normal speed, and is under positive ATC identification and contact.

3.2.1.2 Airspace Control Structure under the No Action

When aircraft depart or arrive to the DEN Metroplex on an assigned route or SID/STAR, transfer of control of an aircraft occurs between multiple air traffic facilities. As noted previously, these transfer control points are identified points in the airspace for common reference between ATC and the air crew. Under the No Action, the transfer control points would remain unchanged from Existing Conditions. For purposes of this EA, the areas where transfers occur are defined based on arrival gates and departure exit gates. The gates are purposely located to laterally and vertically segregate arrivals and departures where possible.

The DEN Metroplex Study Airports all have independent runway configurations that are based on weather and wind. Airport arrival and departure flows can interact with other airport traffic flows in different runway configurations. DEN generally has a north and south flow, but the airport is unique in that there are transition periods and other conditions that result in a combined configuration of multi-directional flows. Therefore, the D&I Team considered all possible combinations of the various runway operating configurations that are sorted into the categories of North flow, South flow, and Combined flow.

Exhibit 3-7 through **Exhibit 3-9** show these arrival and departure flows to the Study Airports associated with the No Action. Corridors are grouped by ATC procedure type (conventional or RNAV), operation (arrival or departure), and Study Airport.



No Action - Major Study & Satellite Airports, North Flow

This exhibit allows the viewer to see No Action Alternative arrival and departure conventional and RNAV flight corridors under north flow conditions within the GSA (General Study Area).

Layering – To the left of the image you will see a list of conventional and RNAV arrival and departure flight corridors categorized by Study Airport. If the list is not visible, click on the < > icon, and the list of corridor names will appear. The various corridors can be turned off and on by clicking on the box to the left of the corridor title. To turn the corridor layer on, click on the box and an < > icon will appear. Click on multiple boxes and the additional corridors will display. To turn the layer off, click on the box and the < > icon will disappear.

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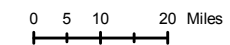
LEGEND

- General Study Area Boundary
- Study Airports
- Counties in the General Study Area
- US Counties
- US State Boundaries
- Highways
- Water
- D01 TRACON Boundary
- ZDV ARTCC Boundary

- Conventional Arrival
- Conventional Departure
- RNAV Arrival
- RNAV Departure
- RNAV Arrival with Vectoring
- RNAV Departure with Vectoring

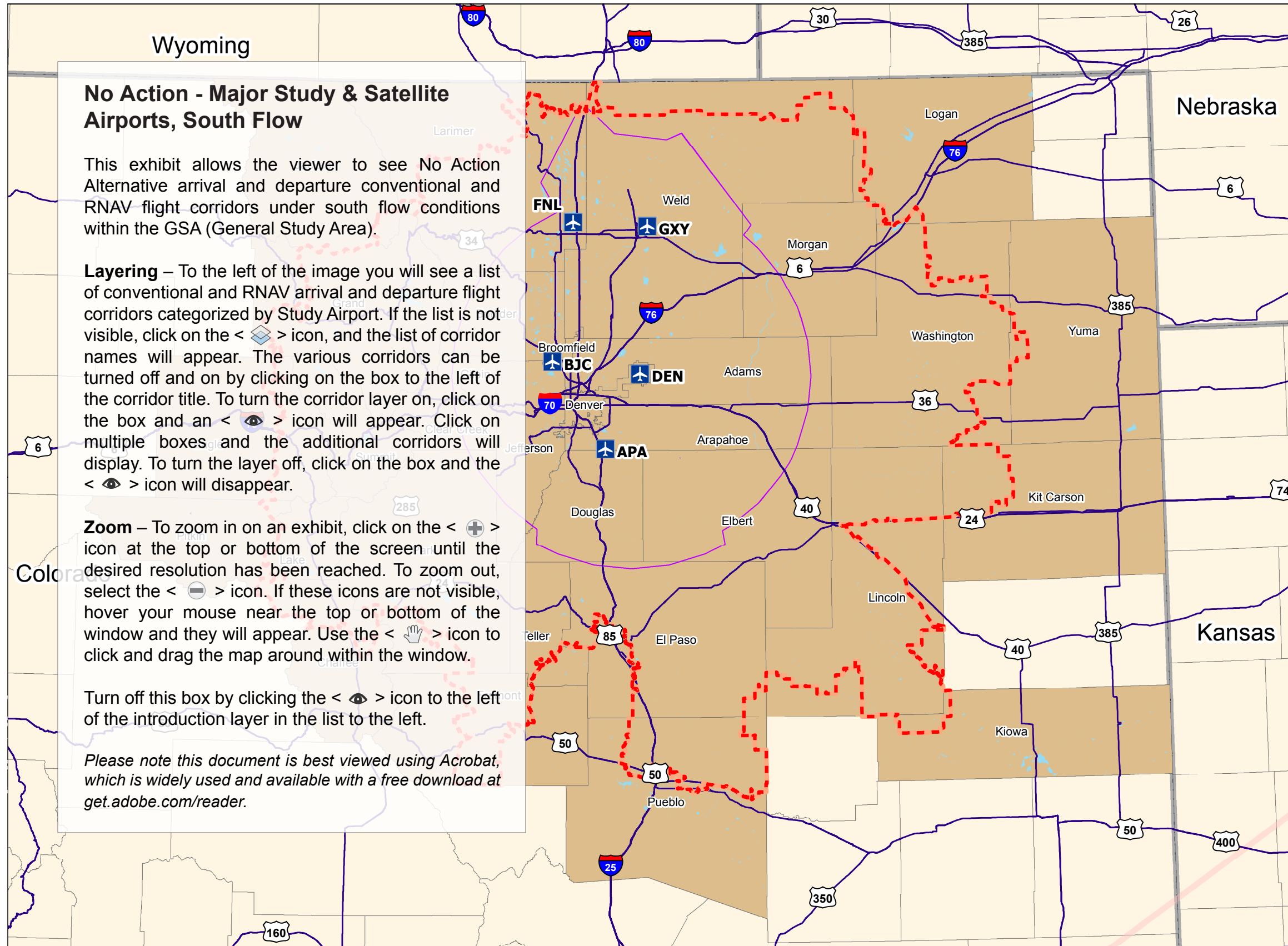
Notes:
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 BJC - Rocky Mountain Metropolitan Airport
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 GXY - Greeley-Weld County Airport

