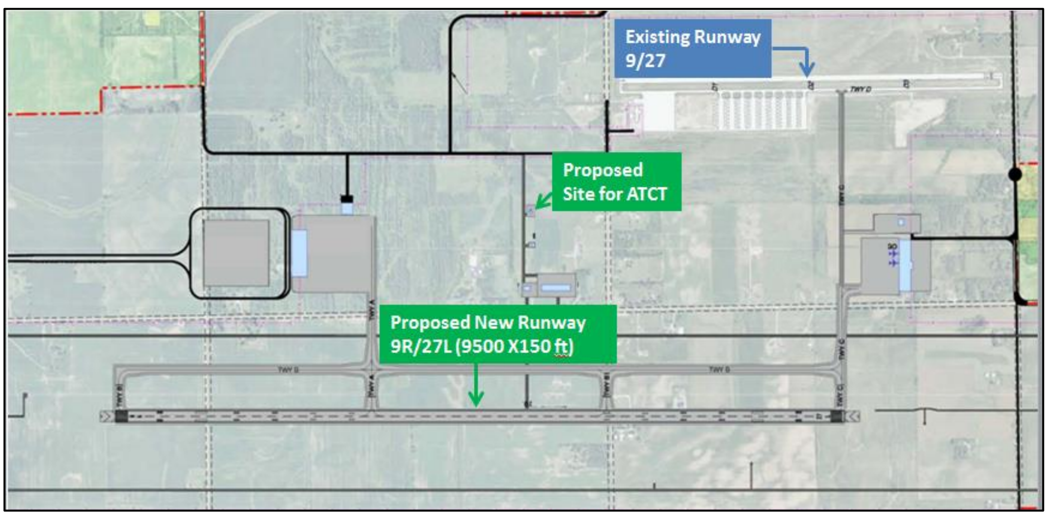
Federal Aviation
Administration

Initial Airspace and Procedures Feasibility Analysis for the Proposed South Suburban Airport (SSA)



PREPARED FOR

ILLINOIS DEPARTMENT OF TRANSPORTATION

BY

FEDERAL AVIATION ADMINISTRATION

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Abstract

Illinois Department of Transportation (IDOT) sponsored a study team (Analysis Team) to analyze the existing Chicago metropolitan area airspace structure, proposed South Suburban Airport (SSA), and to determine the feasibility and challenges of integrating a future supplemental commercial airport into the existing structure.

The Analysis Team examined the integration of the proposed South Suburban Airport, in Will County, IL, using design and modeling tools to vet notional procedures and conceptual airspace designs. The Analysis Team designed the proposed SSA notional procedures and conceptual airspace to have minimal impacts on other Chicago metropolitan area airport operations, and integration into the airspace structure.

This document details the findings of the Analysis Team.

Executive Summary

In May 2014, the Federal Aviation Administration's (FAA) Air Traffic Organization (ATO) committed to an analysis of the proposed South Suburban Airport. The Illinois Department of Transportation (IDOT) sponsored the analysis effort, conducted between July 2014 and December 2014.

The Analysis Team includes representatives from:

- FAA ATO Airspace Services
- National Air Traffic Controller Association (NATCA) Article 48 Representative
- Chicago Terminal Radar Approach Control (C90)
- Chicago Air Route Traffic Control Center (ZAU)
- MITRE Corporation's Center for Advanced Aviation System Development (CAASD)
- CSSI Inc.
- ATAC Inc.
- Human Solutions Inc. (HSI)

Proposed SSA Initial Airspace and Procedures Analysis' primary objective was to examine the existing Chicago metropolitan area air traffic and airspace structure to determine the feasibility and challenges of integrating a supplemental commercial airport, proposed SSA, into the existing structure. The Analysis Team's body of work describes the notional procedures and conceptual airspace. The document does not propose solutions, which were beyond the scope of this initial study.

Analysis demonstrated, through both quantitative modeling and qualitative simulation, that the notional procedures support the Date of Beneficial Occupancy year one (DBO+1) through Date of Beneficial Occupancy year five (DBO+5) projections with minimal impact to ORD, MDW and other Chicago metropolitan area airport operations.

The Analysis Team utilized AirTOp modeling and I-SIM simulation to evaluate design concepts and to visualize design impacts. Of particular importance, AirTOp results showed substaintial level-offs for proposed SSA departures on the RWY09R EAST SID and RWY27L WEST SID, due to altitude restrictions and the requirement for prearranged coordination climb operations.

The combination of the AirTOp and I-SIM analysis aided in identifying potential hot spot, increased coordination, and proposed SSA airspace proximity issues not related to traffic volume. I-SIM analysis also confirmed complexity and controller workload impacts.

Due to the proximity of proposed SSA airport to C90 airspace, two conceptual airspaces were designed to provide alternatives in ATC service providers and support the unique operational procedures that each facility provides. Airspace design considerations were incorporated to address proposed SSA Class D, route structure, radar coverage, Special Use Airspaces (SUA), and adjacent facility altitude and boundary stratums.

Further study must be undertaken to evaluate differing separation standards and traffic volume impacts influenced by potential gains in efficiency. The team members believe that terminalization of the proposed SSA airspace should be considered. proposed SSA proximity to C90 airspace and the required ZAU conceptual airspace 3000' Class D/final approach shelf (35 NM long and 3 NM wide) that conflicts with current MDW and other C90 satellite traffic flows, adds challenges to airspace utilization and requirements.

Notional procedure design presented additional and unique challenges particularly the two routes transiting C90 airspace. All procedures were designed with scope of work limitations affecting potential design alternatives. Considerations in design were made for Special Use Airspace (SUA), skydive operations, and minimal number of altitudes available for new streams of traffic. Due to traffic complexity and volume, RWY27L WEST SID and RWY09R EAST SID are not separated procedurally from the ORD/MDW traffic. Additionally, C90 internal sectorization would require controllers to work divergent streams of traffic simultaneously (i.e. same controller working proposed SSA departures and MDW arrivals). Analysis Team maintains that these routes are not supportable beyond DBO+5 traffic levels.

Conclusion

Within the scope of the 2009 FAA agreed to traffic forecast data for proposed SSA DBO+1 through DBO+5, the integration of proposed SSA in the Chicago metropolitan airspace structure is feasible. The notional STARs, SIDS, and conceptual airspace designs were solely designed to evaluate the feasibility of proposed SSA integration within those set parameters and not intended for implementation. Workload, complexity, and coordination are the three major challenges due to the close proximity of ORD, MDW and C90 airspace. The actual integration of proposed SSA will require extensive formal review and further study.

Safety Risk Management processes will be provided in furture detailed procedure development to ensure all safety issues are fully addressed.

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1 Introduction

This report documents the Federal Aviation Administration's (FAA) Air Traffic Organization (ATO) analysis of the proposed South Suburban Airport conducted from July 2014 to December 2014. Illinois Department of Transportation (IDOT) sponsored an Analysis Team including representatives from:

- FAA ATO Airspace Services
- National Air Traffic Controller Association (NATCA) Article 48 Representative
- Chicago Terminal Radar Approach Control (C90)
- Chicago Air Route Traffic Control Center (ZAU)
- MITRE Corporation's Center for Advanced Aviation System Development (CAASD)
- CSSI Inc.
- ATAC Inc.
- Human Solutions Inc. (HSI)

The purpose of the analysis was to examine the integration of the proposed South Suburban Airport (SSA), a new commercial service airport, into the existing Chicago metropolitan area airspace structure. To evaluate the system impacts in meeting future aviation demand in the south suburban Chicago metropolitan area, important analysis objectives included:

- Review of existing system characteristics and constraints pertaining to current and potential future area air traffic movement
- Consider the impacts of the proposed SSA Date of Beneficial Occupancy year one (DBO+1) and Date of Beneficial Occupancy year five (DBO+5) traffic projections.[1]
- Perform analysis to identify potential future capacity requirements and constraints
- Identify airspace and procedural challenges associated with the development of the proposed South Suburban Airport.
- Draft notional Instrument Flight Procedures (IFPs) and conceptual airspace configurations needed to support the proposed South Suburban Airport
- Perform simulation and modeling of notional procedures and conceptual airspace

2 Background

Prior to the 1990s, the City of Chicago and State of Illinois recognized the need for an additional commercial service airport to serve the greater Chicago metropolitan area. Through the 1990s

[1] IDOT (2009 and Amended 2014) SSA Forecast Data for DBO+1 and DBO+5 See Appendix A: Proposed South Suburban Airport Documentation Validation Letter

IDOT evaluated a number of sites for a proposed airport and selected a preferred location in Will County, Illinois.

The Federal Aviation Administration approved the proposed SSA site as a location for an airport in December 2002. IDOT has prepared a draft master plan and Airport Layout Plan for the proposed airport and acquired more than 3,900 acres of land including Bult Field to preserve the option of developing the proposed SSA. IDOT's Division of Aeronautics is the sponsor of the proposed SSA.

3 Study Area

The initial IDOT defined Study Area is the proposed SSA inaugural configuration, Chicago metropolitan area airspace, and adjacent facilities that influenced the team's analysis.

3.1 Proposed SSA Inaugural Configuration

The proposed inaugural SSA is located in Will County, Illinois. IDOT's proposed South Suburban Airport plan includes the existing airfield plus an inaugural commercial service runway, taxiways, air traffic control tower and passenger/cargo facilities (Illustrated in Figure 3.1).

Figure 3.1. Proposed SSA Inaugural Airport Configuration

3.1.1 Infrastructure

IDOT plans to add new infrastructure to ready proposed SSA for commercial operations.

3.1.1.1 Tower

Per IDOT, the inaugural configuration of proposed SSA will include an operating control tower with discrete air/ground communication frequencies and associated Class D airspace.

3.1.1.2 Runways and Configuration

Per IDOT, the inaugural configuration of proposed SSA will include parallel runways: RWY09L/27R and RWY09R/27L. RWY09L/27R will measure 5,001 feet in length and 75 feet in width and will be served by an RNAV/GPS Instrument Approach. RWY09R/27L will measure 9,500 feet in length and 150 feet in width and will be served by an RNAV/GPS Instrument Approach.

3.1.1.3 Passenger and Cargo facilities

Per IDOT, the inaugural configuration of proposed SSA will include a passenger terminal, air cargo handling facilities, and supporting infrastructure.

3.1.2 Traffic Demand

The analysis was focused on two periods, DBO+1 and DBO+5. Traffic demand was based on IDOT forecasts that were approved by the FAA. Table 3.1 list Airspace Modeling Parameters-Utilized by MITRE/proposed SSA Analysis.[2]

[2] IDOT (2009 and Amended 2014) SSA Forecast Data for DBO+1 and DBO+5 Note: traffic count is rounded. See Appendix A: Proposed South Suburban Airport Documentation Validation Letter. Note: IDOT Modeling Parameters Exhibits (Technical Memo, Exhibits 1-5) are archived in FAA Repository System for reference.

Table 3-1. Airspace Modeling Parameters-Utilized by MITRE/SSA Analysis Team

Airspace Modeling Parameters – Utilized by MITRE/SSA Analysis Team		
Aeronautical Modeling Components	DBO+1	DBO+5
	Daily Schedule	Daily Schedule
Commercial Passenger Operations	4	30
Commercial Air Cargo Operations	0	4
GA IFR Turbine/Turbo-Prop Operations on Commercial Runway	21	25
GA IFR SEL/MEL Operations on Commercial Runway	8	6
GA VFR Operations on GA Runway	101	108
Total Operations – Commercial/GA Runways	134	173
Total Operations – Commercial/GA Runways	40200	51900

3.2 Existing and Future System Characteristics and Design Constraints

This section describes existing system characteristics and constraints pertaining to current and future area air traffic movement for the establishment of the proposed SSA.

3.2.1 Existing Air Traffic Service Provider

ZAU is the air traffic service provider for the current C56. Second tier services are provided by C90 and South Bend TRACON (SBN).

3.2.1.1 Current Constraints

The Analysis Team identified challenges that needed to be addressed during the design process. Due to the close proximity of C90 airspace to C56, controller and pilot task saturation is increased with additional coordination and radio communications. Airspace proximity complications restrict northbound navigation from C56 below 16,000 feet. ZAU currently uses en route lateral separation standard of 5 nautical miles (NM), compared to C90 that uses terminal lateral separation of 3 NM. Without an operating control tower at C56 IFR operations are limited in uncontrolled airspace. Limited radar coverage and radio communications further limit airport capacity and throughput.

3.2.1.2 Design Consideration

The Analysis Team determined that considerations would be included in the design development process to mitigate the current constraints. Conceptual airspace, which includes Class D airspace, would reduce controller and pilot workload, coordination, and radio communications. A control tower and Class D airspace would increase throughput and airport capacity. Improved radar coverage and resulting application of terminal radar separation rules (3 NM), would also increase airport capacity and throughput. Proposed RNAV procedures allow for repeatable and predictable arrival and departure flight paths with increased aircraft navigation guidance accuracy and reduced pilot/controller workload.

3.2.1.3 Future Constraints

The Analysis Team identified issues that were not in scope or could not be addressed in this Report but worthy of note. Proximity to ORD and MDW, and an increase of proposed SSA traffic beyond DBO+5 forecasts, would present challenges to integration with C90, SBN, and ZAU traffic flows. For example, the opportunity for procedure optimization due to constrained airspace and ORD/MDW traffic volume is extremely limited.

3.2.2 Existing Airports

3.2.2.1 Bult Field (C56)

Bult Field had 13,140 operations in 2013, consisting mainly of GA traffic. It has one runway, RWY09/27 that is 5,001 feet long by 75 feet wide with full concrete parallel taxiway and connectors (Illustrated in Figure 3.2)

Figure 3.2. C56 Airport

3.2.2.2 Chicago O'Hare International Airport (ORD)

ORD provides domestic and international commercial services to include a mix of passenger, air cargo, corporate and general aviation (GA). ORD is located approximately 40 NM north of proposed SSA, occupies approximately 7,200 acres, and was the nation's second busiest airport in 2013 with 883,287 operations.

Existing Runways and Configurations

ORD has four sets of parallel runways ranging in length from 7,500 to 13,000 feet (Illustrated in Figure 3.3).

Figure 3.3. ORD Airport

Table 3-2 provides information on ORD runways dimensions and associated instrument approaches.

Table 3-2. ORD Runway Dimensions and Instrument Approaches

Runways	Dimensions (feet)	Instrument Approaches
04L/22R	7,500 x 150	RNAV/GPS (04L)/CAT I ILS (22R)
04R/22L	8,075 x 150	CAT I ILS (04R/22L)
09L/27R	7,500 x 150	CAT II/III ILS (09L/27R)
09R/27L	7,967 x 150	CAT I ILS (09R/27L)
10L/28R	13,000 x 150	CAT II/III ILS (10L/28R)
10C/28C	10,801 x 200	CAT II/III ILS (10C/28C)
14L/32R	10,005 x 150	CAT II/III ILS (14L)/CAT I ILS (32R)
14R/32L	9,686 x 200	CAT II/III ILS (14R)

3.2.2.3 Chicago Midway International Airport (MDW)

MDW provides domestic and international commercial services to include a mix of passenger, air cargo, corporate and general aviation (GA). MDW is located approximately 28 NM north of proposed SSA and occupies approximately 840 acres and accommodated 252,126 takeoffs and landings in 2013.

MDW Existing Runways and Configurations

The airport has two sets of parallel runways ranging in length from 3,859 feet to 6,522 feet (Illustrated in Figure 3.4).

Figure 3.4. MDW Airport

Table 3-3 provides information on MDW runways dimensions and associated instrument approaches.

Table 3-3. MDW Runway Dimension and Associated Instrument Approaches

Runways	Dimensions (feet)	Instrument Approaches
04L/22R	5,507 x 150	RNAV/GPS
04R/22L	6,445 x 150	CAT I ILS (04R) RNAV/GPS (22L)
13L/31R	5,141 x 150	RNAV/GPS
13C/31C	6,522 x 150	CAT I ILS
13R/31L	3,859 x 60	RNAV/GPS

3.2.2.4 Adjacent Airports

Appendix B: Adjacent Airports, provides a basic information tabulation regarding Study Area adjacent airports that were considered having relevance to this analysis.

3.2.2.5 Satellite Airports

Appendix C: Satellite Airports, provides a basic information tabulation regarding Study Area satellite airports that were considered having relevance to this analysis. In Figure 3.5 Study Area satellite airports are depicted.

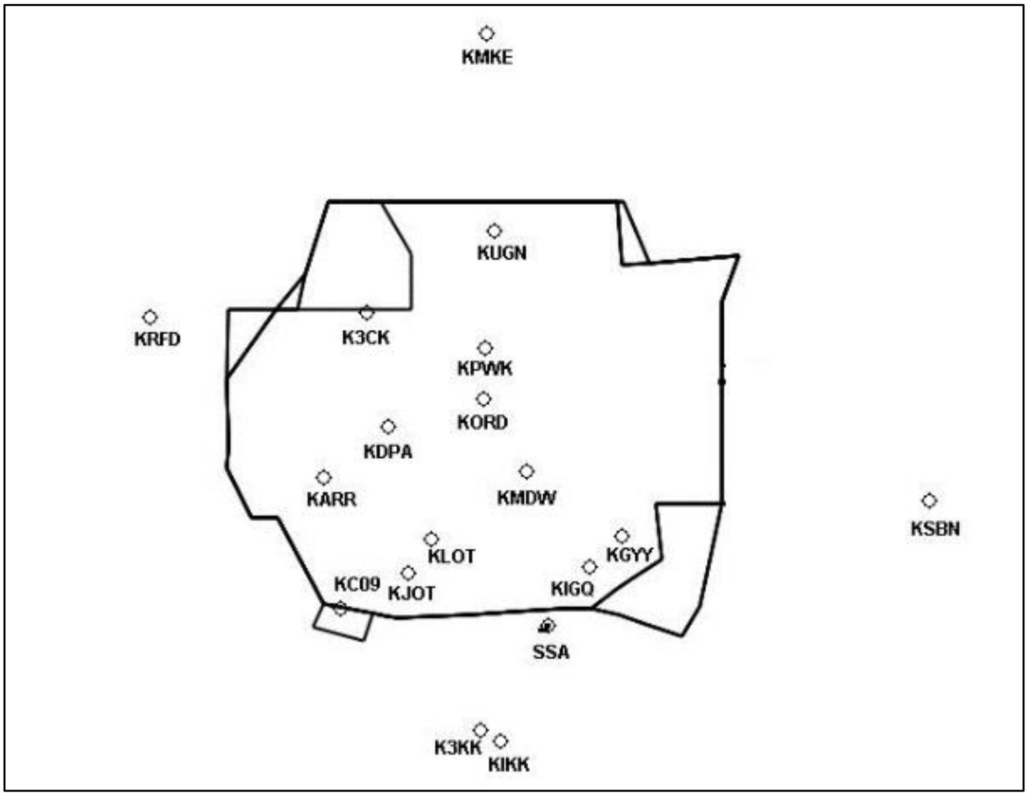

Figure 3.5. Study Area Satellite Airports

3.2.3 Airspace Design Considerations

This section describes the system characteristics that influenced the conceptual airspace design process. The Analysis Team was tasked with identifying conceptual airspace, including Class D airspace, which would reduce controller and pilot workload, coordination, and radio communications. An operating control tower and Class D airspace would also increase throughput and airport capacity.

3.2.3.1 ZAU Airspace

The ZAU airspace encompasses 91,000 square NM of the Midwestern United States including parts of Illinois, Indiana, Michigan, Wisconsin, and Iowa. ZAU is the 5th-busiest ARTCC in the United States. Between January 1, 2012, and December 31, 2012 (latest available information), ZAU handled 2,343,281 aircraft operations.

ZAU Airspace Considerations

The special use airspace (Hilltop MOA and 12 NM E/W MOA 34 NM southeast of proposed SSA), the (IKK) Skydive operations area located 18 NM south of proposed SSA (See Appendix D: Special Use Airspace), and proposed SSA Class D/final approach airspace were considered in the design of the conceptual airspace. Current ZAU Sector 50/57 boundary (12 NM west of proposed SSA) and overflights circumnavigating the C90 airspace also influenced the design of conceptual airspace boundaries.

ZAU Future Airspace Considerations

Future airspace consideration must be given to optimizing conceptual airspace altitude stratum, refining facility/sector boundaries, and improving Standard Operating Procedures (SOP) and Letter of Agreement (LOA) efficiency.