Projection :GCS North American 1983
 Scale: 1:2,631,162



Sources: US Census Bureau. Tiger mapping services: US State Boundaries; US Counties; US Incorporated Places; US Hydrology; US Primary and Secondary Roads; Native American Areas. generated May 1, 2015, from <http://www.census.gov/geo/maps-data/data/tiger-line.html>. Data.gov: National Park Boundaries, generated May 1, 2015, from <https://catalog.data.gov/dataset/national-park-boundariesf0a4c>. USGS. TNM: USGSShadedReliefOnly Basemap, generated January, 26, 2016. NFDC. Study Airports, generated January 26, 2016. Prepared by: ATAC Corporation, January 2019.

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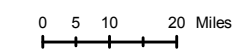
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No Action - Major Study & Satellite Airports, South Flow

This exhibit allows the viewer to see No Action Alternative arrival and departure conventional and RNAV flight corridors under south flow conditions within the GSA (General Study Area).

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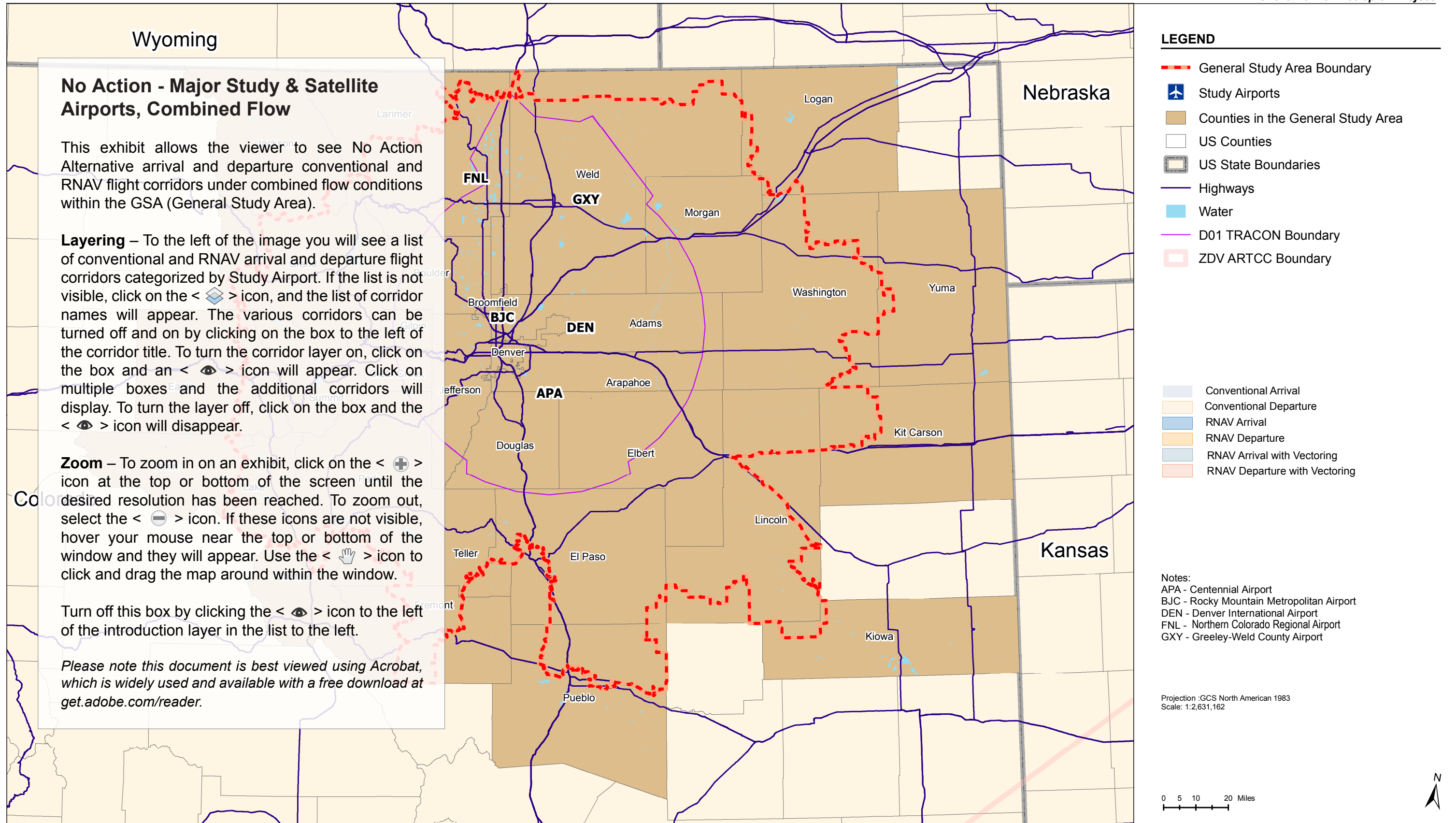
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No Action - Major Study & Satellite Airports, Combined Flow

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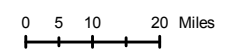
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- Water
- D01 TRACON Boundary
- ZDV ARTCC Boundary

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- Conventional Departure
- RNAV Arrival
- RNAV Departure
- RNAV Arrival with Vectoring
- RNAV Departure with Vectoring

Notes:
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3.2.2 Proposed Action

As discussed in Section 3.1, the Proposed Action consists of the PFDs for all ATC procedures the D&I Team developed, plus existing ATC procedures that would continue to be used in a configuration that is the same or similar to current configurations and has been cleared by the NEPA process when necessary. This Alternative is expected to increase efficiency in the DEN Metroplex airspace by improving flexibility in transitioning aircraft, segregating arrivals and departures, and improving the predictability of air traffic flows.

The Proposed Action contains 45 ATC procedures, including:

- 12 new RNAV STARs,
- 20 new RNAV SIDs,
- 8 existing/no action conventional STARs,
- 5 existing/no action conventional SIDs.

Table 3-2 lists the Proposed Action ATC procedures, the No Action ATC procedure that the Proposed Action would replace (if applicable), the ATC procedure type, the basis of design (indicated by the type of NAVAID on which the ATC procedures are based and shown as RNAV or CONV); and the number of runway and en route transitions for each ATC procedure. The table also shows the airport(s) that the Proposed Action ATC procedures serve, and the number of runway and en route transitions for each ATC procedure. Finally, the table lists the objectives each ATC procedure design achieves.

Table 3-2 Proposed Action SIDs and STARs

Proposed Action Procedure	No Action Procedure	Procedure Type	Basis of Design	Transitions (en route/ runway)	Airports Served
AALLEE ONE	ANCHR FOUR	STAR	RNAV	2/5	DEN
	KIPPR FIVE	STAR	RNAV	2/5	DEN
NIIXX ONE	BOSSS TWO	STAR	RNAV	3/6	DEN
	ZPLYN THREE	STAR	RNAV	3/6	DEN
SSKII ONE	CREDE THREE	STAR	RNAV	6/5	DEN
	TELLR TWO	STAR	RNAV	6/5	DEN
DANDD NINE	DANDD NINE	STAR	CONV	3/0	DEN, APA BJC, GXY, FNL
LONGZ ONE	FRNCH THREE	STAR	RNAV	3/6	DEN
	KAILE TWO	STAR	RNAV	3/6	DEN
CLASH ONE	JAGGR THREE	STAR	RNAV	2/5	DEN
	PURLL TWO	STAR	RNAV	2/5	DEN
LAWGR ONE	KOHOE THREE	STAR	RNAV	1/4	DEN
	WAHUU TWO	STAR	RNAV	1/4	DEN
LANDR NINE	LANDR NINE	STAR	CONV	5/0	DEN, APA BJC, GXY, FNL
LARKS NINE	LARKS NINE	STAR	CONV	5/0	DEN, APA BJC, GXY, FNL
TBARR ONE	LDORA TWO	STAR	RNAV	4/6	DEN
	PEEKK THREE	STAR	RNAV	4/6	DEN
FLATI ONE	MOLTN THREE	STAR	RNAV	3/6	DEN
	TSHNR THREE	STAR	RNAV	3/6	DEN
POWDR NINE	POWDR NINE	STAR	CONV	3/0	DEN, APA BJC, GXY, FNL
QUAIL NINE	QUAIL NINE	STAR	CONV	3/0	DEN, APA BJC, GXY, FNL
RAMMS SEVEN	RAMMS SEVEN	STAR	CONV	4/0	DEN, APA BJC, GXY, FNL
SAYGE ONE	SAYGE ONE	STAR	CONV	4/0	DEN, APA BJC, GXY, FNL
TOMSN SEVEN	THOMSN SEVEN	STAR	CONV	3/0	DEN, APA BJC, GXY, FNL
BAYLR FIVE	BAYLR FOUR	SID	RNAV	1/12	DEN
HHOTH ONE	BRYCC FOUR	SID	RNAV	2/10	DEN
CONNR SIX	CONNR FIVE	SID	RNAV	1/12	DEN
COORZ FIVE	COORZ FOUR	SID	RNAV	1/12	DEN
DENVER ONE	DENVER ONE	SID	CONV	0/0	DEN, APA BJC, GXY, FNL
ECHOO ONE	PLAINS NINE	SID	RNAV	4/0	APA BJC, GXY, FNL
	EEONS SIX	SID	RNAV	4/0	APA BJC, GXY, FNL
	EMMYS SIX	SID	RNAV	4/0	APA BJC, GXY, FNL
	EPKEE FIVE	SID	RNAV	4/0	APA BJC, GXY, FNL
	EXTAN FIVE	SID	RNAV	4/0	APA BJC, GXY, FNL
EEONS SEVEN	EEONS SIX	SID	RNAV	1/12	DEN