3.2.3.2 C90 Airspace

C90 is located in Elgin, Illinois. The lateral dimension of the airspace is approximately a 40 NM radius surrounding the ORD airport. The vertical dimension is surface to 15,000 feet. proposed SSA is located 3 NM south of the southern boundary of C90 airspace.

C90 Airspace Considerations

The location of proposed SSA (3 NM south of C90 boundary), the IKK Skydive operation (located 21 NM south of C90 boundary), proposed SSA Class D airspace, current C90 airspace (designed primarily for ORD and MDW traffic), and existing C90 FUSION[3] Radar coverage (See Appendix E: Radar Coverage Map) were considered in the conceptual airspace.

C90 Future Airspace Considerations

Future airspace consideration must be given to optimizing conceptual airspace altitude stratum, refining facility/sector boundaries, and improving SOP/LOA efficiency.

3.2.3.3 South Bend Airspace

South Bend International Airport (SBN) is a public use airport 3 NM northwest of South Bend, in St. Joseph County, Indiana. It is the state's second busiest airport in terms of commercial traffic after Indianapolis International Airport. The airport had 33,122 aircraft operations in calendar year 2013.

SBN Airspace Considerations

SBN western boundary is 22 NM from proposed SSA. Conceptual airspaces' eastern lateral boundaries were designed to abut SBN airspace boundary and the conceptual airspaces' vertical limits of 10,000 feet were designed to coincide with SBN vertical airspace limits.

SBN Future Airspace Considerations

Future SBN airspace considerations must be given to optimizing altitude stratums, refining adjacent facility boundaries, and improving SOP/LOA efficiency.

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[3] FUSION performance is characteristic of a single-sensor radar display system. Terminal areas use mono-pulse secondary surveillance radar (ASR-9, Mode S). The performance of this system will be used as the baseline radar system to ensure minimal degradation of current separation operations within the NAS. From N JO 7110.588

3.2.4 Procedure Design Considerations

This section describes system characteristics that were considered during notional procedure design.

3.2.4.1 Current Procedure Considerations

In the design of notional procedures, the Analysis Team considered:

- IKK skydive jump zone
- Overflights circumnavigating C90 airspace and non-over water routes
- Holding traffic at IKK VOR/DME and EON VORTAC for proposed SSA airport
- C90 arrivals and departures
- V38 is an east/west airway approximately 5 NM south of proposed SSA

3.2.4.2 SSA Procedure Influencers

MDW STARs - Standard Terminal Arrivals

- ENDEE THREE (RNAV)
- FISSK THREE (RNAV)
- GOSHEN FIVE
- MOTIF FOUR
- PANGG TWO (RNAV)

MDW Departure Procedures

- MIDWAY ONE
- CICERO SEVEN

ORD STARs - Standard Terminal Arrivals

- BENKY TWO (RNAV)
- ESSPO ONE (RNAV)
- KNOX FOUR
- TRIDE TWO (RNAV)
- TRTLL TWO (RNAV)
- VEECK ONE (RNAV)
- WATSN TWO (RNAV)
- BRADFORD FIVE

ORD Departure Procedures

- O'HARE EIGHT

3.2.4.3 Procedure Mitigations

Notional procedures, where possible, were designed to procedurally separate from ZAU and C90 traffic and avoid the IKK skydive jump zone.

3.2.4.4 Potential Future Considerations

In future design of notional procedures, the following should be considered:

- Possible T-Route for satellite arrivals and overflights
- SSA holding patterns development
- Routing proposed SSA north, west, and east departures southbound over ADELL and ELANR to mimic the O'HARE EIGHT DEPARTURE
- Further evaluation of the proposed SSA SIDs through C90 airspace

4 Proposed SSA Design

4.1 Proposed Airspace and Procedure Designs

The Analysis Team used the data compiled in Section 3 to guide them in developing notional procedures and conceptual airspace.

4.1.1 Proposed Airspace Design

Two conceptual airspaces were developed to address notional procedure, radar coverage, controller workload, boundary proximity, altitude stratum, and SUA design considerations.

4.1.2 Proposed Procedure Design

The primary goal was to develop RNAV STARS and SIDs in order to integrate the proposed proposed SSA into the Chicago metropolitan airspace structure. The use of these procedures allow enhanced lateral and vertical paths, providing predictability and repeatability, while reducing ATC task complexity and frequency congestion. The notional SSA STARs and SIDs attempt to procedurally segregate SSA traffic from existing ORD/MDW traffic, while keeping level offs to a minimum.

4.1.3 Design Assumptions and Constraints

Prior to developing SSA notional procedures, the Analysis Team created a Design Assumption Matrix to identify current system characteristics and Study Area considerations that would influence integration of those notional procedures. (Appendix F: Design Assumption Matrix, contains the complete tabulation of those assumptions) This section delineates the most salient constraints and assumptions.

4.1.3.1 Assumptions

Proposed SSA will have an Air Traffic Control Tower with Class D airspace. Conceptual SSA airspace will be surface to 10,000 feet. Traffic operating at proposed SSA will be 100% RNAV equipped aircraft supporting future equipment requirements. Notional procedures will be designed free of legacy infrastructure constraints and will not adversely affect ORD and MDW traffic. **The notional SIDS/STARS will be designed for feasibility assessment not environmental analysis or implementation.**

4.1.3.2 Constraints

The notional procedures must be designed with minimal impact to current ORD and MDW traffic patterns. ORD and MDW traffic limits routing options for proposed SSA. The Analysis Team did not account for northbound traffic in C90 airspace. Final runways headings are not assumed.

4.2 Analysis and Design Tools

Simulation and modeling tools were employed by the Analysis Team in the process of collecting and analyzing flight track data for designing notional procedures for SSA evaluation

4.2.1 I-SIM

I-SIM is a platform-independent integrated suite of products and applications for high-fidelity ATM/ATC simulation. The I-SIM suite allows users to create simulation environments (ARTS, STARS, HOST, and ERAM), import maps, rapidly create scenarios, drag-and-drop elements of airspace and flight routes design, and support all aircraft types with realistic performance characteristics. The system offers a reproduction of actual, recorded data (i.e. PDARS) that can be used to rapidly create, edit, and compare scenarios. PDARS data is available at all ARTCCs and larger TRACONs, permitting the user to select traffic scenarios for playback.

4.2.2 Terminal Area Route Generation Evaluation and Traffic Simulation (TARGETS)

The Terminal Area Route Generation Evaluation and Traffic Simulation (TARGETS) tool offers a unique combination of capabilities for the design, analysis, and operational assessment of procedures and airspace. Developed by The MITRE Corporation's Center for Advanced Aviation System Development (CAASD) under sponsorship of the Federal Aviation Administration (FAA), the tool is being used by a variety of FAA and non-government users supporting the implementation of area navigation (RNAV) and Required Navigation Performance (RNP) operations within the United States and internationally.

4.3 Airspace

The Analysis Team developed two conceptual airspace designs to highlight the pros and cons of which facility provides airspace services to proposed SSA. As mentioned in Section 3.2.3 an ARTCC and a TRACON conceptual airspace were analyzed.

4.3.1 ARTCC Conceptual Airspace

ARTCC conceptual airspace includes current ZAU Sector 57, the eastern portion of ZAU Sector 50, plus the addition of the airspace north of proposed SSA that will encompass the new Class D/final approach airspace. (Altitude limits of the Class D inclusion - SFC to 3,000 feet). The Class D inclusion will require a portion of the C90 south satellite airspace. The conceptual airspace will be the new ZAU Sector 59. (See Figure 4.1)

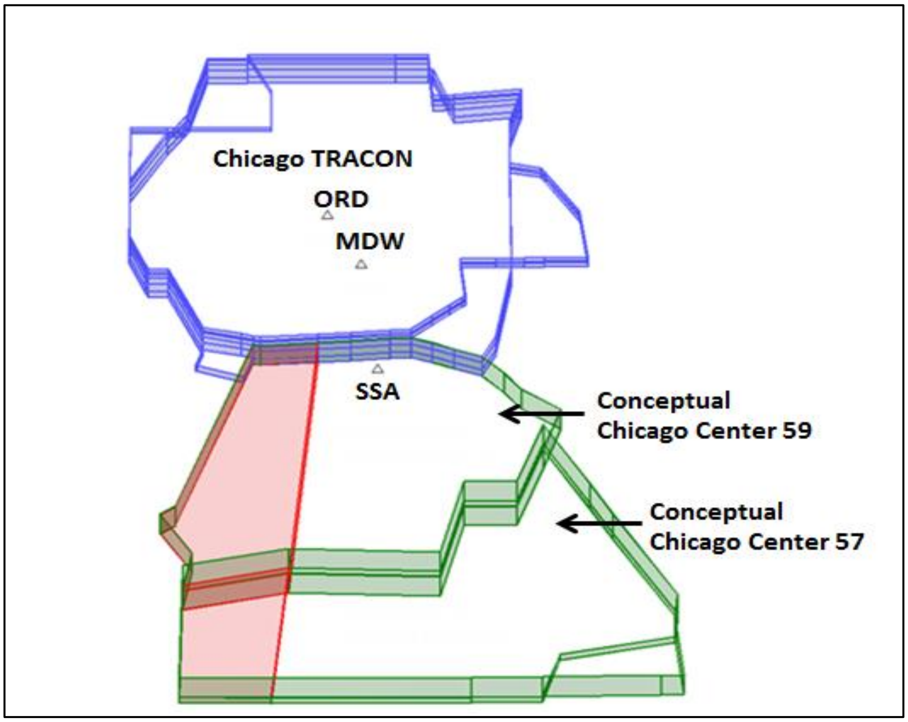


Figure 4.1. ARTCC Conceptual Airspace

4.3.2 TRACON Conceptual Airspace

C90 conceptual airspace includes current C90 airspace plus the addition of a new sector south of the current C90 southern boundary. The new sector will include parts of the northern portions of the current ZAU Sectors 50 and 57. The southern boundary of the new sector will extend approximately 25 NM south of the current C90 southern boundary (4.5 NM south of and parallel to V144). The north, east, and west boundaries will overlay the current C90 southern boundary, and the east and west boundaries of ZAU Sector 57. (See Figure 4.2)

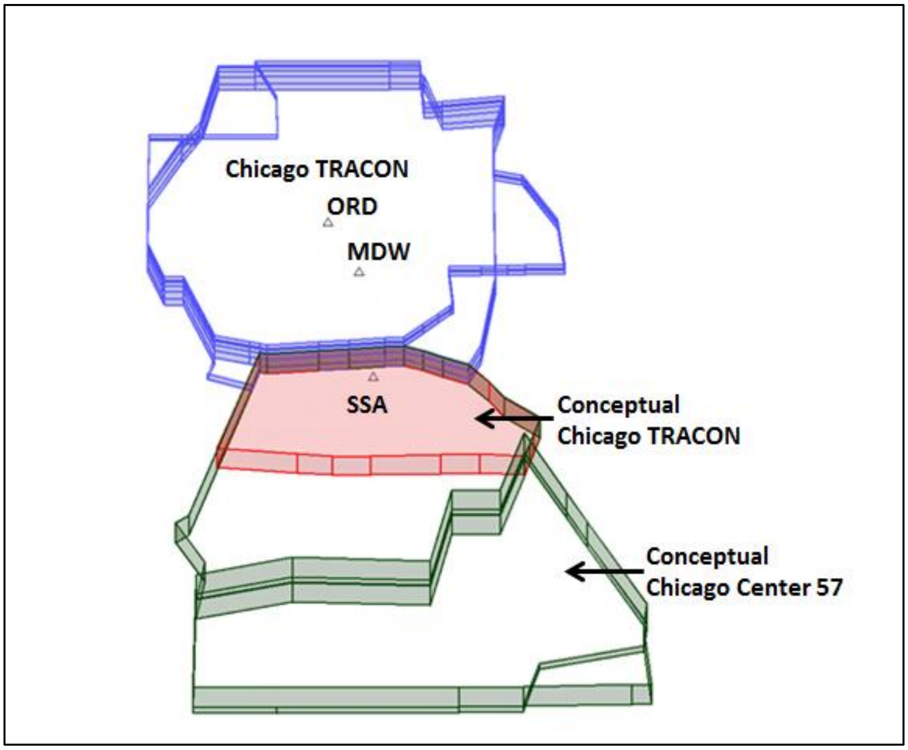


Figure 4.2. Conceptual TRACON Airspace

4.4 Notional Procedures Design

4.4.1 Notional STARs

The notional STARs developed allow enhanced lateral and vertical paths, providing predictability and repeatability, while reducing ATC task complexity and frequency congestion. The notional STARs attempt to procedurally segregate proposed SSA traffic from existing ORD/MDW traffic, while keeping level offs to a minimum.

4.4.1.1 WEST STAR

This notional STAR was designed with three en route transitions to serve proposed SSA traffic arriving from the southwest, west, northwest, and north (Illustrated in Figure 4.3).

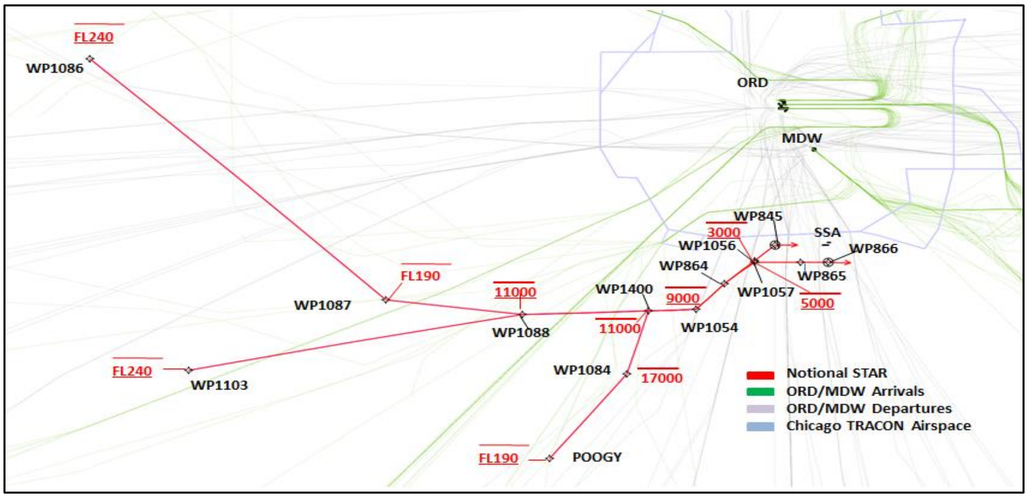


Figure 4.3. WEST STAR

En Route Transitions

The POOGY transition was designed for aircraft arriving from the south and southwest. POOGY and WP1084 are restricted to FL190 and at-or-below 17,000 feet, respectively, to segregate from the MDW ENDEE STAR (Illustrated in Figure 4.4).

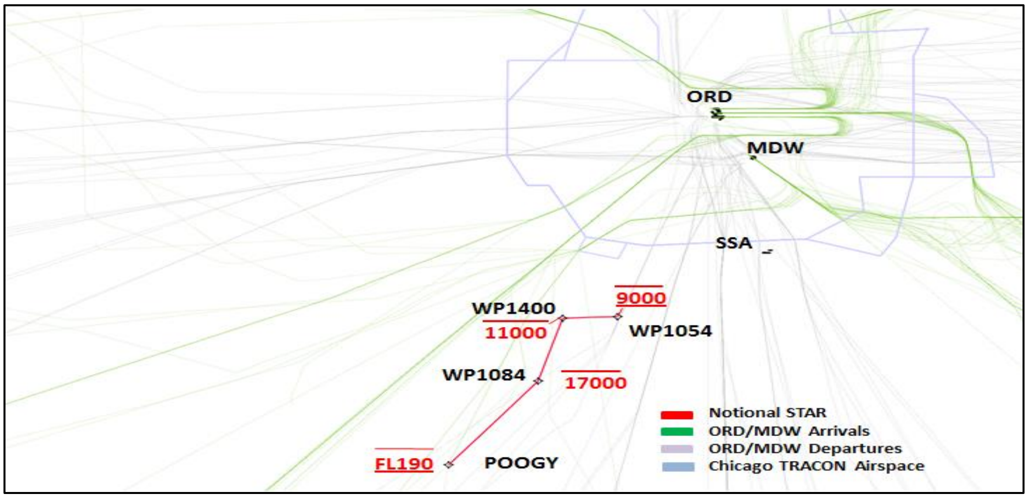


Figure 4.4. WEST STAR POOGY Transition

The WP1103 transition was designed for aircraft arriving from the west. WP1103 is located between two transitions of the MDW ENDEE STAR. WP1103 and WP1088 are restricted to FL240 and 11,000 feet, respectively, to segregate from the ENDEE STAR (Illustrated in Figure 4.5).

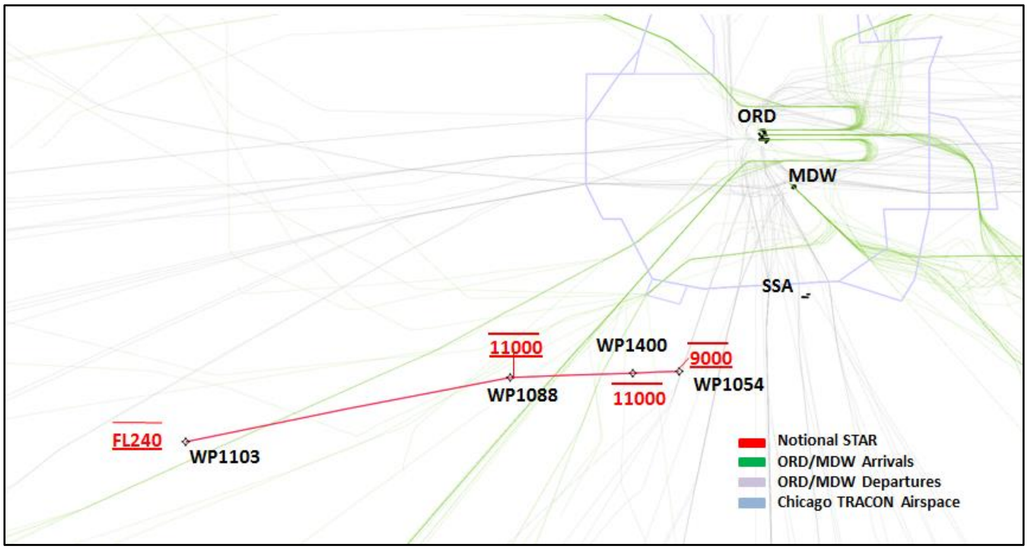


Figure 4.5. WEST STAR WP1103 Transition

The WP1086 transition was designed for aircraft arriving from the northwest and north. WP1086 is located 6 NM west of and parallel to the MDW ENDEE STAR. WP1087 and WP1088 are restricted to FL190 and 11,000 feet, respectively, to segregate from the ORD TRTLL and MDW ENDEE STARs (Illustrated in Figure 4.6).

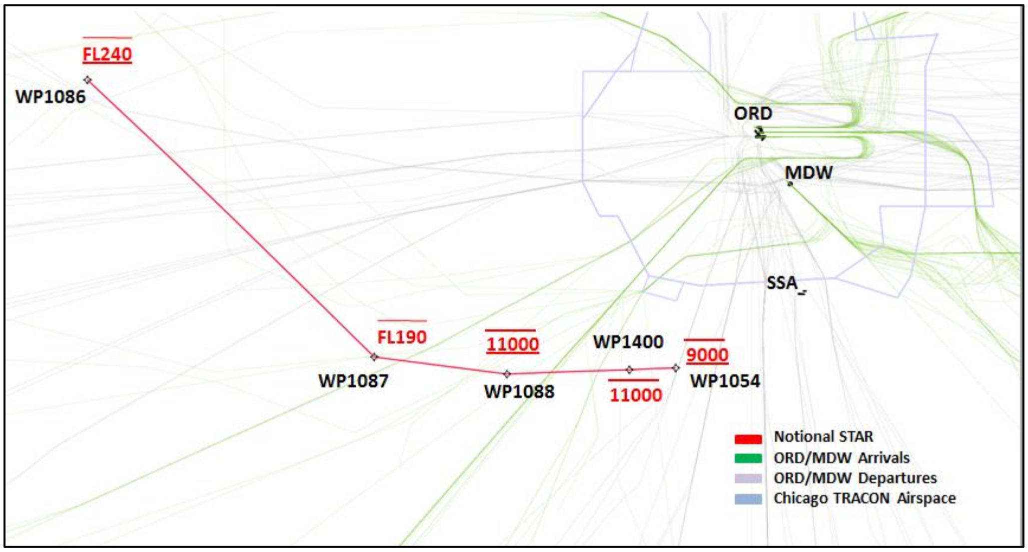


Figure 4.6. WEST STAR WP1086 Transition

Common Route

The common route is defined as WP1400..WP1054..WP864. WP1400 is restricted to at-or-below 11,000 to allow for sequencing and coordination. At WP1400 ZAU Sector 50 will initiate hand off to the conceptual sector (either C90 Sector or ZAU Sector) that will sequence proposed SSA arrivals. WP1054 is restricted to 9,000 feet to segregate from the SSA RWY09R W SID and the C90 south departures (Illustrated in Figure 4.7).

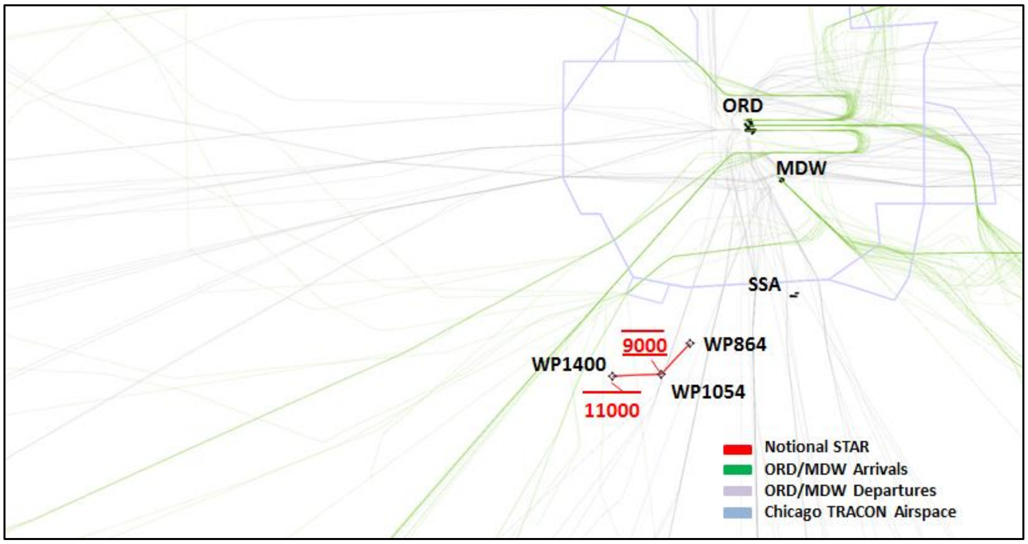


Figure 4.7. WEST STAR Common Route

Runway Transitions

RWY09R Runway Transition: WP864 defines the beginning of the runway transition. WP1056 restricted to 3,000 feet to segregate from the C90 satellite arrivals. WP1056 to WP845 defines the right base leg (Illustrated in Figure 4.8).

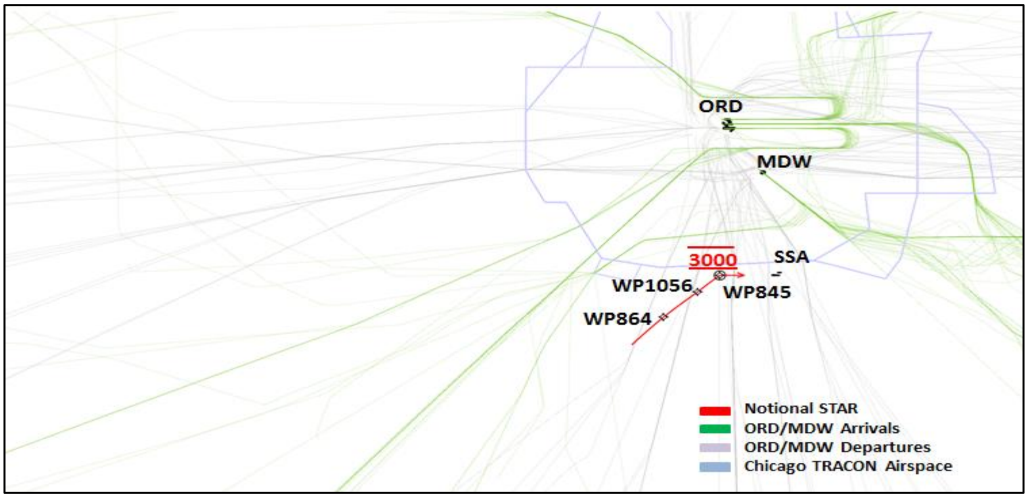


Figure 4.8. WEST STAR RWY09R Runway Transition

RWY27L Runway Transition: WP864 defines the beginning of the runway transition. WP1057 restricted to 5,000 feet to segregate from the C90 satellite arrivals and proposed SSA departure traffic. WP1057 to WP866 defines the left downwind leg (Illustrated in Figure 4.9).

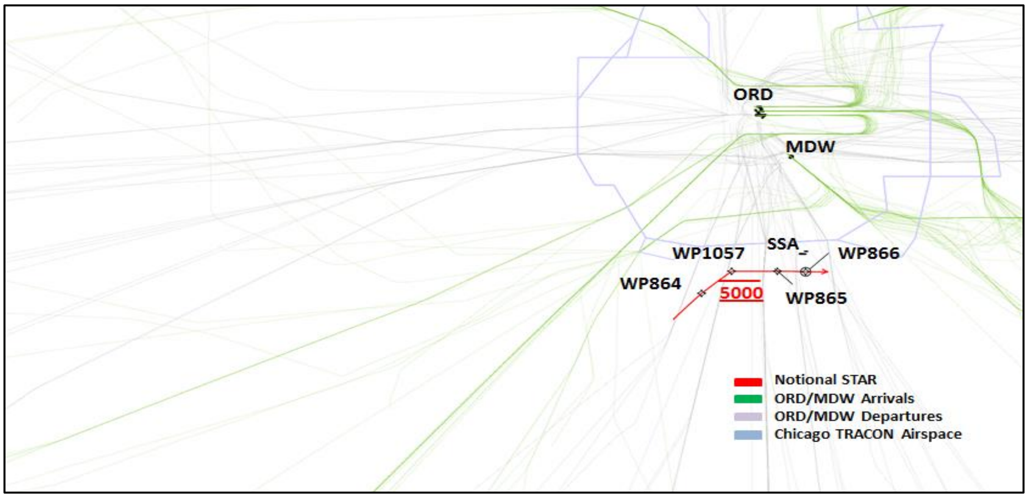


Figure 4.9. WEST STAR RWY27L Runway Transition

4.4.1.2 EAST STAR

This notional STAR was designed with three en route transitions to serve proposed SSA traffic arriving from the north, northeast, east and southeast (Illustrated in Figure 4.10).

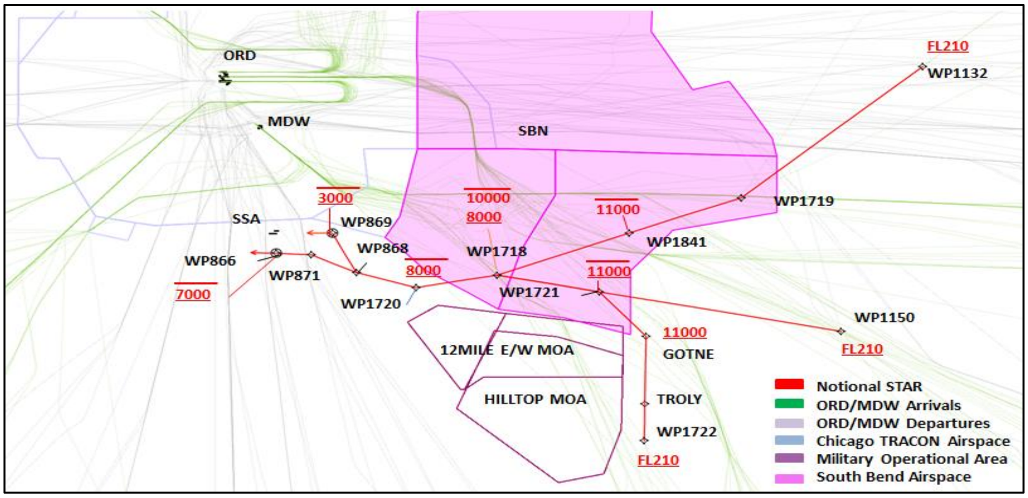


Figure 4.10. EAST STAR

<u>En Route Transitions</u>

The WP1132 transition was designed for aircraft arriving from the north and northeast. WP1132 is restricted to FL210 to segregate from the MDW PANNG STAR. WP1841 is restricted at-or-below 11,000 feet to transition the aircraft into South Bend (SBN) TRACON airspace (Illustrated in Figure 4.11).

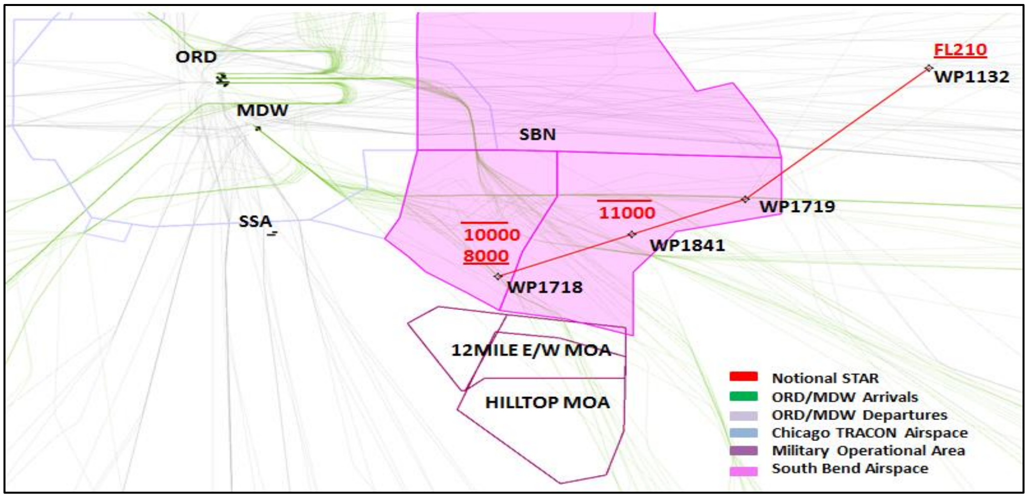


Figure 4.11. EAST STAR WP1132 En Route Transition

The WP1150 transition was designed for aircraft arriving from the east. WP1150 is located between the MDW FISSK and PANNG STARs. WP1150 and WP1721 are restricted to FL210 and 11,000 feet, respectively, to segregate from the MDW FISSK and PANNG STARs (Illustrated in Figure 4.12).

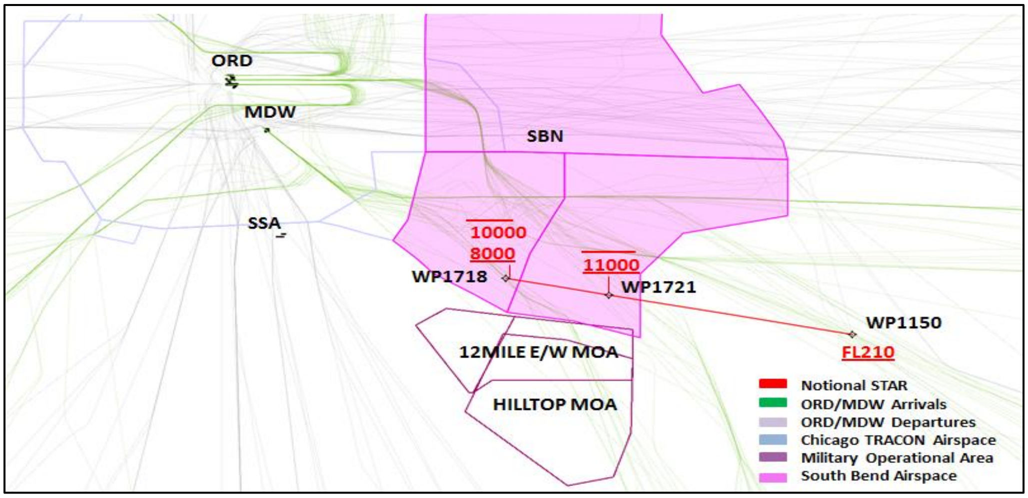


Figure 4.12. EAST STAR WP1150 En Route Transition

The WP1722 transition was designed for aircraft arriving from the southeast and south. WP1722, GOTNE, and WP721 are restricted to FL210, at-or-above 11,000 feet and 11,000 feet, respectively, to segregate from the MDW FISSK and PANNG STARs. The transition from WP1722 to GOTNE was positioned east of and parallel to Hilltop MOA. The segment from GOTNE to WP1721 was positioned northeast and parallel to the 12 NM MOA (Illustrated in Figure 4.13).

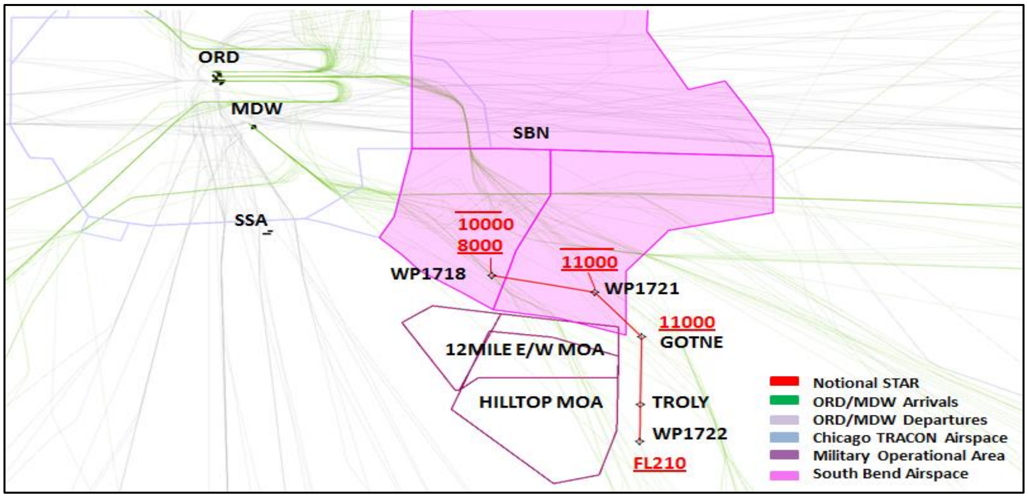


Figure 4.13. EAST STAR WP1722 En Route Transition

Common Route

The common route is defined as WP1718..WP1720..WP868. WP1718 has an altitude restriction of 8,000 feet to 10,000 feet to segregate from the MDW FISSK STAR and to allow for sequencing and coordination. WP1720 is restricted to 8,000 feet to segregate from the SSA RWY09R south departures climbing to 7,000 feet (Illustrated in Figure 4.14).

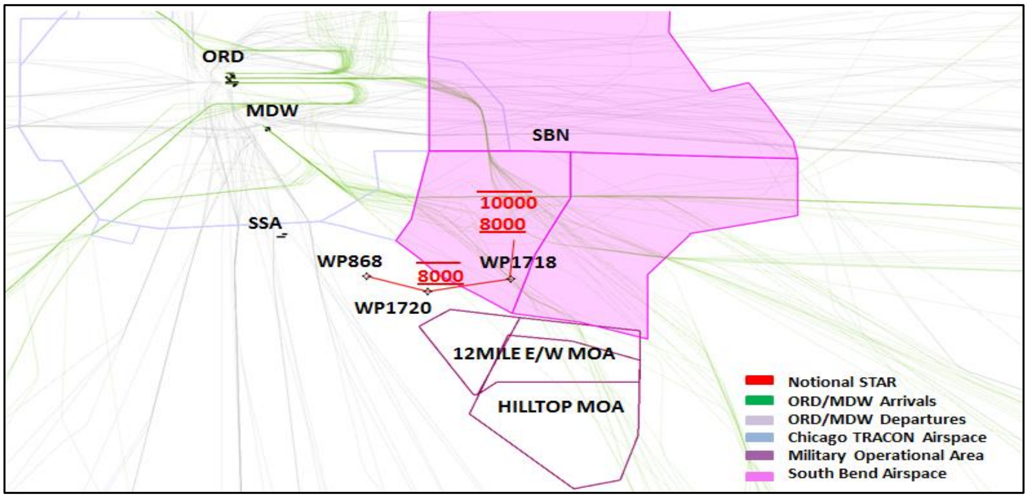


Figure 4.14. EAST STAR Common Route

Runway Transitions

Runway Transition RWY09R: the runways transition is defined as, WP868..WP871..WP866. WP866 is restricted to 7,000 feet to segregate from the C90 satellite arrivals and proposed SSA departure traffic. WP871 and WP866 define the right downwind leg (Illustrated in Figure 4.15).

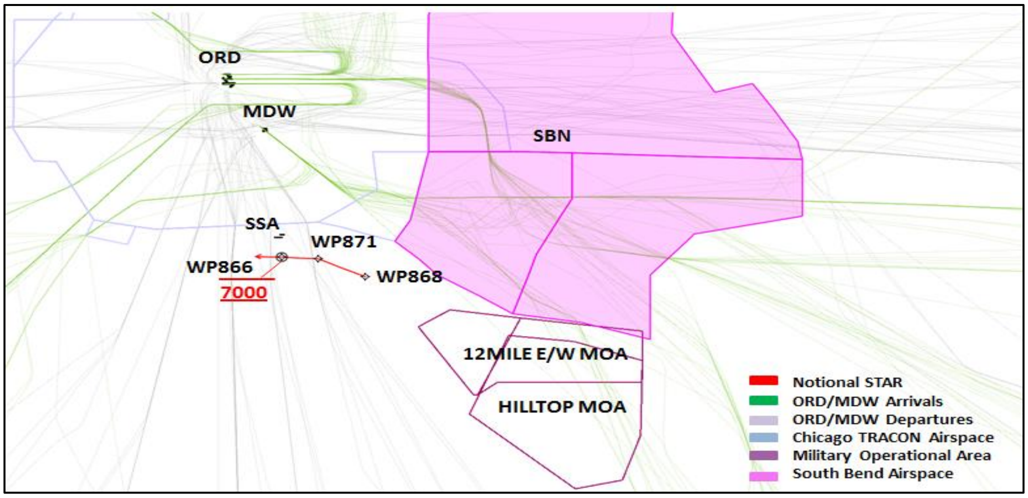


Figure 4.15. EAST STAR RWY09R Runway Transition

Runway Transition RWY27L: the runway transition is defined as WP868 ..WP869. WP869 is restricted to 3,000 feet to segregate from the C90 satellite arrivals. WP868 and WP869 define the modified left base leg (Illustrated in Figure 4.16).

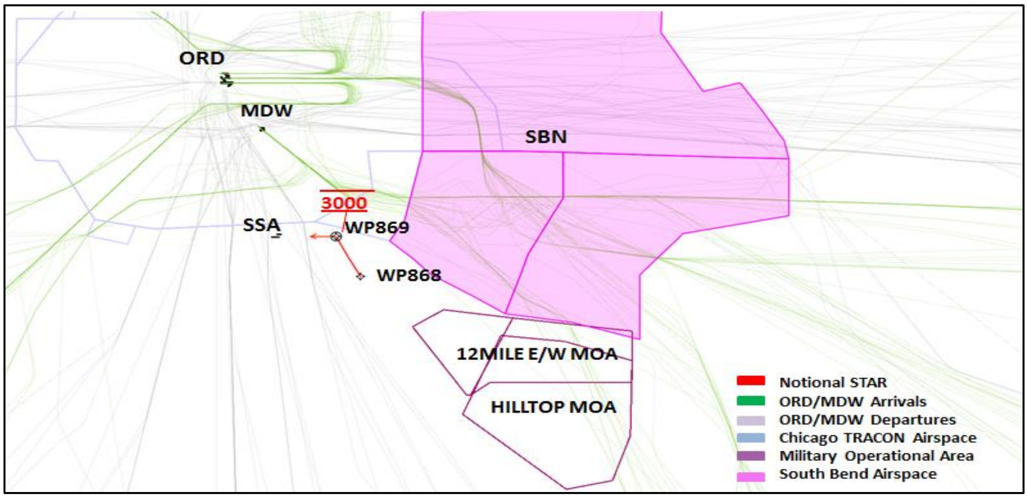


Figure 4.16. EAST STAR RWY27L Runway Transition

4.4.2 Notional SIDs

The notional SIDs were developed to allow enhanced lateral and vertical paths, providing predictability and repeatability, while reducing ATC task complexity and frequency congestion. The notional SIDs attempt to procedurally segregate proposed SSA traffic from existing ORD/MDW traffic, while keeping level offs to a minimum.