Table 3-2 Proposed Action SIDs and STARs

Proposed Action Procedure	No Action Procedure	Procedure Type	Basis of Design	Transitions (en route/ runway)	Airports Served
EMMYS SEVEN	EMMYS SIX	SID	RNAV	1/12	DEN
EPKEE SIX	EPKEE FIVE	SID	RNAV	2/12	DEN
EXTAN SIX	EXTAN FIVE	SID	RNAV	1/12	DEN
ZIMMR ONE	FOOOT FOUR	SID	RNAV	1/12	DEN
MRSHH ONE	YELLOWSTONE TWO	SID	RNAV	5/0	APA BJC, GXY, FNL
	BRYCC FOUR	SID	RNAV	5/0	APA BJC, GXY, FNL
	RIKKK FOUR	SID	RNAV	5/0	APA BJC, GXY, FNL
	YOKES SIX	SID	RNAV	5/0	APA BJC, GXY, FNL
	YAMMI FOUR	SID	RNAV	5/0	APA BJC, GXY, FNL
PIKES ONE	PIKES ONE	SID	CONV	3/0	DEN, APA BJC, GXY, FNL
PLAINS NINE	PLAINS NINE	SID	CONV	10/0	DEN, APA BJC, GXY, FNL
EXWNG ONE	RIKKK FOUR	SID	RNAV	1/10	DEN
ROCKIES FOUR	ROCKIES FOUR	SID	CONV	6/0	DEN, APA BJC, GXY, FNL
	SOLAR FOUR	SID	RNAV	5/0	DEN, APA BJC, GXY, FNL
	SPAZZ FOUR	SID	RNAV	5/0	DEN, APA BJC, GXY, FNL
SKYEE ONE	STAKR FOUR	SID	RNAV	5/0	APA BJC, GXY, FNL
	DENVER ONE	SID	RNAV	5/0	APA BJC, GXY, FNL
	PIKES ONE	SID	RNAV	5/0	APA BJC, GXY, FNL
SMMUR ONE	SOLAR FOUR	SID	RNAV	2/10	DEN
SUDDZ ONE	SPAZZ FOUR	SID	RNAV	1/10	DEN
SABTH ONE	SPAZZ FOUR	SID	RNAV	2/10	DEN
SLEEK ONE	STAKR FOUR	SID	RNAV	1/10	DEN
DDRTH ONE	YAMMI FOUR	SID	RNAV	1/10	DEN
YELLOWSTONE TWO	YELLOWSTONE TWO	SID	CONV	7/10	DEN, APA BJC, GXY, FNL
CHUWY ONE	YOKES SIX	SID	RNAV	1/10	DEN
DUNNN THREE	DUNNN TWO	STAR	RNAV	2/0	APA, BJC
	PUFFR FOUR	STAR	RNAV	2/0	APA, BJC
BRNKO ONE	PUFFR FOUR	STAR	RNAV	2/0	APA BJC, GXY, FNL
	KIPPR FIVE	STAR	RNAV	2/0	APA BJC, GXY, FNL
ZOMBZ TWO	ZOMBZ ONE	STAR	RNAV	1/0	APA
	N/A	N/A	RNAV		BJC
PINNR ONE	RAMMS SEVEN	STAR	RNAV	1/0	APA BJC, GXY, FNL

Table 3-2 Proposed Action SIDs and STARs

Proposed Action Procedure	No Action Procedure	Procedure Type	Basis of Design	Transitions (en route/ runway)	Airports Served
	TSHNR THREE	STAR	RNAV	1/0	APA BJC, GXY, FNL
WNGSS ONE	BAYLR FOUR	SID	RNAV	4/0	APA BJC, GXY, FNL
	CONNR FIVE	SID	RNAV	4/0	APA BJC, GXY, FNL
	COORZ FOUR	SID	RNAV	4/0	APA BJC, GXY, FNL
	FOOOT FOUR	SID	RNAV	4/0	APA BJC, GXY, FNL
	ROCKIES FOUR	SID	RNAV	4/0	APA BJC, GXY, FNL