4.4.2.1 RWY27L WEST SID

This notional procedure for RWY27L was developed to accommodate SSA traffic departing to the north, northwest, and west (Illustrated in Figure 4.17).

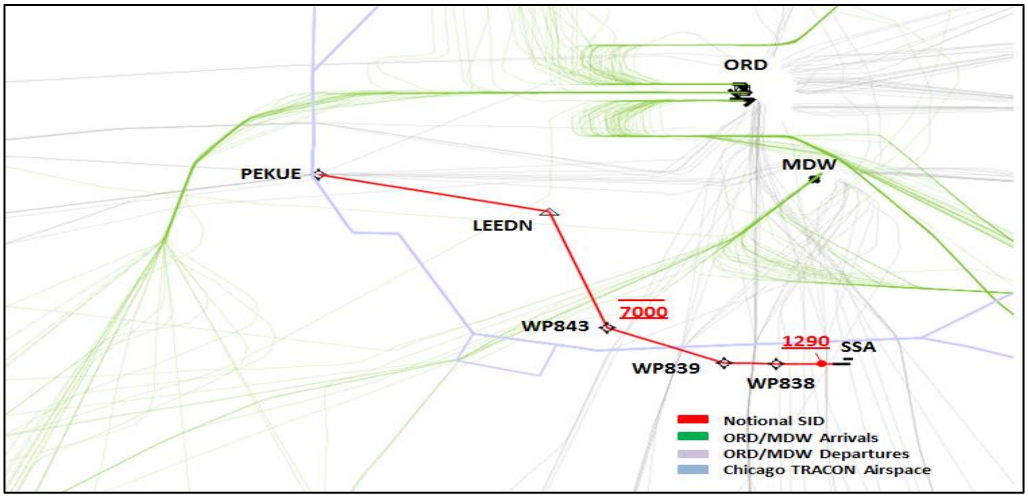


Figure 4.17. RWY27L WEST SID

<u>Runway Transition</u>

The runway transition is defined as WP838..WP839..WP843. Aircraft have to be at 1,290 feet (airport elevation plus 500 feet) before turning. WP838 establishes the runway departure heading. The turn to the northwest at WP839 provides transitional separation between terminal and en route facilities (Illustrated in Figure 4.18).

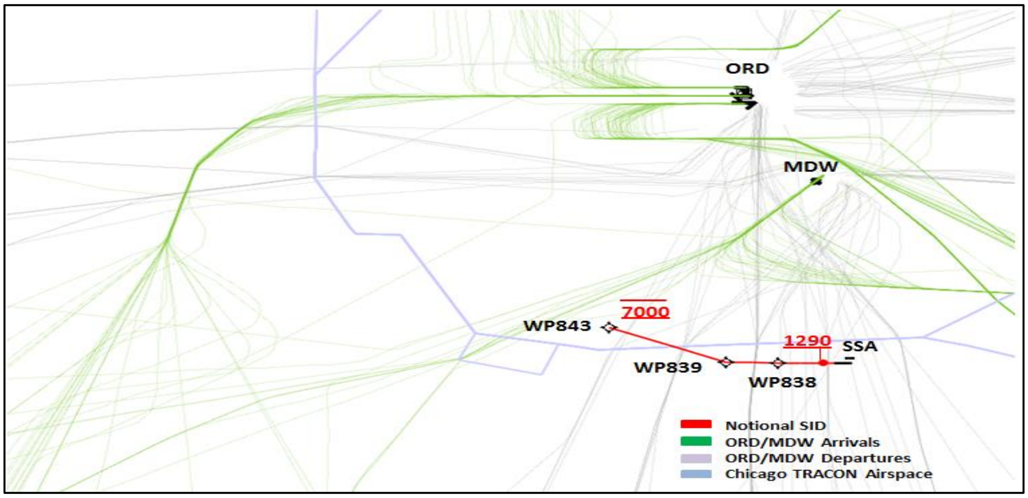


Figure 4.18. RWY27L WEST SID Runway Transition

<u>Common Point</u>

WP843 defines the common point. The 7,000 feet restriction at WP843 procedurally separates proposed SSA departures from C90 southwest arrival traffic. From WP843 westbound proposed SSA departures will be climbed to requested altitude when clear of C90 arrivals and departures.

En Route Transition

The en route transition is defined by WP843..LEEDN..PEKUE. At LEEDN proposed SSA departure traffic will be blended into the C90 PEKUE departure track. When all traffic conflictions are resolved proposed SSA departures will be climbed to requested altitude. proposed SSA departure traffic will be blended with C90 west departure traffic between LEEDN and PEKUE (Illustrated in Figure 4.19).

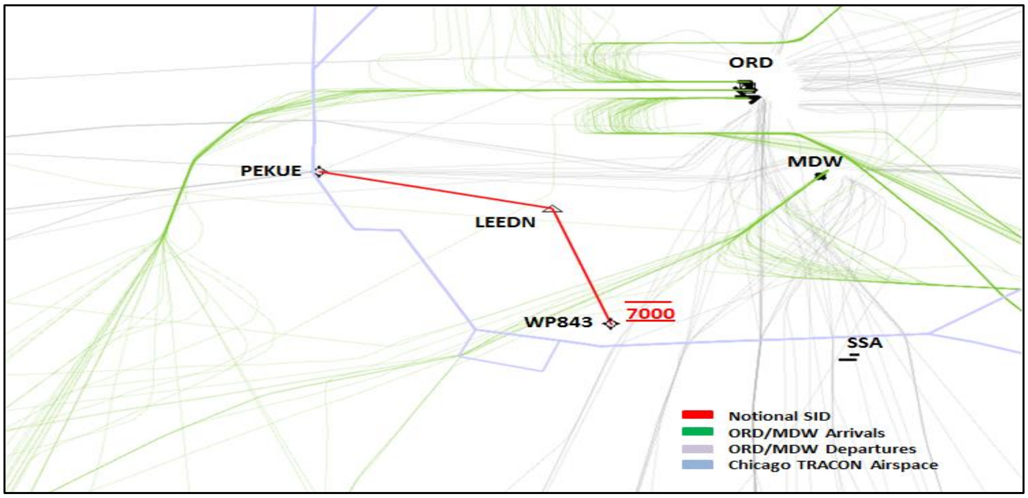


Figure 4.19. RWY27L WEST SID PEKUE Transition

4.4.2.2 RWY09R WEST SID

This notional procedure for RWY09R was developed to accommodate proposed SSA traffic departing to the north, northwest, and west (Illustrated in Figure 4.20).

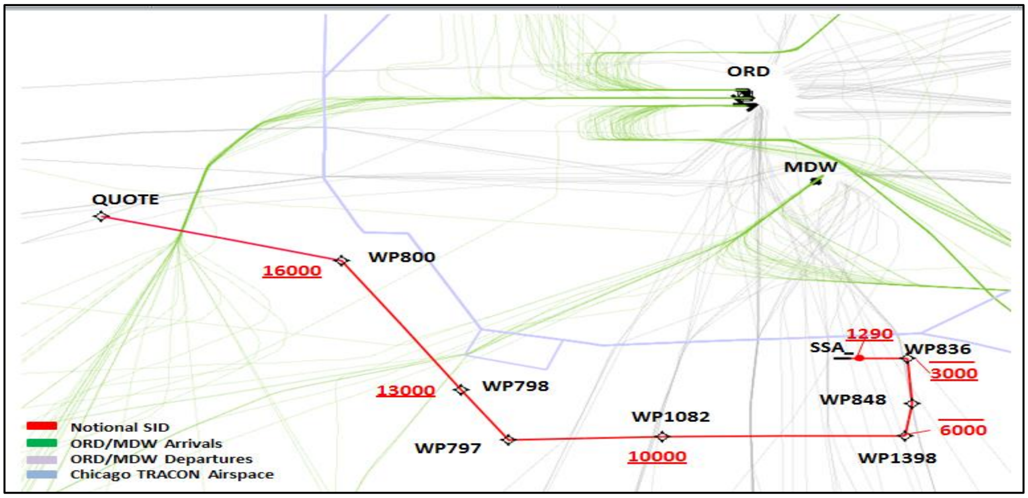


Figure 4.20. RWY09R WEST SID

Runway Transition

The runway transition is defined as WP836..WP848..WP1398..WP1082..WP797. Aircraft have to be at 1,290 feet (airport elevation plus 500 feet) before turning. The altitude restriction of 3,000 feet at WP836 procedurally segregates proposed SSA departures below C90 south satellite arrivals and departures. WP1398 altitude restriction of at-or-below 6,000 feet segregates from the proposed SSA downwind traffic. At WP1398 the procedure turns westbound, parallel to and laterally segregated from proposed SSA downwind traffic. The altitude restriction of 10,000 feet at WP1082 segregates the proposed SSA departures from C90 south departures and proposed SSA arrivals (Illustrated in Figure 4.21).

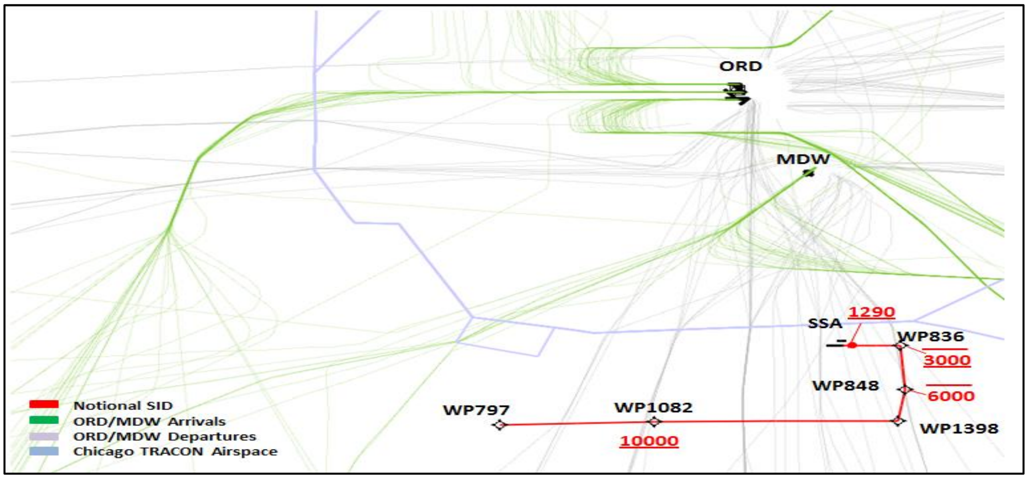


Figure 4.21. RWY09R WEST SID Runway Transition

Common Route

The common route is defined by WP797..WP798..WP800. At WP797 the procedure turns northwest to provide lateral clearance for proposed SSA departures to climb above ORD southwest arrival traffic. The altitude restriction of at-or-above 13,000 feet at WP798 segregates proposed SSA departures from the ORD southwest arrivals. The altitude restriction of at-or-above 16,000 feet at WP800 provides transitional separation between terminal and en route facilities (Illustrated in Figure 4.22)

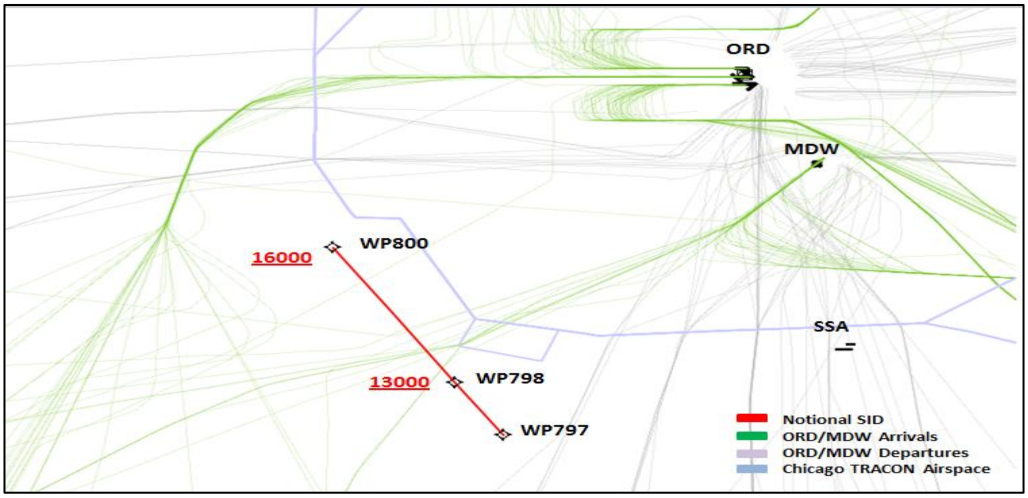


Figure 4.22. RWY09R WEST SID Common Route

<u>En Route Transition</u>

The en route transition is defined by WP800..QUOTE. The altitude restriction of at-or-above 16,000 feet at WP800 provides transitional separation between terminal and en route facilities. proposed SSA departure traffic will be blended with C90 west departure traffic between WP800 and QUOTE (Illustrated in Figure 4.23).

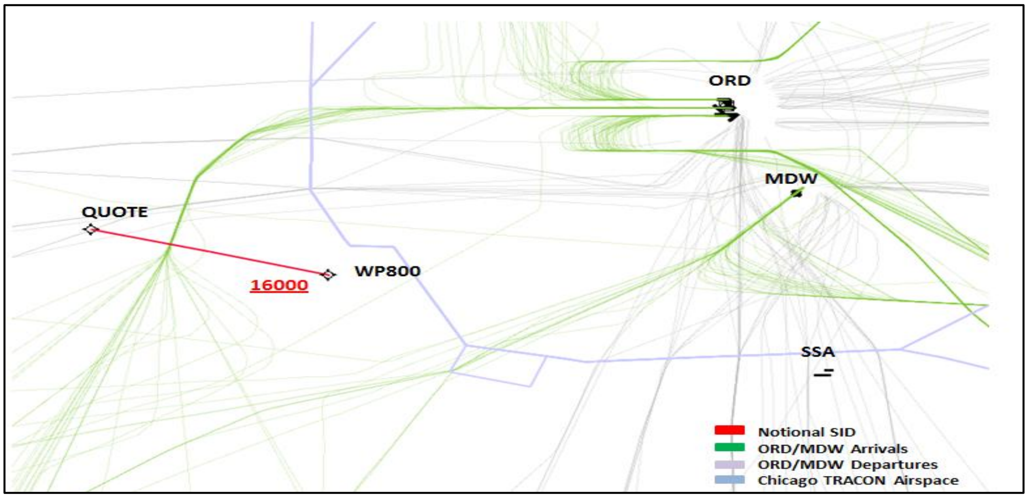


Figure 4.23. RWY09R WEST SID QUOTE Transition

4.4.2.3 RWY09R EAST SID

This proposed SSA notional procedure for RWY09R was developed to accommodate north, northeast, and east departures (Illustrated in Figure 4.24).

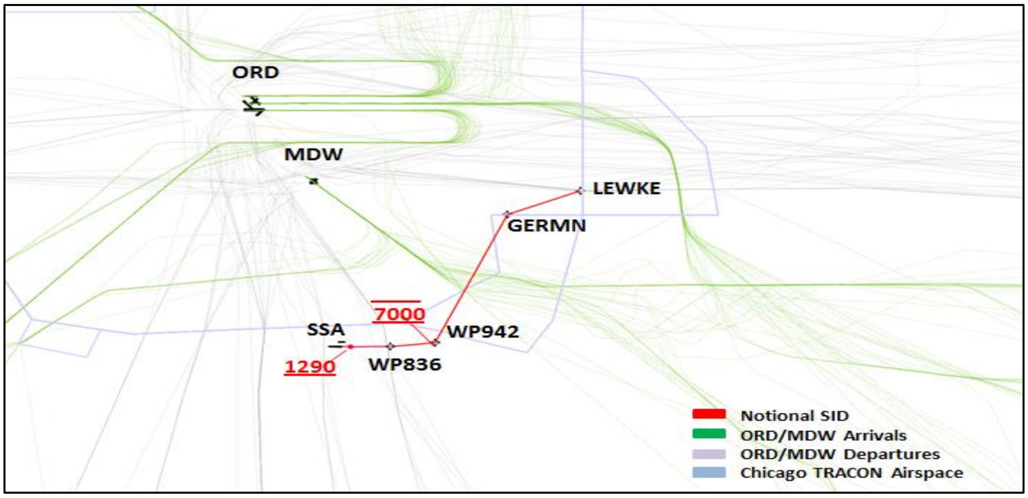


Figure 4.24. RWY09R EAST SID

Runway Transition

The runway transition is defined as WP836..WP942. Aircraft have to be at 1,290 feet (airport elevation plus 500 feet) before turning. WP836 establishes the runway departure heading. The 7,000 feet restriction at WP942 procedurally separates proposed SSA departures from C90 southeast arrival traffic (Illustrated in Figure 4.25).

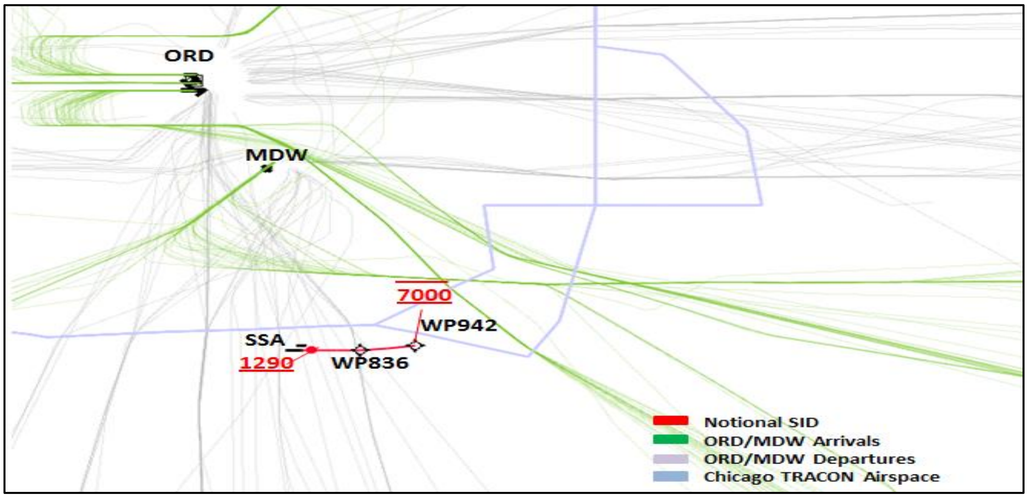


Figure 4.25. RWY09R EAST SID Runway Transition

Common Point

WP942 defines the common point. The 7,000 feet restriction at WP942 procedurally separates proposed SSA departures from C90 southeast arrival traffic.

En Route Transition

The en route transition is defined by WP942..GERMN..LEWKE. At WP942 the procedure turns northeast bound to provide proposed SSA departures lateral spacing from C90 arrivals. When all traffic conflictions are resolved proposed SSA departures will be climbed to requested altitude. proposed SSA departure traffic will be blended with C90 east departure traffic between GERMN and LEWKE (Illustrated in Figure 4.26).

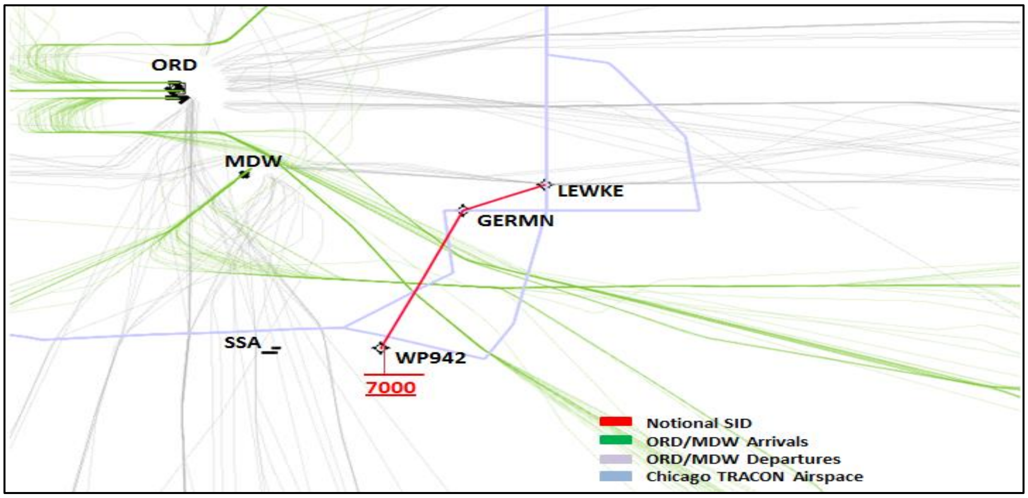


Figure 4.26. RWY09R EAST SID LEWKE Transition

4.4.2.4 RWY27L EAST SID

This proposed SSA notional procedure for RWY27L was developed to accommodate north, northeast, and east departures (Illustrated in Figure 4.27).