Notes:

STAR=Standard Terminal Arrival Route

DEN – Denver International Airport
GXY – Greeley-Weld County Airport

SID=Standard Instrument Departure

APA – Centennial Airport

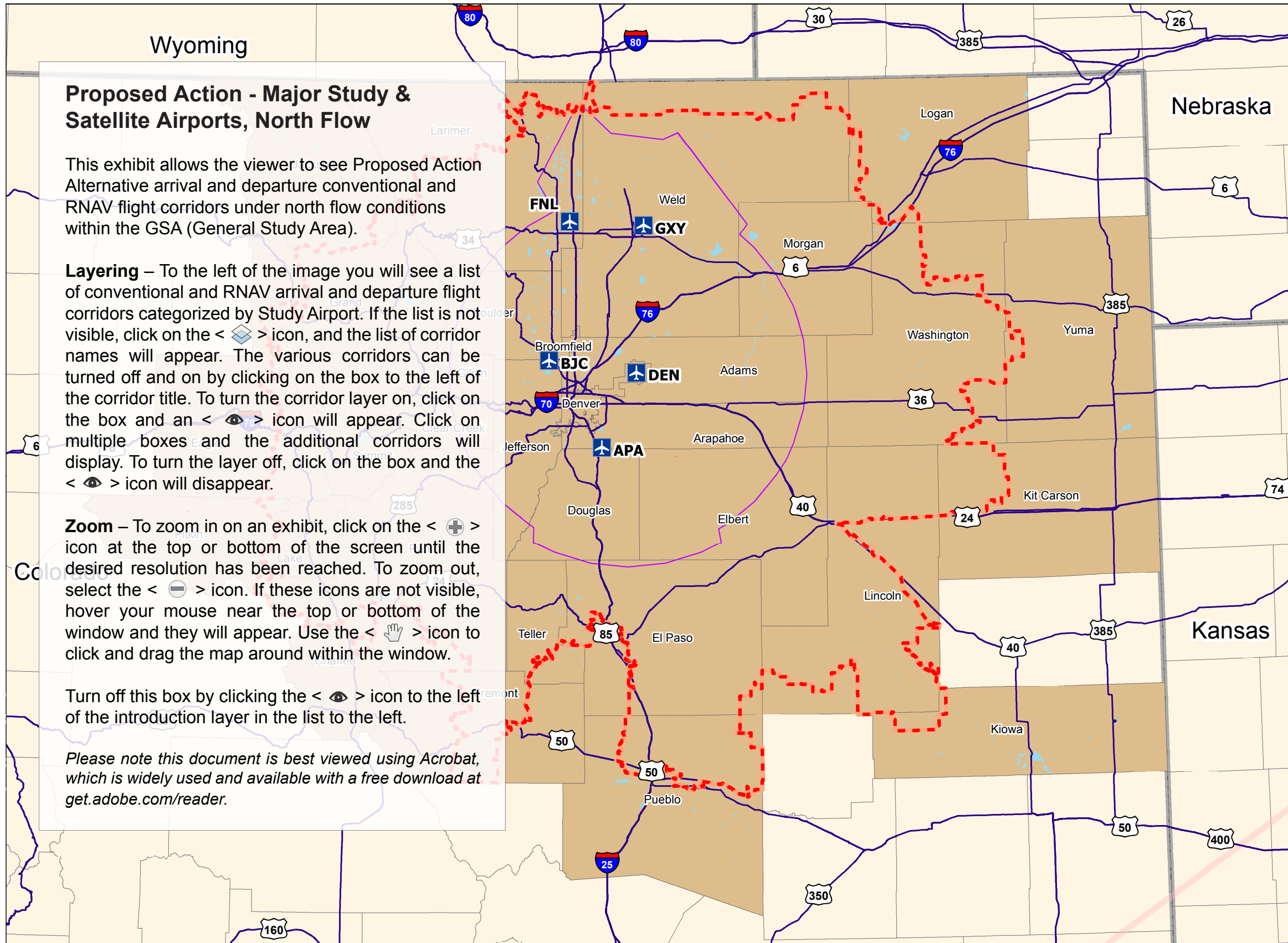
RNAV=Area Navigation

BJC – Rocky Mountain Metropolitan Airport

CONV=Conventional ground based navaid ATC procedure
FNL – Northern Colorado Regional Airport

Sources: National Flight Data Center National Airspace System Resources Database, accessed November 2018; Department of Transportation, FAA Operational Procedure Files, accessed November 2018.
Prepared by: ATAC Corporation, February 2019.

Exhibit 3-10 through **Exhibit 3-12** show all arrival and departure flows to the Study Airports associated with the Proposed Action. Corridors are grouped by ATC procedure type (conventional or RNAV), operation (arrival or departure), and airport.