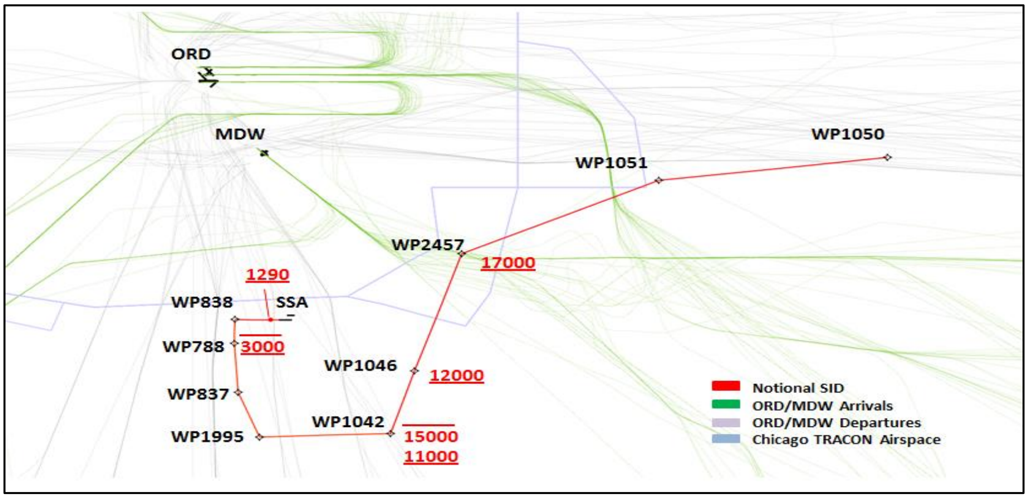


Figure 4.27. RWY27L EAST SID

Runway Transition

The runway transition is defined as WP838..WP788..WP837..WP1995..WP1042. Aircraft have to be at 1,290 feet (airport elevation plus 500 feet) before turning. WP838 establishes the runway departure heading. The 3,000 feet restriction at WP788 is to protect from C90 satellite arrivals and proposed SSA downwind traffic. The procedure continues southbound to WP1995 where it turns east. This allows aircraft to meet the altitude restrictions at WP1042 without interfering with C90 south departures. At WP1042 the procedure turns northeast to be sequenced in the east departure climb corridor (Illustrated in Figure 4.28).

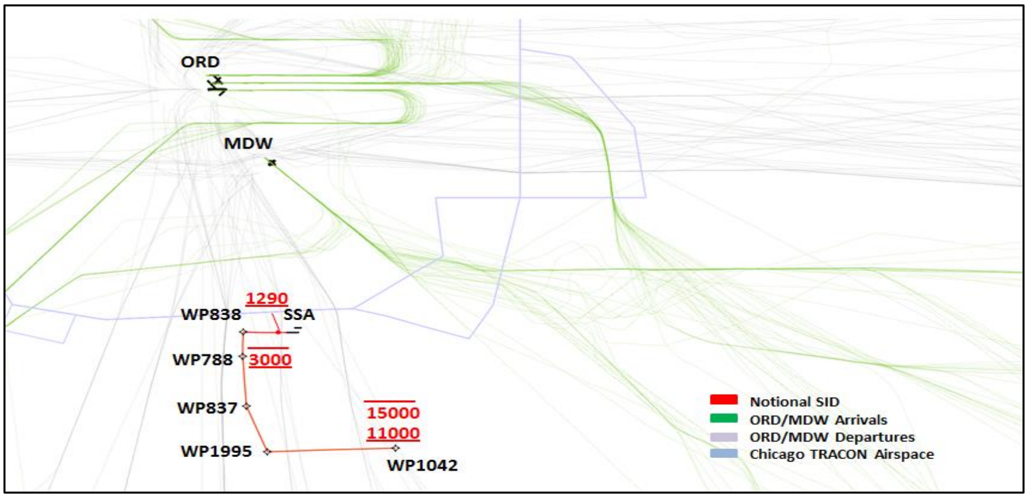


Figure 4.28. RWY27L EAST SID Runway Transition

Common Point

WP1042 defines the common point. The 11,000 feet to 15,000 feet altitude restriction at WP1042 allows proposed SSA departures to climb above ORD arrivals and C90 airspace traffic while staying below the C90 south departures.

En Route Transition

The en route transition is defined by WP1042..WP1046..WP2457..WP1051..WP1050. The at-or-above 12,000 feet altitude restriction at WP1046 segregates proposed SSA departures from ORD southeast arrivals. The at-or-above 17,000 feet altitude restriction at WP2457 segregates proposed SSA departures from ORD east arrivals. When all traffic conflictions are resolved, proposed SSA departures will be climbed to requested altitude. proposed SSA departure traffic will be blended with C90 east departure traffic between WP2457 to WP1050 (Illustrated in Figure 4.29).

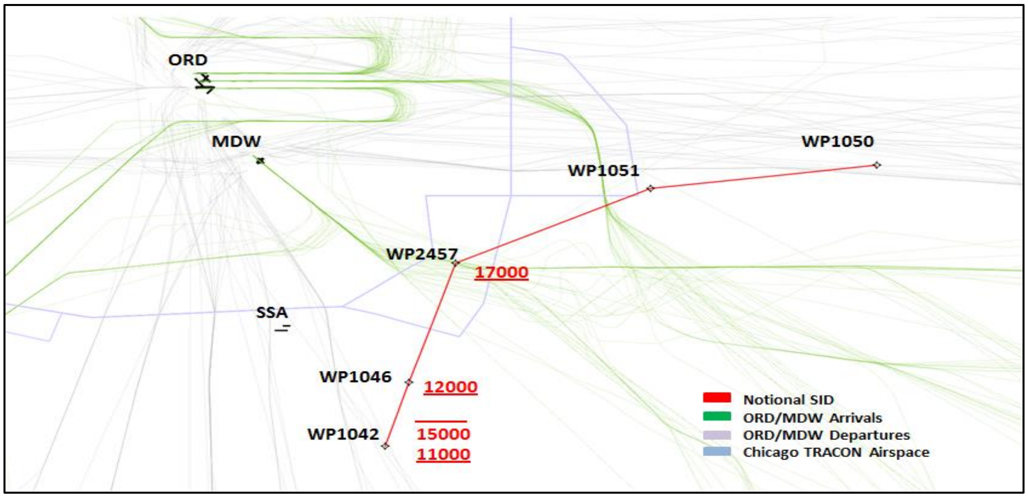


Figure 4.29. RWY27L EAST SID En Route Transition

4.4.2.5 RWY09R SOUTH SID

This proposed SSA notional procedure for RWY09R was designed with seven transitions to accommodate southeast, south, and southwest departures (Illustrated in Figure 4.30).

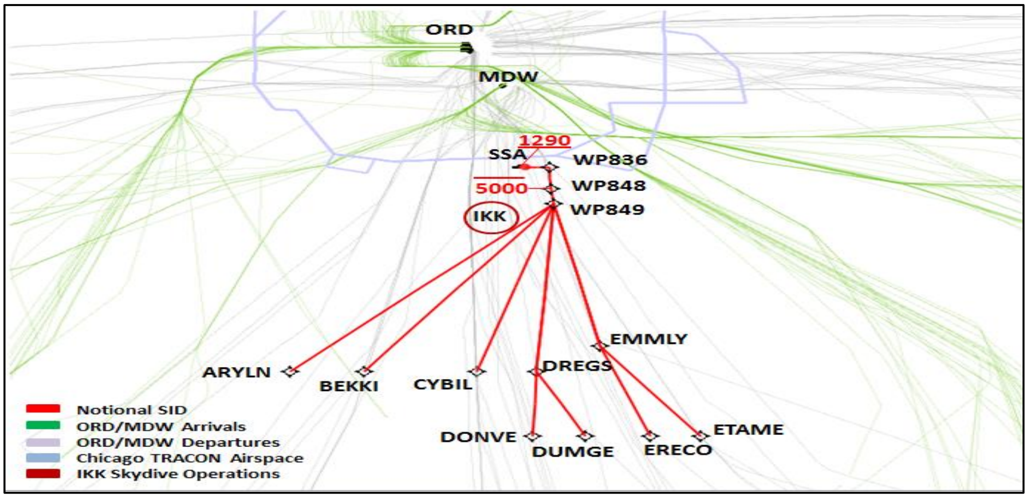


Figure 4.30. RWY09R SOUTH SID

<u>Runway Transition</u>

The runway transition is defined as WP836..WP848..WP849. Aircraft have to be at 1,290 feet (airport elevation plus 500 feet) before turning. WP836 establishes the runway departure heading. The at-or-below 5,000 feet altitude restriction at WP848 segregates proposed SSA departure traffic from C90 satellite arrivals and proposed SSA downwind traffic (Illustrated in Figure 4.31).

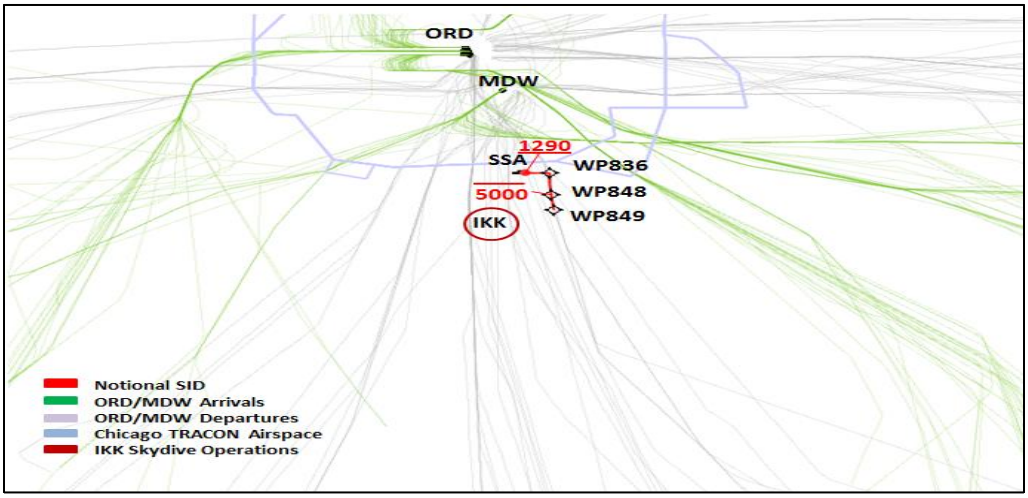


Figure 4.31. RWY09R SOUTH SID Runway Transition

Common Point

WP849 defines the common point.

En Route Transition Descriptions

ETAME En Route Transition is defined by WP849..EMMLY..ETAME

ERECO En Route Transition is defined by WP849..EMMLY..ERECO

DUMGE En Route Transition is defined by WP849..DREGS..DUMGE

DONVE En Route Transition is defined by WP849..DREGS..DONVE

CYBIL En Route Transition is defined by WP849..CYBIL

BEKKI En Route Transition is defined by WP849..BEKKI

ARLYN En Route Transition is defined by WP849..ARLYN

After WP849 proposed SSA departure traffic will be blended with C90 south departure traffic and join the appropriate C90 City Pair routing. When all traffic conflictions are resolved proposed SSA departures will be climbed to requested altitude (Illustrated in Figure 4.32).

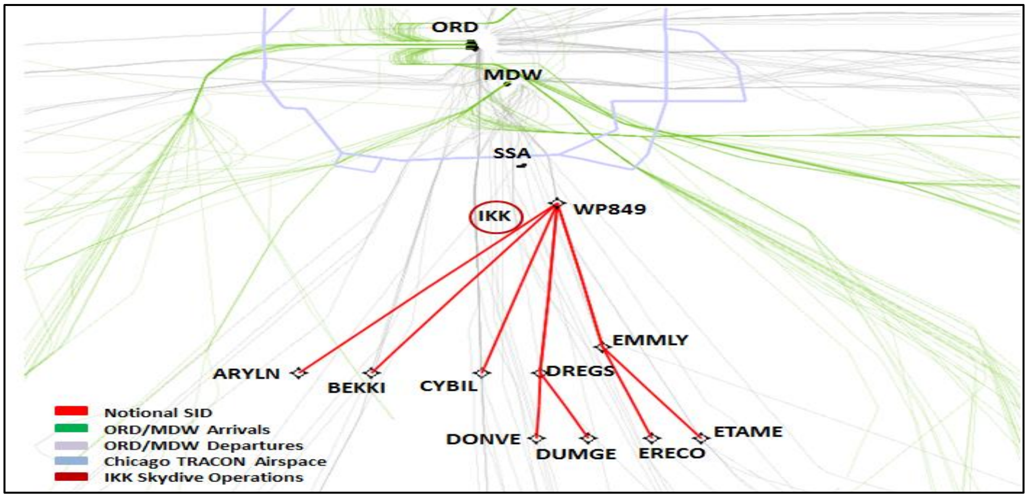


Figure 4.32. RWY09R SOUTH SID En Route Transitions

4.4.2.6 RWY27L SOUTH SID

This proposed SSA notional procedure for RWY27L was designed with seven transitions to accommodate southeast, south, and southwest departures (Illustrated in Figure 4.33).

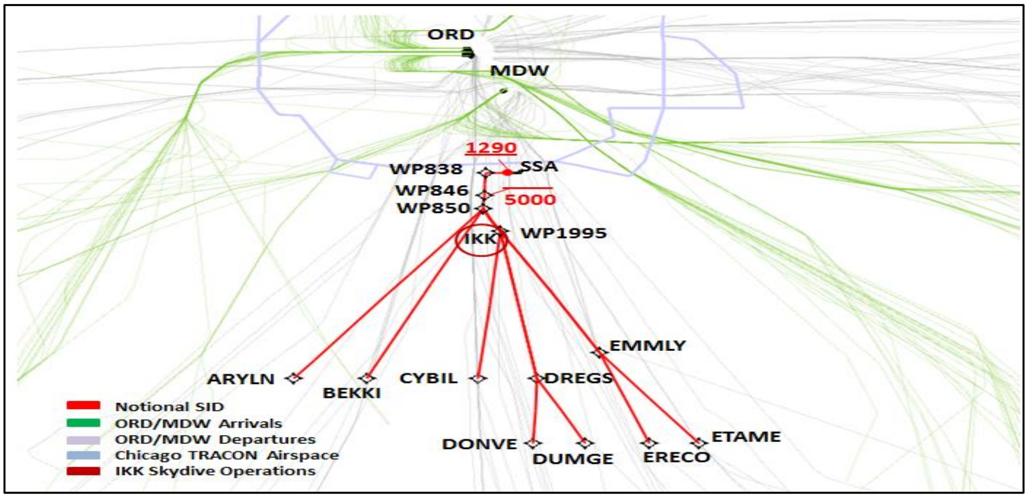


Figure 4.33. RWY27L SOUTH SID

Runway Transition

The runway transition is defined as WP838..WP846..WP850. Aircraft have to be at 1,290 feet (airport elevation plus 500 feet) before turning. WP838 establishes the runway departure heading. The at-or-below 5,000 feet altitude restriction at WP846 segregates proposed SSA departure traffic from C90 satellite arrivals and proposed SSA downwind traffic (Illustrated in Figure 4.34).

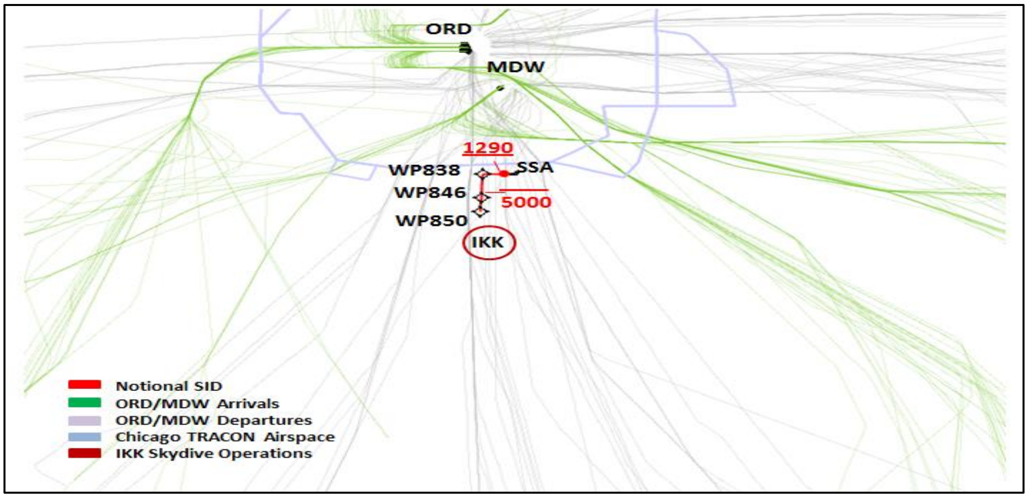


Figure 4.34. RWY27L SOUTH SID Runway Transition

<u>Common Point</u>

WP850 defines the common point.

<u>En Route Transition Descriptions:</u>

ETAME En Route Transition is defined by WP850..WP1995..EMMLY..ETAME

ERECO En Route Transition is defined by WP850..WP1995..EMMLY..ERECO

DUMGE En Route Transition is defined by WP850..WP1995..DREGS..DUMGE

DONVE En Route Transition is defined by WP850..WP1995..DREGS..DONVE

CYBIL En Route Transition is defined by WP850..WP1995..CYBIL

BEKKI En Route Transition is defined by WP850..BEKKI

ARLYN En Route Transition is defined by WP850..ARLYN

WP1995 was added to the ETAME, ERECO, DUMGE, DONVE and CYBIL transitions to circumnavigate to the east of the Greater Kankakee Airport's skydive operations. After WP850 proposed SSA departure traffic will be blended with C90 south departure traffic and join the appropriate C90 City Pair routing. When all traffic conflictions are resolved proposed SSA departures will be climbed to requested altitude (Illustrated in Figure 4.35).

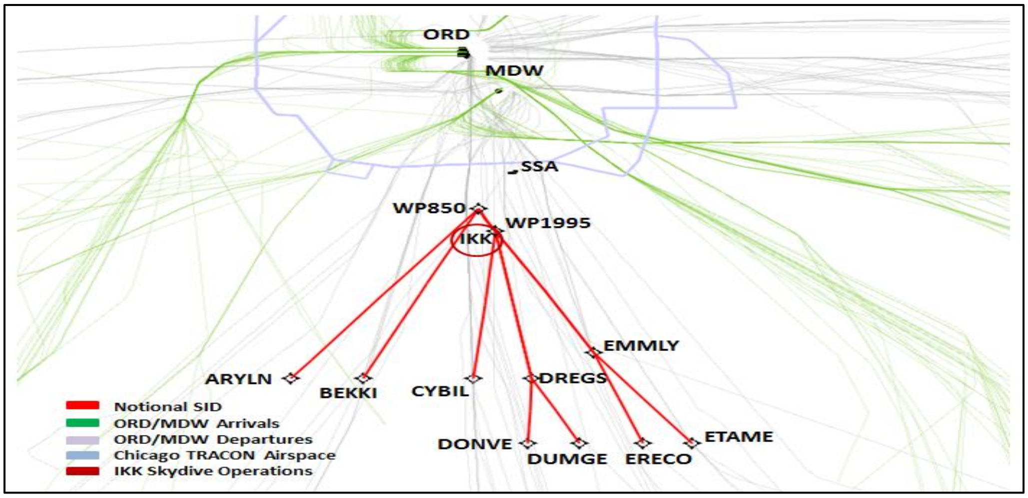


Figure 4.35. RWY27L SOUTH SID En Route Transitions

5 Modeling Analysis

5.1 AirTOp Analysis

The Air Traffic Optimization Fast Time Simulator (AirTOp) provides discrete-event, gate-to-gate, fast time simulation for high-fidelity modeling and quantitative analysis of ground, terminal, and en route airspace operations. AirTOp was first developed in 2007 by the Belgian company AirTOpSoft and has been used extensively by air navigation service providers, research institutions, and the consultant community.

In this study, AirTOp was used to model operations within ZAU airspace whose origin or destination were proposed SSA or within C90 in order to quantify the impact of proposed SSA operations. A detailed report of the modeling analysis is provided in Attachment 1.

5.1.1 Scenarios

Eight scenarios were analyzed in AirTOp, reflecting all possible combinations of three modeling variables: traffic levels, the presence of proposed SSA operations, and runway flow direction as shown in Figure 5.1.

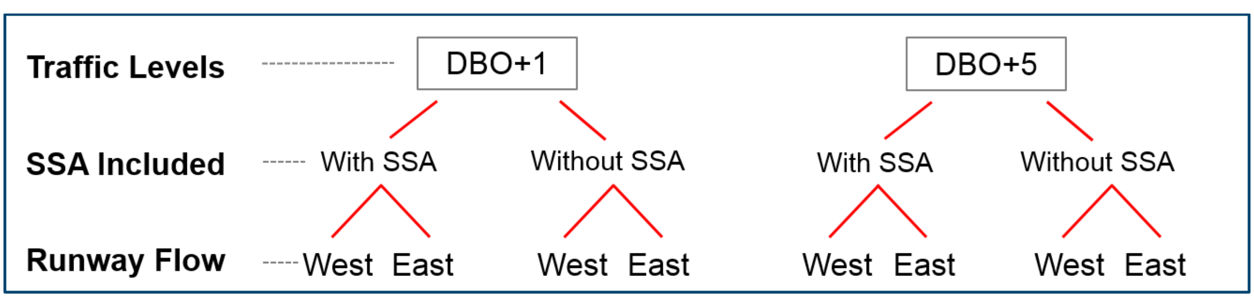


Figure 5.1. Modeled AirTOp Scenarios

The traffic levels were the DBO+1 and DBO+5 schedules as described in Section 3.1.2. In order to measure the impact of proposed SSA operations, one set of scenarios used a traffic file containing proposed SSA operations while the other set had the proposed SSA operations removed, leaving only the other C90 operations. Finally, the runway flow direction allowed the Analysis Team to evaluate proposed SSA impacts with respect to the primary operating directions at C90 airports.

Due to time constraints all scenarios contained the C90 Conceptual Airspace design, hence no comparison was made between operations in the ZAU Conceptual Airspace design and operations in the C90 Conceptual Airspace design. The Analysis Team made this decision because the purpose of this analysis was to determine the feasibility of proposed SSA, and not to determine which airspace design is most efficient. The Analysis Team independently evaluated the ZAU Conceptual Airspace Design qualitatively.

For simulation purposes, the runway flow direction at proposed SSA was assumed to mirror the runway flow direction at ORD. The Analysis Team recognized that in certain conditions with a light east wind, ORD could continue to operate in a west flow while proposed SSA may prefer to operate in an east flow. The Analysis Team felt this scenario would occur infrequently, so it was not modeled.

5.1.2 Key Metrics

All metrics in this study are comparative metrics; that is, the difference between a measurement taken in a scenario containing proposed SSA operations and in the corresponding scenario without proposed SSA operations. Hence, all metrics show the impact that proposed SSA operations had on other operations in the airspace. The quantitative metrics derived from the AirTOp simulations are:

- Throughput by airport
- Ground delay by airport
- Time in level flight by airport
- Flight time by airport
- Potential conflicts requiring ATC resolution
- Prearranged coordination climb operations involving proposed SSA departures
- Distance in level flight for proposed SSA departures

A potential conflict requiring ATC resolution occurs when two departures desire paths that violate ATC separation standards. AirTOp detects these potential conflicts and alters the course of one of the involved aircraft to avoid a loss of separation. In this study, AirTOp alters the course with a change in altitude or speed, or with a ground delay. Because the metrics are comparative, a reported conflict involves either an proposed SSA departure or a departure from another airport whose course was altered due to a conflict with an proposed SSA departure. Note that all conflicts resolved by AirTOp also result in a change in the other comparative metrics if a non-SSA flight is impacted. For example, if due to a conflict, AirTOp changes the altitude of a departure and holds it down, the time in level flight metric for that flight changes as well. If two aircraft violate separation standards by no more than 100 feet vertically or by no more than 0.5 NM laterally, AirTOp will not resolve the conflict. The results in Section 5.1.7 include all conflicts, resolved and unresolved, since all conflicts will need the attention of the Certified Professional Controllers (CPCs).

As described in Section 4.4.2, the RWY09R East SID procedurally passes below an arrival corridor into ORD in the southeast corner of C90, and similarly the RWY27L West SID passes under ORD arrivals in the southwest corner of C90. In each case, if no arrivals are in the corridor to ORD, ATC will have prearranged coordination to allow the proposed SSA departures to climb through the empty ORD arrival corridor. The number of these prearranged coordination climb operations is reported as a metric.

5.1.3 Modeling Assumptions and Techniques

The following modeling assumptions and techniques were used to build the AirTOp scenarios:

- Each scenario was run eleven times to produce the metrics. The arrival or departure times of the aircraft were the only changes among these eleven runs; the changes were generated from a uniform distribution of plus or minus ten minutes. This was done because the key metrics are highly dependent on aircraft interactions.
- All flights used the arrival or departure procedures as charted in July 2014, described by the modeling team or derived from the O'Hare Modernization Program Final Environmental Impact Statement (OMP FEIS).
- All ORD flights followed procedures as derived from the OMP FEIS. Arrival patterns were derived from current triple simultaneous independent runway operations with an adjustment for final approach to match the runway configuration in the OMP FEIS since the current procedure mirrors the arrival procedure in the OMP FEIS. The departure patterns and arrival and departure separation standards were derived directly from the OMP FEIS.
- No flights with both origin and destination airports within C90 were modeled.
- All arrival flights had an origin at a waypoint outside of ZAU, or at the airport for flights originating in ZAU.
- All departure flights ended at a waypoint outside of ZAU.
- Modeling ground operations was outside the scope of this analysis. Airports within C90 and proposed SSA were modeled down to the runway. Airports outside of C90 were modeled as locations only.
- Visual Flight Rules (VFR) operations in and out of proposed SSA began and ended, respectively, within 10 NM of the airport. These operations were only modeled to account for the runway occupancy and throughput at proposed SSA.
- Visual Meteorological Conditions (VMC) were in effect for all airports. VMC allows for increased throughput at airports, which increases the probability of interaction of operations in the airspace.

5.1.4 Traffic Demand

AirTOp simulation requires a traffic schedule, complete with aircraft information, origin and destination airport, route of flight, and estimated time of operation for each flight. Arrival flights into C90 required an estimated time of arrival, and departure flights out of C90 required an estimated time of departure.

Two traffic schedules were generated for quantitative analysis based on the DBO+1 and DBO+5 notional levels provided by IDOT as described in Section 3.1.2. The source of the traffic schedule varied by type of operation.

proposed SSA commercial flight information was provided by IDOT in detail, complete with aircraft type, origin and destination airport (or metropolitan area), and estimated time of operation. The Analysis Team produced the route of flight based on direction of travel and waypoints used by ORD or MDW flights serving the same market.

proposed SSA corporate and general aviation flight information was provided by IDOT with less detail. IDOT provided engine type, estimated time of operation, a general sector of operation, and whether the flight would be operating under VFR or Instrument Flight Rules (IFR). IDOT also provided candidate aircraft types for each engine type. The Analysis Team assigned aircraft types based on engine type and selected the arrival or departure airport based on the sector of operation. Figure 5.2 depicts the sectors of operation.

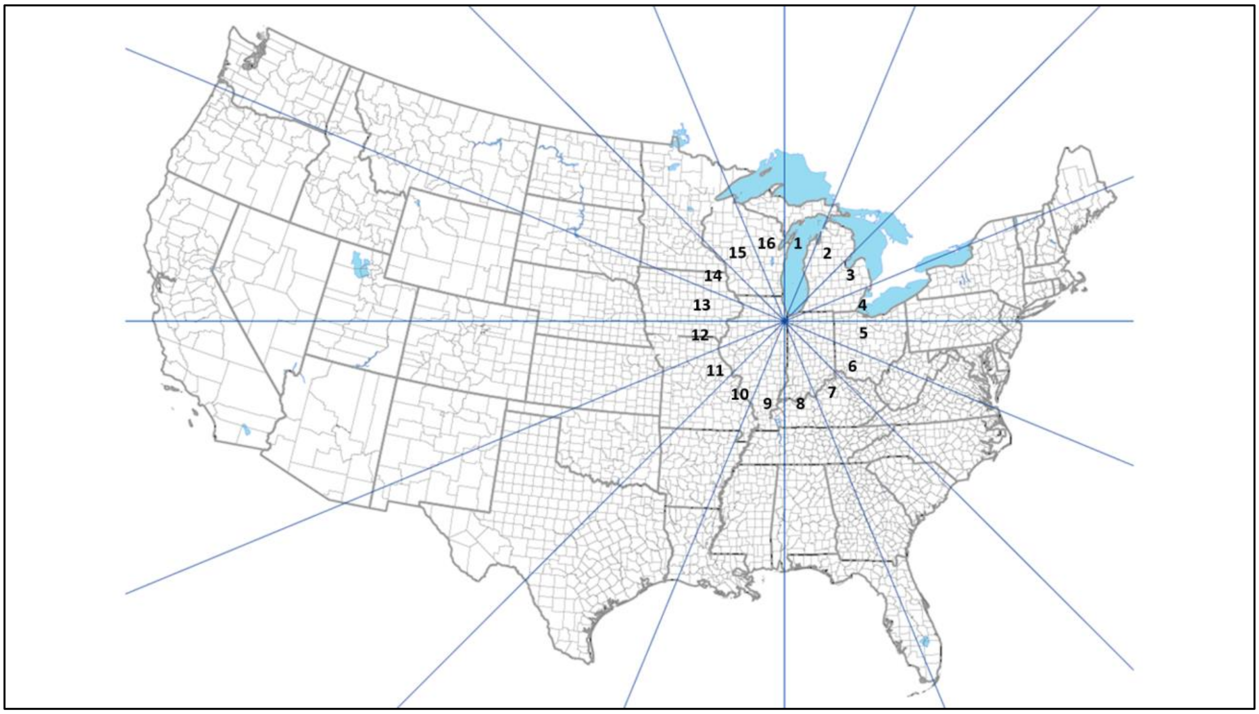


Figure 5.2. Sectors of Operation for Proposed SSA Corporate and General Aviation Flights

For all other flights in C90, the FAA's Forecast Analysis Group was the source for flight information. In coordination with the Chicago Airports District Office, the Analysis Team selected traffic levels in line with DBO+1 and DBO+5 operations. The FAA data contained full information for each flight, including aircraft type, origin and destination airport, route of flight, and estimated time of operation.

Table 5-1 provides counts of all the modeled arrival and departure operations by airport and by date. All flights were IFR except for proposed SSA flights as noted.

Table 5-1. Modeled Daily Traffic Demand

Modeled Daily Traffic Demand						
Airport and Operation Type	DBO+1 Arrivals	DBO+1 Departures	DBO+1 Total Operations	DBO+5 Arrivals	DBO+5 Departures	DBO+5 Total Operations
SSA IFR	16	17	33	32	33	65
SSA VFR	50	51	101	55	53	108
SSA Total	66	68	134	87	86	173
ORD	1470	1469	2939	1589	1598	3187
MDW	392	424	816	421	456	877
Aurora Municipal Airport (ARR)	14	9	23	13	10	23
DuPage Airport (DPA)	26	30	56	25	32	57
Gary/Chicago International Airport (GYY)	14	17	31	14	18	32
Lansing Municipal Airport (IGQ)	1	1	2	1	1	2
Joliet Regional Airport (JOT)	0	1	1	0	1	1

Modeled Daily Traffic Demand						
Airport and Operation Type	DBO+1 Arrivals	DBO+1 Departures	DBO+1 Total Operations	DBO+5 Arrivals	DBO+5 Departures	DBO+5 Total Operations
Lewis University Airport (LOT)	6	7	13	6	7	13
Chicago Executive Airport (PWK)	47	48	95	47	50	97
Waukegan Regional Airport (UGN)	16	19	35	17	20	37
Lake in the Hills Airport (3CK)	2	4	6	2	4	6

5.1.5 Configuration and Runway Use

The model included a west flow and east flow configuration for each airport. For detailed information on the SID and STAR usage in each flow, see Attachment 1. Table 5-2 contains runway use information by airport for both configurations.

Table 5-2. Runway Use by Airport and Configuration

Runway Use				
Airport	East Flow Arrivals	East Flow Departures	West Flow Arrivals	West Flow Departures
SSA	09R	09R	27L	27L
ORD	09L, 09C, 10C	09R, 10L, 10R	27C, 27R, 28C	22L, 27L, 28R
MDW	04R	31C	31C	22L
ARR	09	09	09	09
DPA	02L	02L	02L	02L
GYY	30	30	30	30
IGQ	36	36	36	36
JOT	13	13	13	13
LOT	02	02	02	02
PWK	16	34	16	34
UGN	05	05	05	05
3CK	26	26	26	26

5.1.6 Separation Rules and Assumptions

In C90 airspace, all aircraft were separated 1,000 feet vertically and 3 NM laterally, with the exception of compression on final approach and visual standards on immediate departure. In ZAU airspace, all aircraft were separated 1,000 feet vertically and 5 NM laterally.

From a given airport, departures from the same runway that used fixes in the same cardinal direction (north, south, east, or west) departed with 3 NM separation from the runway - unless those departures used the same departure fix, then they departed with 4 NM separation from the runway. Departures from the same runway that used fixes that were not in the same cardinal direction started their takeoff roll when the previous departure was airborne.

Arrivals could compress to 2.5 NM separation on final due to the VMC conditions.

5.1.7 AirTOp Simulation Results

The presence of proposed SSA departures had a minimal impact on surrounding C90 traffic at the DBO+1 and DBO+5 predicted traffic levels. There was no change in throughput or change in ground delay at any of the airports in C90. There was a change in the distance in level flight for a very small number of MDW, ORD and DPA departures, which also led to a slight change in time flown for these flights.

There were no changes in metrics due to proposed SSA arrivals. The Analysis Team designed the proposed SSA arrival flows to be segregated completely from the other C90 traffic flows; therefore, the arrivals had no impact on surrounding traffic.

5.1.7.1 Potential Conflicts Requiring ATC Resolution

Table 5-3 summarizes the change in the average daily number of conflicts in each scenario.

Table 5-3. Average Daily Number of Conflicts by Date and Flow

Runway Flow	DBO+1	DBO+5
East Flow	3.5	5.8
West Flow	3.6	7.0

The majority of these conflicts were resolved by stopping the climb of the proposed SSA departure. Since proposed SSA departures encountered more restrictive altitude restrictions farther from the airport than departures from other airports, the proposed SSA departure approaching a conflict often was at a lower altitude than the other aircraft and typically had their climb stopped. The remaining conflicts were resolved by stopping the climb of the non-SSA departure. On average this occurred on less than two departures daily from any C90 airport.

In east flow, conflicts mostly occurred in ZAU Sector 77 due to westbound proposed SSA departures interacting with PEKUE departures from ORD and MDW. Conflicts also occurred in C90 due to eastbound proposed SSA LEWKE departures interacting with LEWKE departures from MDW. Conflicts increased in ZAU Sector 89 and ZAU Sector 92 as traffic increased in the DBO+5 scenarios.

In west flow, conflicts occurred mostly in C90 due to the westbound proposed SSA PEKUE departures interacting with ORD and MDW PEKUE departures, with additional conflicts in ZAU Sector 77, ZAU Sector 81, and ZAU Sector 92.

Figure 5.3 depicts the sectors in which conflicts primarily occurred.

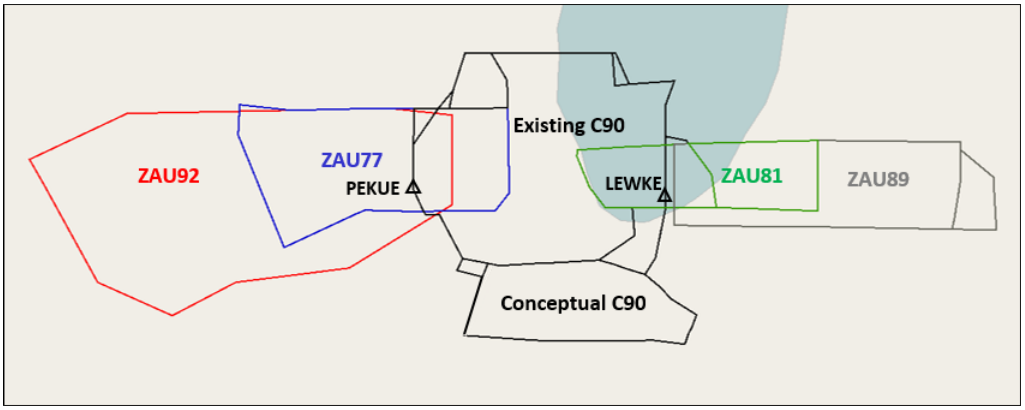


Figure 5.3 Sectors in which Conflicts Occured

5.1.7.2 Time in Level Flight

Tables 5-4 through 5-6 describe the increase in time in level flight that resulted from non-SSA departure climbs being stopped due to a conflict with an proposed SSA departure. These metrics are for all 11 simulation runs.

Table 5-4. Time in Level Flight Caused by a Conflict with a Proposed SSA Departure, ORD

Altitude Level	DBO+1 East Flow		DBO+5 East Flow		DBO+1 West Flow		DBO+5 West Flow	
	Count	Average Time (Seconds)	Count	Average Time (Seconds)	Count	Average Time (Seconds)	Count	Average Time (Seconds)
15,000ft	0	-	0	-	1	29	0	-
23,000ft	3	150	0	-	0	-	0	-
24,000ft	0	-	1	139	0	-	0	-
26,000ft	0	-	1	304	0	-	0	-
28,000ft	0	-	3	234	0	-	0	-
31,000ft	1	277	0	-	0	-	0	-
32,000ft	3	212	0	-	0	-	0	-

Table 5-5. Time in Level Flight Caused by a Conflict with a Proposed SSA Departure, MDW

Altitude Level	DBO+1 East Flow		DBO+5 East Flow		DBO+1 West Flow		DBO+5 West Flow	
	Count	Average Time (Seconds)	Count	Average Time (Seconds)	Count	Average Time (Seconds)	Count	Average Time (Seconds)
12,000 Feet	0	-	0	-	1	455	1	341
13,000 Feet	2	238	7	263	6	317	10	318
14,000 Feet	2	112	0	-	0	-	0	-
20,000 Feet	0	-	1	313	0	-	0	-
21,000 Feet	0	-	1	181	0	-	1	321
23,000 Feet	0	-	0	-	2	241	0	-
24,000 Feet	0	-	1	220	0	-	0	-
29,000 Feet	0	-	1	88	0	-	3	250
31,000 Feet	0	-	0	-	0	-	1	120
33,000 Feet	0	-	0	-	0	-	1	138

Table 5-6. Time in Level Flight Caused by a Conflict with a Proposed SSA Departure, DPA

Altitude Level	DBO+1 East Flow		DBO+5 East Flow		DBO+1 West Flow		DBO+5 West Flow	
	Count	Average Time (Seconds)	Count	Average Time (Seconds)	Count	Average Time (Seconds)	Count	Average Time (Seconds)
10,000 Feet	0	-	0	-	0	-	1	218
18,000 Feet	0	-	1	151	0	-	1	174
26,000 Feet	2	464	0	-	0	-	0	-

The ORD departure climbs were stopped when an proposed SSA departure was heading north and crossed the ORD departure streams. MDW departure climbs were stopped primarily at the C90 boundary when there was an proposed SSA departure already at 15,000 feet at the departure fix.

5.1.7.3 Total Flight Time

Due to the increase in level flight for departures there was also a slight increase in total time flown. Table 5-7 shows the total number of operations with an increase in time flown, and the average increase in time flown per affected flight at each airport over the 11 simulation runs.

Table 5-7. Increase in Time Flown by Airport

Airport	DBO+1 East Flow		DBO+5 East Flow		DBO+1 West Flow		DBO+5 West Flow	
	Count	Average Time (Seconds)	Count	Average Time (Seconds)	Count	Average Time (Seconds)	Count	Average Time (Seconds)
ORD	3	11	4	15	0	-	0	-
MDW	3	40	8	35	1	78	8	22
DPA	2	20	0	-	0	-	2	12

Note that these counts are totals of all 11 simulation runs, which equates to more than 16,000 ORD departures, more than 4,500 MDW departures and more than 300 DPA departures in both predicted traffic levels. This is less than .1% of all C90 departure operations.