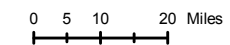
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Projection :GCS North American 1983
 Scale: 1:2,631,162



Proposed Action - Major Study & Satellite Airports, North Flow

This exhibit allows the viewer to see Proposed Action Alternative arrival and departure conventional and RNAV flight corridors under north flow conditions within the GSA (General Study Area).

Layering – To the left of the image you will see a list of conventional and RNAV arrival and departure flight corridors categorized by Study Airport. If the list is not visible, click on the < > icon, and the list of corridor names will appear. The various corridors can be turned off and on by clicking on the box to the left of the corridor title. To turn the corridor layer on, click on the box and an < > icon will appear. Click on multiple boxes and the additional corridors will display. To turn the layer off, click on the box and the < > icon will disappear.

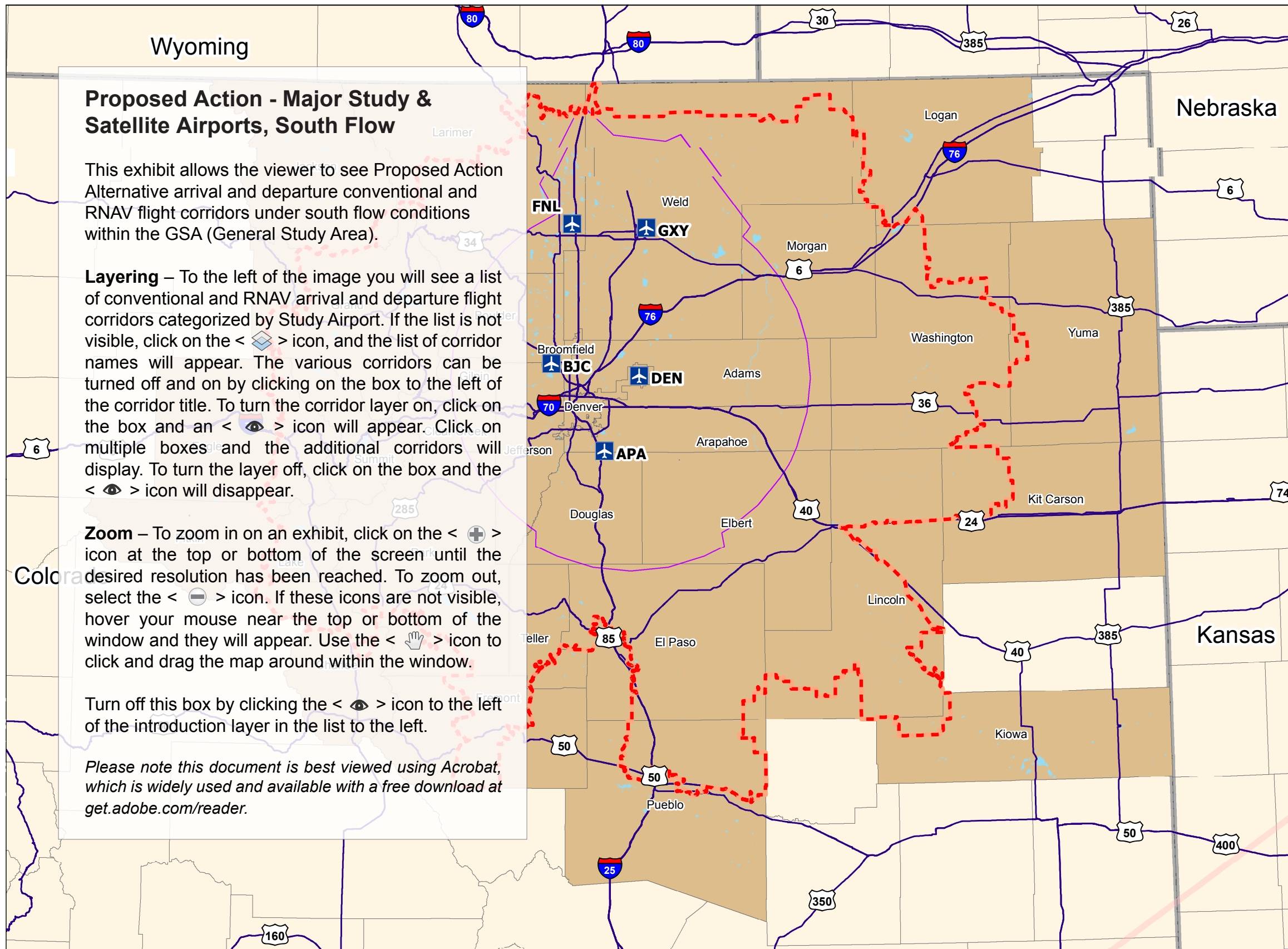
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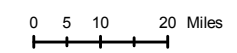


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Proposed Action - Major Study & Satellite Airports, South Flow