5.1.7.4 Prearranged Coordination Climb Operations

Table 5-8 summarizes the average daily number of prearranged coordination climb operations at proposed SSA. Operations are enumerated by the location in the prearranged coordination climb segment where the aircraft started to climb, which is shown in Figure 5.4 for east flow operations and Figure 5.5 for west flow operations.

Table 5-8. Average Daily Proposed SSA Prearranged Coordination Climb Operations by Date and Runway Flow

Date	Runway Flow	Beginning	During	Unable	Total
DBO+1	East	0.5	2.5	0.1	3.0
DBO+5	East	2.7	8.3	1.1	12.0
DBO+1	West	3.4	4.2	0.5	8.0
DBO+5	West	5.5	7.0	0.5	13.0

The "beginning" column counts flights that started their climb at the beginning of the prearranged coordination climb corridor. The "during" column counts flights that did not have the clearance to climb at the beginning of the corridor but received it during the corridor. The "unable" column counts flights that were unable to complete any part of the prearranged coordination climb procedure.

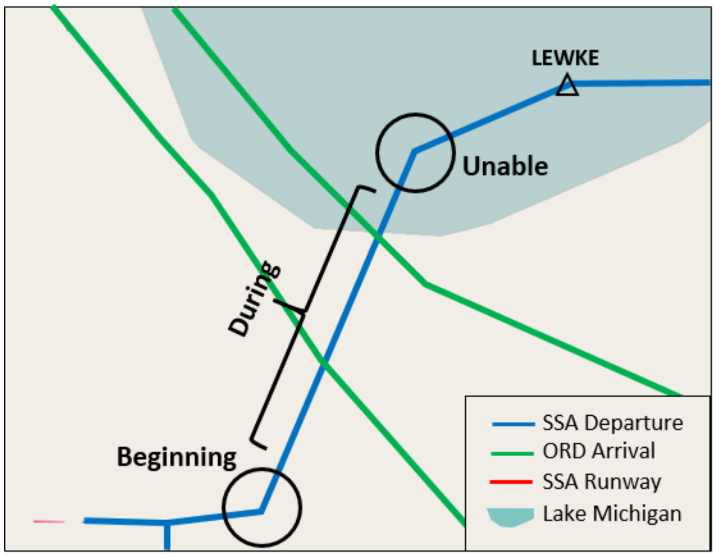


Figure 5.4. Prearranged Coordination Climb Operations for East Flow Proposed SSA Departures

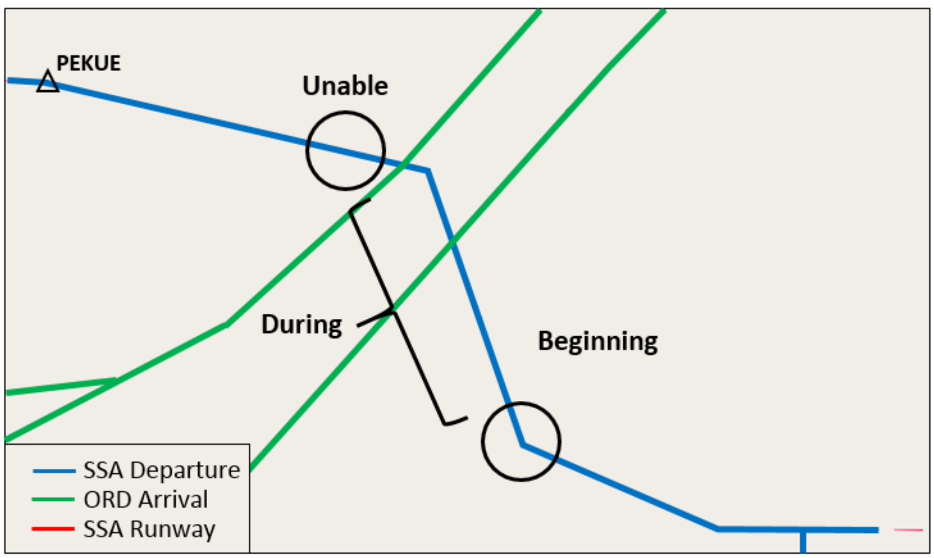


Figure 5.5. Prearranged Coordination Climb Operations for West Flow Proposed SSA Departures

In east flow, only the departures passing over the LEWKE fix on the east side of C90 could participate in the prearranged coordination procedure. In west flow, departures passing over the PEKUE fix on the west side of C90 could participate.

In both time periods and both runway flows the majority of proposed SSA flights were able to complete at least some portion of the prearranged coordination climb procedure. In east flow, the ORD arrival stream closest to the beginning of the procedure contained more arrival flights, so the majority of the departures that started their climb during the procedure passed by the first, busier stream and then found the second ORD arrival stream empty. The two ORD arrival streams involved in the west flow prearranged coordination climb procedure had fewer flights than the ORD arrival streams in the east flow. Because of this, more flights in the west flow started their climb at the beginning of the prearranged coordination climb corridor. Table 5-9 contains the average distance that a “during” flight traveled along the prearranged coordination climb corridor before receiving a clearance to climb.

Table 5-9. Average Distance Before Commencing Climb for Flights that Climbed During the Prearranged Coordination Climb Procedure

	DBO+1 East Flow	DBO+5 East Flow	DBO+1 West Flow	DBO+5 West Flow
Distance Level (NM)	10.9	11.3	10.9	10.4

The total distance flown from runway end until the aircraft climbed above 7,000 feet was approximately 20 NM for the proposed SSA LEWKE departures in east flow and 29 NM for the proposed SSA PEKUE departures in west flow on average.

5.1.7.5 SSA Distance in Level Flight

The Analysis Team placed altitude restrictions on the proposed SSA departure procedures to avoid interactions with current C90 traffic as much as possible. As a result, proposed SSA departures experienced substaintial distance in level flight during their climb out. Table 5-10 presents the distance in level flight metric for proposed SSA departures caused by altitude restrictions on the departure procedures. Note there were 17 IFR proposed SSA departures in the DBO+1 traffic file and 33 IFR proposed SSA departures in the DBO+5 traffic file.

Table 5-10. Average Daily Proposed SSA Departure Level-offs due to Procedure Constraints

Altitude Level	DBO+1 East Flow		DBO+5 East Flow		DBO+1 West Flow		DBO+5 West Flow	
	Count	Average Distance (NM)	Count	Average Distance (NM)	Count	Average Distance (NM)	Count	Average Distance (NM)
3,000 Feet	8	3.0	13	2.6	3	5.3	12	4.9
5,000 Feet	4	7.1	6	6.9	4	7.3	6	7.2
6,000 Feet	8	5.5	13	5.4	0	N/A	0	N/A
7,000 Feet	3	12.4	12	11.3	8	20.1	13	20.5
10,000 Feet	6	17.4	11	17.7	0	N/A	0	N/A
15,000 Feet	0	N/A	0	N/A	3	11.3	12	10.9

In east flow, proposed SSA departures encounter altitude restrictions at 3,000 feet, 5,000 feet, 6,000 feet, 7,000 feet, and 10,000 feet. In addition, there were additional level-offs due to conflict resolutions, which are shown in Table 5-11:

Table 5-11. Proposed SSA Departure Level-offs due to Conflict Resolutions, East Flow

Traffic Level	Run Number	Altitude (Feet)	Distance Level (NM)
DBO+1	4	25,000	9.5
DBO+5	1	24,000	16.4
DBO+5	5	7,000	18.6
DBO+5	9	12,000	7.5
DBO+5	10	17,000	22.9
DBO+5	11	9,000	12.2
DBO+5	11	17,000	22.9
DBO+5	11	27,000	40.5

In west flow, proposed SSA departures encounter altitude restrictions at 3,000 feet, 5,000 feet, 7,000 feet, and/or 15,000 feet depending on the SID being flown. In addition, there were additional level-offs due to conflict resolutions, which are shown in Table 5-12.

Table 5-12. Proposed SSA Departure Level-offs due to Conflict Resolutions, West Flow

Traffic Level	Run Number	Altitude (Feet)	Distance Level (NM)
DBO+1	1	12,000	8.2
DBO+1	3	12,000	8.3
DBO+1	5	11,000	8.7
DBO+1	7	13,000	7.4
DBO+1	10	11,000	18.9
DBO+1	11	20,000	1.3
DBO+5	1	13,000	3.1
DBO+5	1	14,000	42.9
DBO+5	2	13,000	10.1
DBO+5	2	14,000	43.4
DBO+5	2	24,000	35.6
DBO+5	3	13,000	1.2
DBO+5	4	13,000	10.1
DBO+5	4	23,000	15.9

Traffic Level	Run Number	Altitude (Feet)	Distance Level (NM)
DBO+5	4	24,000	19.0
DBO+5	5	13,000	1.7
DBO+5	5	14,000	42.7
DBO+5	7	12,000	32.0
DBO+5	7	13,000	9.1
DBO+5	7	14,000	44.9
DBO+5	7	19,000	18.6
DBO+5	9	13,000	3.4
DBO+5	9	18,000	10.6
DBO+5	10	13,000	9.1
DBO+5	11	13,000	4.4

5.1.8 AirTOp Conclusions

The AirTOp analysis found the addition of proposed SSA had minimal impact on the surrounding C90 traffic at the DBO+1 and DBO+5 predicted traffic levels. At the higher DBO+5 traffic levels there were on average less than 7 conflicts daily involving proposed SSA departures that required ATC action to maintain separation, which equates to less than 22% of proposed SSA departures and less than 0.5% of C90 departures. The majority of conflicts were resolved by stopping the climb of the SSA departure. On average, less than two departures daily from an airport other than proposed SSA had their climb stopped due to an proposed SSA departure. Proposed SSA departures experienced substaintial distance in level flight during their climb out.

There were no changes in metrics due to proposed SSA arrivals. The Analysis Team designed the proposed SSA arrival flows to be completely segregated from the other C90 traffic flows; and therefore, they had no impact on the surrounding traffic.

5.2 I-SIM Analysis Approach

I-SIM is a platform-independent integrated suite of products and applications for high-fidelity ATM/ATC simulation. The I-SIM suite allows users to create simulation environments (ARTS, STARS, HOST, and ERAM), import maps, rapidly create scenarios, drag-and-drop elements of airspace and flight routes design, and support all aircraft types with realistic performance characteristics. The system offers a reproduction of actual, recorded data (i.e. PDARS) that can be used to rapidly create, edit, and compare scenarios. PDARS data is available at all ARTCCs and larger TRACONs, permitting the user to select traffic scenarios for playback.

I-SIM was used to qualitatively evaluate proposed SSA notional procedures and conceptual airspace within the Chicago metropolitan area. I-SIM was also used in lieu of Human in the Loop Simulation (HITLS) for SME's input and evaluation. (See Appendix H: I-SIM Technical Data, which contains a more detailed report of the I-SIM modeling analysis).

5.2.1 I-SIM Simulation Methodology

The Analysis Team evaluated the notional procedures and conceptual airspace in seven I-SIM scenarios. Simulation methodology included data selection, scenario creation, scenario run, and scenario evaluation.

5.2.1.1 Data Selection

Each scenario was developed with one proposed SSA departure procedure and one proposed SSA arrival procedure. To ensure that appropriate traffic data would be studied, a specific day and times of operational traffic was selected for the corresponding procedure. To study the interaction of existing traffic and proposed SSA traffic, 5 NM buffer was placed around the notional procedures. Chicago metropolitan area traffic was selected for the corresponding procedure.

5.2.1.2 Scenario Creation

- Relevant traffic was simulated to fly their historical route or a defined track
- Proposed SSA traffic was modeled into the scenarios
- SME's evaluated and revised the scenario modeling for realism
- The completed scenarios were approved by the group and readied for evaluation

5.2.1.3 Scenario Run

The SME's observed the scenario runs documenting interactions between historical flight tracks and proposed SSA flight on the notional procedure. The SME's could verify the viability of the designed notional procedures and determine potential in-trail merging required with C90 traffic. Special note was taken to record any changes in impacts, complexity, coordination, and workload.

5.2.1.4 Scenario Procedure Design Evaluation

Seven scenarios were run independently by each SME to evaluate the notional procedure designs documenting their impressions (See Appendix H: I-SIM Technical Data).

5.2.2 I-SIM Simulation Assumptions

The Analysis Team made various assumptions to simulate current operations to include airspace, date and time, data source, proposed SSA traffic, proposed SSA fleet mix, and historical traffic.

5.2.2.1 Conceptual Airspace Review

ZAU SME's evaluated the scenarios using the conceptual airspace as illustrated in Figure 5.6. ZAU conceptual airspace is highlighted in red and purple.

C90 SME's evaluated the scenarios using the conceptual airspace as illustrated in Figure 5.7. C90 conceptual airspace is highlighted in red.

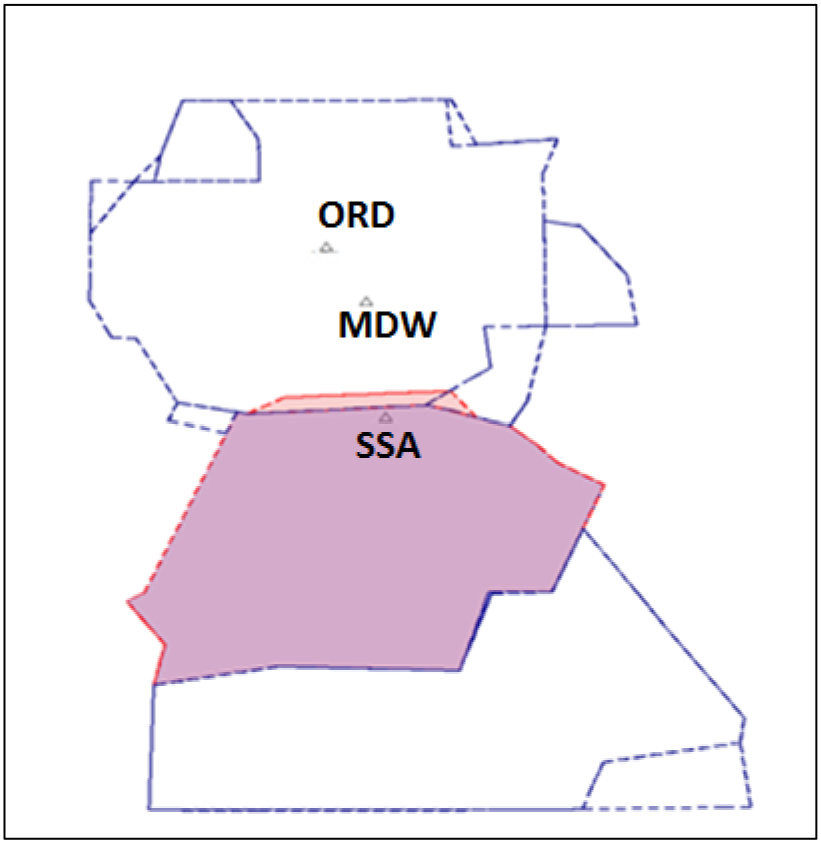


Figure 5.6. ZAU Conceptual Airspace

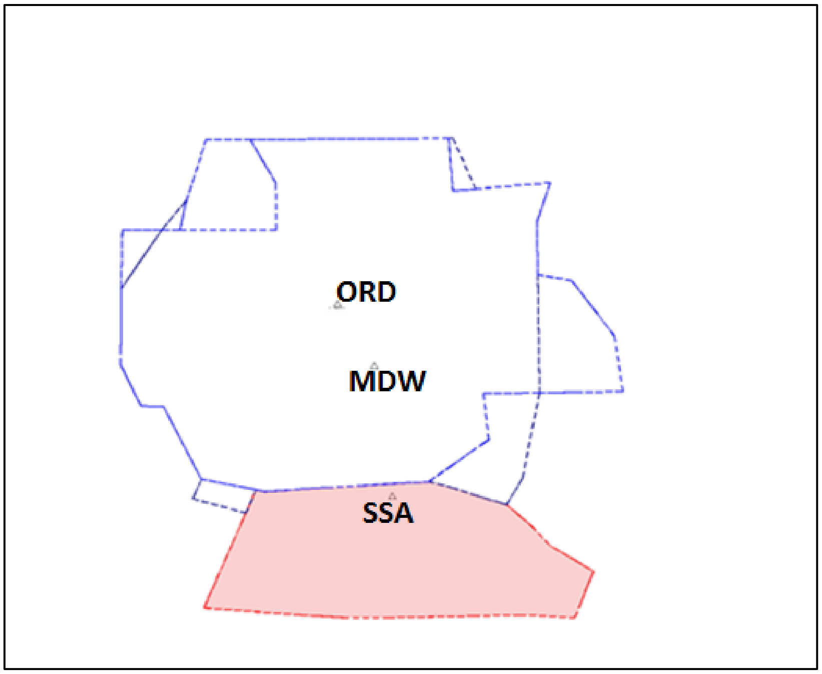


Figure 5.7. C90 Conceptual Airspace

5.2.2.2 Date and Time Period Assumptions

Two traffic days were selected to simulate east and west flow operations for the scenarios:

- East flow period chosen was May 6, 2014, 1030-1130Z and 2230-2330Z
- West flow period chosen was June 11, 2014, 1130-1230Z

5.2.2.3 Data Source Assumption

Traffic data was derived from ZAU PDARS for the periods listed in 5.2.2.2.

5.2.2.4 SSA Traffic Assumptions

Various assumptions were made by the Analysis Team to simulate current operations, LOAs, Memorandums of Understanding (MOU), historical traffic, and proposed proposed SSA traffic.

The projected flight schedule provided by IDOT for arrival/departure rates and aircraft types with the following exception:

1. Aircraft undefined in the I-SIM database were substituted with a pre-defined aircraft type with similar performance characteristics
2. Aircraft arriving proposed SSA entered the scenario at approximately 5 minute intervals, at least one from each of the entry points
3. Aircraft departed proposed SSA at 5 minute intervals, at least one routed to each of the exit points

4. The modeling simulation included more aircraft than the baseline data to increase the chance of interactions and identification of potential hot spots. The volume modeled assisted in documenting potential conflicts.
5. The schedules were adjusted in each scenario to highlight operational interactions

Table 5-13 summarizes the proposed SSA fleet mix used in each scenario. Included is the time when the aircraft enters the scenario, the aircraft type, and either starting altitude for arrivals or final altitude for departures.

Table 5-13. Proposed SSA General Fleet Mix Parameters

SSA General Fleet Mix Parameters			
Operation Start Time (in Min)	Aircraft Type	Departure/Arrival	Altitude
Start + 1:00	B737-200	Arrival	240
Start + 2:00	B737-800	Departure	300
Start + 5:00	F900	Arrival	240
Start + 7:00	H25B	Departure	300
Start +10:00	BE30	Arrival	240
Start +15:00	C421	Arrival	90
Start +17:00	C525	Departure	400
Start +19:00	M20	Arrival	90
Start +21:00	FA10	Departure	400
Total Operations:	10 total operations Per half hour	5 Arrivals 5 Departures Per half hour	20 Total operations per hour

5.2.2.5 Historical Traffic Assumptions

The historical traffic data utilized ZAU PDARS. Historical traffic data was selected from relevant traffic in 60-minute intervals and did not include periods of severe weather or military activity. To maintain realism, historical traffic was modeled to fly their filed flight plan routes.