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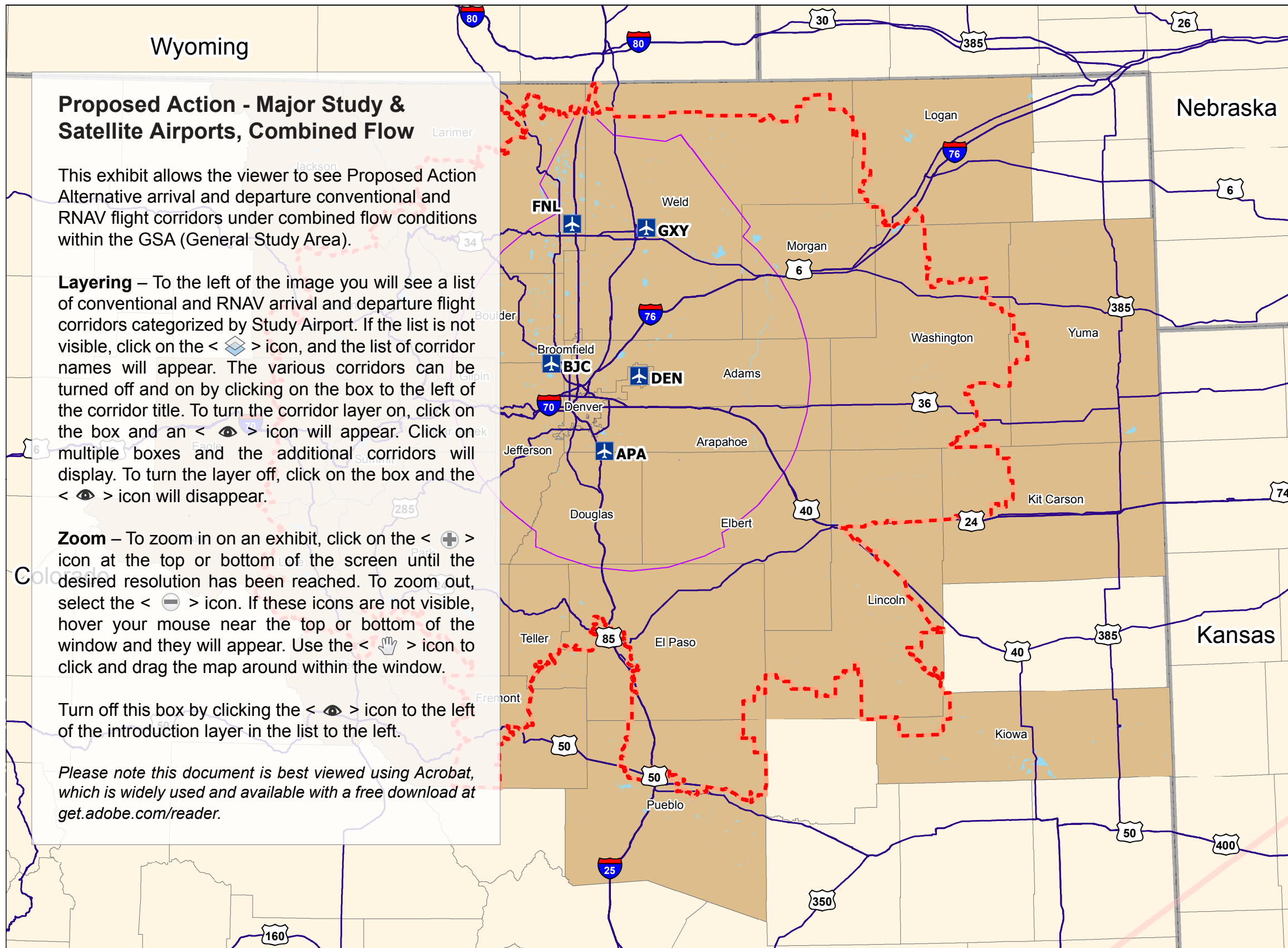
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Exhibit 3-11

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Proposed Action - Major Study & Satellite Airports, Combined Flow

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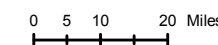
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Exhibit 3-12

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3.3 Summary Comparison of the Proposed Action and No Action

This section provides a comparative summary between the No Action and Proposed Action based on the objectives defined in Section 2.2:

- Improve the flexibility in transitioning traffic between en route and terminal area airspace and between terminal area airspace and the runways;
- Improve the segregation of arrivals and departures in terminal area airspace and en route airspace; and,
- Improve the predictability of air traffic flow for traffic transitioning between en route and terminal area airspace and between terminal area airspace and the runways.

3.3.1 Improve the Flexibility in Transitioning Aircraft

Section 2.2.1 includes two criteria established to measure the objective to increase the flexibility in transitioning aircraft between the terminal airspace area and the en route airspace:

- Where possible, increase the number of available transitions compared with the No Action (measured by number of exit/entry points).
- Where possible, increase the number of RNAV STARs and SIDs compared with the No Action (measured by total count of RNAV STARs and RNAV SIDs for each of the Study Airports.)

Table 3-3 provides a summary comparison of the Proposed Action and No Action based on the criteria defined above. Under the No Action, there are 81 IFR entry points into the DEN Metroplex airspace and 46 exit points. Under the Proposed Action, the number of IFR entry points decreases to 63, while the IFR exit points increase to 64. This balance allows for more efficient use of the airspace. The decrease in IFR entry points is due to the elimination of unused transitions and combining routes that were previously specific to defined Study Airport runway configuration.

Under the No Action, there are 127 en route transitions and 113 runway transitions. Under the Proposed Action the number of en route transitions remains unchanged at 127 and the number of runway transitions increases to 219. It should be noted that there are additional en route transitions for departures increasing the flexibility for routing associated with departing aircraft. The decrease in en route transitions for arriving aircraft is not expected to reduce flexibility, as the transitions that were eliminated were not used or infrequently used and their elimination allowed for the development of other routings thereby increasing flexibility. The additional runway transitions allow controllers to assign aircraft to routes that were not available previously.

Table 3-3 Alternatives Evaluation: Improve Flexibility in Transitioning Aircraft

Criteria	Alternative	
	No Action	Proposed Action
Total Entry Points	81	63
Total Exit Points	46	64
Total Enroute Transitions	127	127
Total Runway Transitions	113	219

Notes:

*A runway transition is counted if it is a unique path (identical paths serving more than one runway are counted only once) and there is at least one waypoint or fix beyond the common route.

Sources: Denver Metroplex Study Team, November 2014.

Prepared by: ATAC Corporation, April 2019.

3.3.2 Segregate Arrival and Departure Flows

Section 2.2.2 includes one criterion to measure the objective to increase flexibility in transitioning aircraft between the terminal area airspace and en route airspace:

- Segregate arrival and departure traffic (measured by number of RNAV STARs and/or SIDs that can be used independently to/from Study Airports).

Table 3-4 provides a summary comparison of the Proposed Action and No Action based on the criteria defined above. Under the No Action, there are 15 independent RNAV ATC procedures. The Proposed Action has 24 independent RNAV ATC procedures. The greater number of independent RNAV routes allows for greater segregation of arrival and departure flows. Most notable is the segregation of DEN traffic from nearby airport traffic which was achieved by increasing the number of independent ATC procedures at DEN from 14 to 24.

Table 3-4 Alternatives Evaluation: Segregate Arrival and Departure Flows

Criteria	Alternative	
	No Action	Proposed Action
Number of Independent RNAV Procedures		
DEN	14	24
APA	1	0
BJC	0	0
FNL	0	0
GXY	0	0

Sources: Denver Metroplex Study Team, November 2014.

Prepared by: ATAC Corporation, February 2019.

3.3.3 Improve Predictability of Air Traffic Flow

Section 2.2.3 includes two criteria to measure the objective to increase flexibility in transitioning aircraft between the terminal area airspace and en route airspace:

- RNAV ATC procedures with altitude controls intended to optimize descent or climb patterns (measured by count of ATC procedures with altitude controls);
- Ensure that the majority of STARs and SIDs to and from the Study Airports are based on RNAV technology (measured by count of RNAV STARs and SIDs for an individual Study Airport).

Under the No Action, 35 of the ATC procedures include altitude controls that define or limit vertical ranges of altitudes within which aircraft may operate. In comparison, the Proposed

Action includes 33 ATC procedures with altitude controls. Although this indicates a reduction of two ATC procedures, additional analysis demonstrates that when accounting for the ATC procedures that were combined (reducing the STARS from 24 to 16), there is an actual increase in the routing that include altitude controls (i.e. if the ATC procedures had not been combined there would be 41 ATC procedures with altitude controls).

Table 3-5 provides a summary comparison of the Proposed Action and No Action based on the criteria defined above. The total number of RNAV ATC procedures serving study airports increases from 85 under the No Action to 100 under the Proposed Action. Both the No Action and the Proposed Action have a total of 70 conventional ATC procedures. Under the Proposed Action, four of these conventional ATC procedures were retained for non RNAV equipped aircraft and adjusted to more closely align with the proposed new RNAV ATC procedures.

Table 3-5 Alternatives Evaluation: Improve Predictability of Air Traffic Flow

Criteria	Alternative	
	No Action	Proposed Action
DEN	31	32
APA	18	22
BJC	17	20
FNL	17	19
GXY	2	7

Sources: *Denver Metroplex Study Team Final Report*, November 2014. *Denver Metroplex Design and Implementation Team Final Report*. March 2019

Prepared by: ATAC Corporation, April 2019.

3.4 Preferred Alternative Determination

Of the two Alternatives carried forward for analysis, the Proposed Action would better meet the Purpose and Need for the DEN Metroplex Project based on the criteria presented and referenced in this and prior Chapters of this EA document. Therefore, the Proposed Action is the Preferred Alternative. Although it would not meet the Purpose and Need, the No Action was carried forward, as required by Council on Environmental Quality (CEQ) regulations, to establish a benchmark against which decision makers can measure the environmental effects of undertaking the Preferred Alternative.

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