5.2.2.6 Routing Assumption

ORD/MDW historical arrivals were assigned the appropriate STAR based on ORD east and west flows:

- For east flow operations (Illustrated in Figure 5.8)
  - ORD arrivals were assigned the ESSPO,TRIDE, and VEECK STARs
  - MDW arrivals were assigned the ENDEE, FISSK, and PANGG STARs

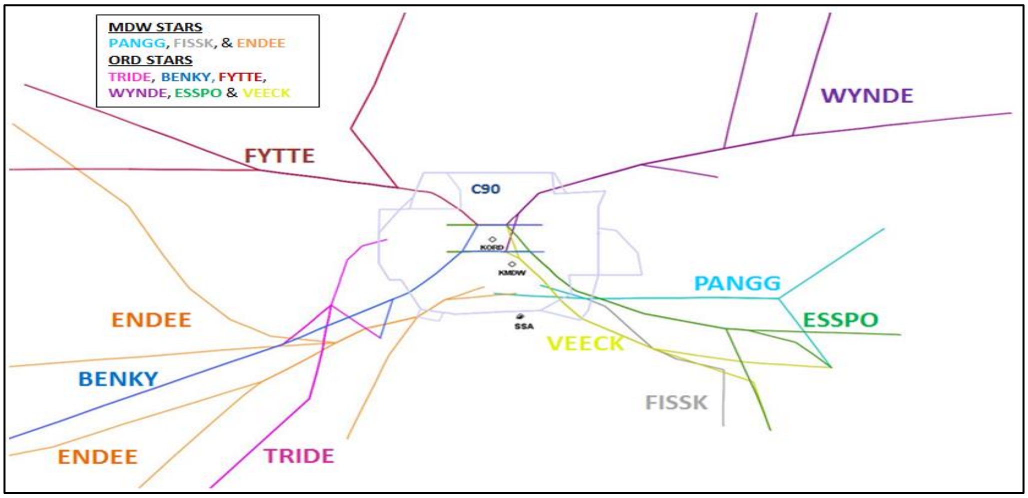


Figure 5.8. Existing Traffic ORD/MDW EAST Flow

- For west flow operations (Illustrated in Figure 5.9)
  - ORD Arrivals were assigned the BENKY, ESSPO, TRTLL, VEECK, and WATSN STARs
  - MDW Arrivals were assigned the ENDEE, FISSK, and PANGG STARs

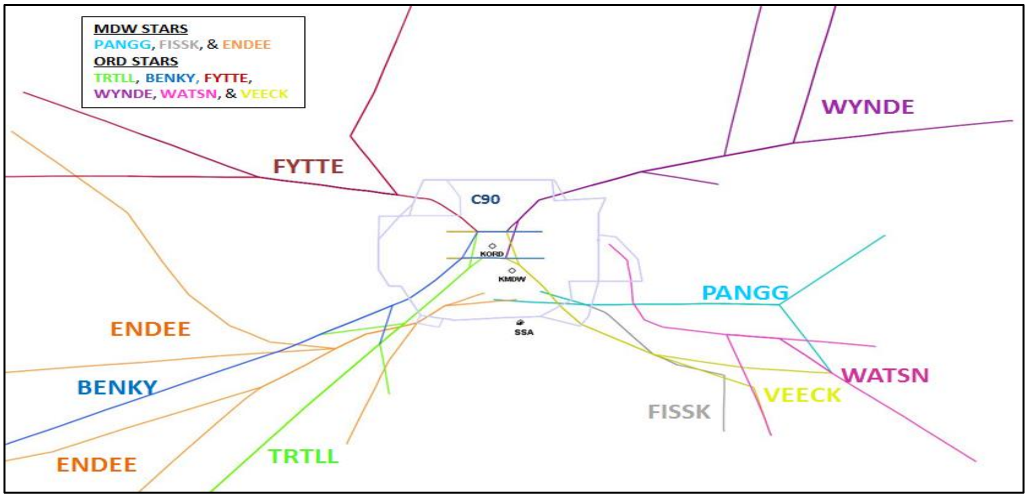


Figure 5.9. Existing Traffic ORD/MDW WEST Flow Evaluation Process and Standards

5.2.3 Evaluation Process and Standards

I-SIM Methodology was used to build and evaluate scenarios. The individual scenario definitions and the tables detailing arrivals, departures, internals, and over flights are listed in Appendix F: Design Assumption Matrix.

Scenarios were evaluated for safety, efficiency, workload, and scenario realism by assigning a rating to a questionnaire formulated by the Analysis Team.

Evaluation responses were rated on a scale of 1 to 5, with 1 being the least desirable and 5 the most desirable.

The four SMEs were asked to contribute comments on specific benefits and challenges to include:

- Which routes, if any, need to be changed
- Which procedures, if any, need to be changed
- List traffic impacts
- List airspace impacts
- Additional comments

After all scenarios were evaluated the comments were compiled and scored. Scores were averaged for each scenario and recorded in Appendix G: I-SIM Technical Data.

5.2.4 I-SIM Analysis Summary

The results of the I-SIM analysis indicated that notional procedures did not compromise safety. Additionally, the analysis indicates that proposed SSA traffic at DBO+1 and DBO+5 levels could be integrated into the current Chicago metropolitan area structure, however, the SME responses indicated that there are increased workload and coordination issues regarless of traffic volume.

5.3 Modeling Summary

The Analysis Team utilized AirTOp modeling and I-SIM simulation to evaluate design concepts and to visualize design impacts. Of particular importance, AirTOp results showed substaintial level-offs for proposed SSA departures on the RWY09R EAST SID and RWY27L WEST SID, due to altitude restrictions and the requirement for prearranged coordination climb operations.

RWY09R EAST SID departures remained at or below 7,000 feet on average for 20 NM from the departure end of proposed SSA RWY09R. RWY27L WEST SID departures remained at or below 7,000 feet on average for 29 NM from the departure end of proposed SSA RWY27L. RWY27L EAST SID departures experienced a level-off at 15,000 feet for an average of 11 NM. RWY09R WEST SID departures experienced a level-off at 10,000 feet for an average of 18 NM. proposed SSA southbound SID departures experienced minimal delays. The Analysis Team designed the proposed SSA STARs with minimal impact to Chicago metropolitan area traffic.

The combination of the AirTOp and I-SIM analysis aided in identifying potential hot spot, coordination, and proposed SSA airspace proximity issues not related to traffic volume. I-SIM analysis also confirmed complexity and controller workload impacts.

Overall, the analysis demonstrated through both quantitative modeling and qualitative simulation that the notional procedures support the DBO+1 through DBO+5 projections with minimal impact to ORD, MDW and other Chicago metropolitan area airport operations.

Safety Risk Management processes will be provided in furture detailed procedure development to ensure all safety issues are fully addressed.

6 Additional Challenges

The Analysis Team identified additional challenges but solutions were beyond the scope of this study. These challenges must be addressed during future design and implementation of proposed SSA traffic integration. The team categorized the challenges: Procedure Hot Spots, Delays, Automation & Equipment, and Procedures.

6.1 Procedure Hot Spots

Due to the location of proposed SSA, the Analysis Team identified areas on the notional procedures where numerous traffic confliction points resulted in substaintial impact to air traffic operations. (See Appendix H: Procedure Confliction/Hot Spots)

6.2 Delays

The Analysis Team identified the following situations with potential for delays:

- Aircraft may be held down and unable to climb to requested altitude due to conflicting traffic
- Off course vectors (headings) from filed flight plan route may be required due to sequencing, spacing and conflicting traffic
- Withholding IFR departure release and airborne holding due to airspace saturation, overflights, Traffic Flow Management (TFM) initiatives or other proposed SSA IFR arrival and departure traffic

6.3 Automation & Equipment

Automation and equipment capabilities will need further evaluation:

- Inter and intra-facility hand offs based on airspace proximity, aircraft climb rate and conflicting traffic
- ZAU automation support for application of 3 NM vs. 5 NM separation standards
- Automated flight plan retrieval at proposed SSA ATCT to reduce interphone communications to servicing air traffic control radar facility
- Proposed move of the EON VOR to proposed SSA
- Proposed Airport Surveillance Radar (ASR) at proposed SSA

6.4 Other Considerations

This feasibility analysis report provides a basis for inaugural phase of proposed SSA. A number of operational and procedural challenges remain and were deemed out-of-scope by the Analysis Team for this report. The Analysis Team identified the following issues for future consideration:

- ZAU operational procedures supporting application of 3 NM vs. 5 NM separation standards
- Terminal vs. En Route separation standards (i.e. passing and diverging courses, simultaneous approaches to parallel runways, etc.)
- Proximity of proposed SSA airport to adjacent facility airspace may induce delays due to inter-facility IFR release coordination
- Addition of conceptual airspace will require current sector redesign
- Automatic IFR releases off proposed SSA departures would reduce coordination
- Impacts and conflictions with current inter-facility/intra-facility LOA/SOP
- Routing proposed SSA north, west, and east departures southbound over ADELL and ELANR to mimic the ORD/MDW southbound routing, instead of routes through C90 airspace
- Development of arrival holding patterns restricted by limited number of available altitudes
- Airspace gap between C90 conceptual airspace and adjacent terminal airspace may require additional coordination and/or hand-offs
- Development of procedure consideration for special events (i.e. EAA and NASCAR)
- RFD SE arrival and departure impacts SSA RWY09R WEST SID
- Development of T-Routes to provide a repeatable, predictable route for C90 satellite traffic to segregate from the proposed SSA SIDS and STARS
- Formal airspace redesign/re-sectorization and Environmental Impact Statement (EIS) prior to implementation
- Impacts to other ARTCC's adjacent to ZAU
- Proposed SSA offloads, no over water, and low performance aircraft into/out of adjacent facility/sector airspace require LOA/SOP changes
- Increase in VFR traffic in the Study Area will increase controller workload, frequency congestion, and complexity

7 Appendices

Appendix A: South Suburban Airport Documentation Validation Letter

Appendix B: Adjacent Airports

Appendix C: Satellite Airports

Appendix D: Special Use Airspace

Appendix E: RADAR Coverage Map

Appendix F: Design Assumptions Matrix

Appendix G: I-SIM Technical Data

Appendix H: Procedure Confliction/Hot Spots

Appendix I: Abbreviations and Acronyms

Illinois Department of Transportation
Division of Aeronautics
1 Langhorne Bond Drive / Capital Airport / Springfield, Illinois / 62707-8415

December 5, 2014

Ms. Christina Drouet, Manager, AGL-1CM
Federal Aviation Administration
Great Lakes Region
Chicago Area Modernization Program Office
2300 East Devon Avenue
Des Plaines, Illinois 60018

Re: South Suburban Airport (SSA)
Chicago/Peotone, Illinois
Airspace Documentation

Dear Ms. Drouet:

On August 29, 2014 we sent an email to you providing certain airport operational input parameters for MITRE's use in conducting an airspace modeling of the South Suburban Airport. The attachments to that email include the following:

- Technical Memo – This memo provides an explanation and clarification of the parameters created for the modeling. It briefly provides an overview of the attached operational spreadsheets.
- Exhibit 1 - Airspace Analysis Sector Map
- Exhibit 2 - DBO+1 – Commercial Passenger and Air Cargo (Excel Spreadsheets) (DBO+1 tab)
- Exhibit 3 - DBO+5 – Commercial Passenger and Air Cargo (Excel Spreadsheets) (DBO+5 tab)
- Exhibit 4 - DBO+1 – General Aviation and Corporate Aviation (Excel Spreadsheets)
- Exhibit 5 - DBO+5 – General Aviation and Corporate Aviation (Excel Spreadsheets)

Our August email submittal clarified a previous airspace documentation provided regarding the SSA project. Attached herein for your files and documentation are date stamped copies of all attachments included in our August 29, 2014 email.

If you have any questions, please contact me at (217) 785-5177 (voice), or by facsimile at (217) 785-4533 or via e-mail at **Terrence.Schaddel@illinois.gov**. Thank you.

Sincerely,

Terrence L. Schaddel
Airport Planning Engineer & Environmental Officer

TLS

cc: Amy Hanson, FAA-CHI-ADO-613 (letter)

Note: IDOT Modeling Parameters Exhibits (Technical Memo, Exhibits 1-5) are archived in FAA Repository System for reference.

Appendix B: Adjacent Airports

Airport	Runways	Approaches	Airport Images
Milwaukee General Mitchell Airport (MKE)	1L/19R (9990 x 200)	CAT II/III ILS (1L) ILS (19R)	
	7R/25L (8300 x 150)	ILS (7R) RNAV/RNP (25L)	
	13/31(5535 x 150)	RNAV/GPS (13/31)	
	7L/25R (4800 x 100)	RNAV/GPS (7L/25R)	
	1R/19L (4183 x 150)	RNAV/GPS (1R/19L)	
Rockford International Airport (RFD)	7/25 (10002 x 15)	CAT II/III ILS (07) RNAV/GPS (25)	
	1/19 (8200 x 150)	ILS (01) RNAV/GPS (19)	
South Bend Airport (SBN)	9R/27L (8412 x 150)	ILS (09R/27L)	

Appendix C: Satellite Airports

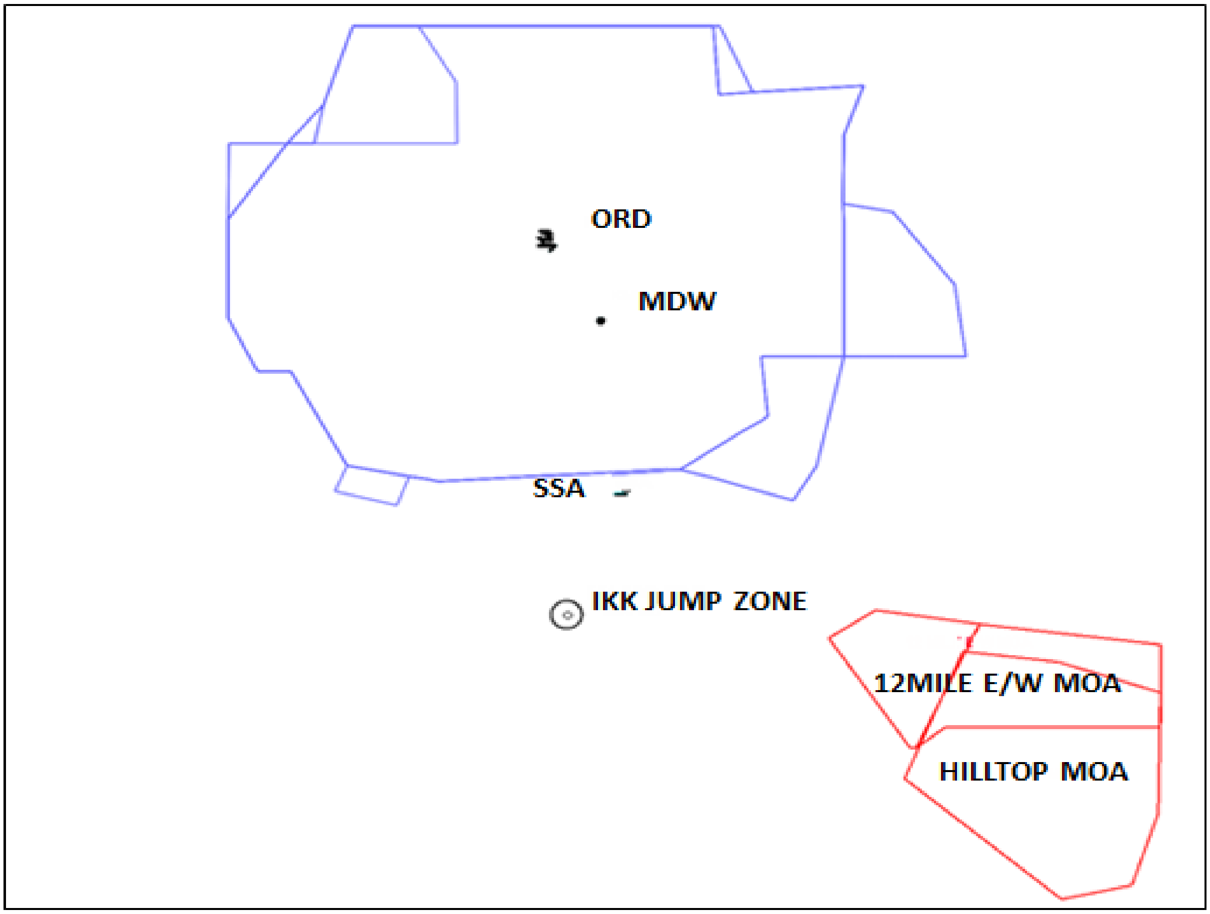
Satellite Airports in Study Area				
Satellite Airports	Location	Runways	Tower	Airport Images
C09 Morris Municipal Airport- James R. Washburn Field	Morris, IL	18/36 5000 X 75 feet	No	
JOT Joliet Regional Airport	Joliet, IL	13/31 2937 x 100 feet 4/22 2746 x 150 feet	No	
LOT Lewis University Airport	Chicago/Romeoville IL	2/20 6500 x 100 feet 9/27 5696 x 75 feet	No	
DPA Dupage Airport	Chicago/West Chicago, IL	2L/28R 7571 x 150 feet 2R/28L 6451 x 100 feet 10/28 4750 x 75 feet 15/33 3399 x 100 feet	Yes	

Satellite Airports in Study Area				
Satellite Airports	Location	Runways	Tower	Airport Images
ARR Aurora Municipal Airport	Chicago/Aurora, IL	9/27 6501 x 100 feet 15/33 5503 x 100 feet 18/36 3198 x 75 feet	Yes	
GYY Gary/Chicago International Airport	Gary, IN	12/30 7003 x 150 feet 2/20 3603 x 100 feet	Yes	
IGQ Lansing Municipal Airport	Chicago, IL	18/36 4002 x 75 feet 9/27 3395 x75 feet	No	

Satellite Airports in Study Area				
Satellite Airports	Location	Runways	Tower	Airport Images
PWK Chicago Executive Airport	Chicago/Prospect Heights/Wheeling, IL	16/34 5001 x 150 feet 12/30 4415 x 75 feet 6/24 3677 x50 feet	Yes	
UGN Waukegan Regional Airport	Chicago/Waukegan, IL	5/23 6000 x 150 feet 14/32 3751 x 75 feet	Yes	
3CK Lake In The Hills Airport	Chicago/Lake In The Hills, IL	8/26 3801 x 50 feet	No	

Satellite Airports in Study Area				
Satellite Airports	Location	Runways	Tower	Airport Images
IKK Greater Kankakee Airport	Kankakee, IL	4/22 5981 x 100 feet 16/34 4398 x75 feet	No	
3KK Kankakee Airport	Kankakee, IL	9/27 2644 x 300 feet 18/36 2564 x 200 feet	No	

Appendix D: Special Use Airspace



Appendix E: RADAR Coverage Map

Appendix F: Design Assumption Matrix

DESIGN ASSUMPTION MATRIX	
Issue: TRACON boundary approx. 3.1 NM from proposed SSA	
Issue Location	C90 Sectors 1/2/ORD South Departures ZAU Sectors 57/44/43
TRACON Impacts	TRACON boundary would need to be extended, coordination, infrastructure
ARTCC Impacts	ZAU coordination
Industry Impacts	Frequency issues (who do I call)
Possible Design Solution	Move the C90 boundary
Issue: Satellite Arrival flows EON-JOT	
Issue Location	C90 Sectors1/2 ZAU Sector 57
TRACON Impacts	N/A
ARTCC Impacts	Arrival/ departure to proposed SSA may affect EON flows. Impacts to other ORD area satellite airports
Industry Impacts	SSA departure aircraft may be held down for extended distances
Possible Design Solution	Develop a new east side satellite arrival route
Issue: V38 flows around C90 airspace or to avoid over water flight. OXI(V156)-EON-KELSI-RFD	
Issue Location	ZAU Sectors 50/57/SBN TRACON
TRACON Impacts	N/A
ARTCC Impacts	Arrival/departure to SSA may affect EON flows. Impacts to other ORD area satellite airports
Industry Impacts	Aircraft may be held down for extended distances. Route altitudes 3000-10000 MSL
Possible Design Solution	Develop a T route

Issue: SSA north departure flows	
Issue Location	C90 (All Sectors) ZAU Sectors 50/51/57/44/43
TRACON Impacts	Complexity, workload, coordination
ARTCC Impacts	Complexity, workload, coordination
Industry Impacts	Aircraft may be held down for extended distances.
Possible Design Solution	SID with ATC assigned altitudes
Issue: SSA westbound departures	
Issue Location	C90 Sectors 2/3/KANE/South Departures/PLANO Feeder ZAU Sectors 57/50/51/43/77
TRACON Impacts	Complexity, workload, coordination
ARTCC Impacts	Complexity, workload, coordination
Industry Impacts	Aircraft may be held down for extended distances. Excessive vectors?
Possible Design Solution	SID tied into west departure track (PEKUE)
Issue: SSA eastbound departures	
Issue Location	C90 1/4/LOOP Dep/OKK Feeder ZAU Sectors 82/83/57/44/32/35 SBN TRACON
TRACON Impacts	Complexity, workload, coordination
ARTCC Impacts	Complexity, workload, coordination
Industry Impacts	Aircraft may be held down for extended distances. Excessive vectors?
Possible Design Solution	SID tied into east departure track (LEWKE)
Issue: SSA southwest/southeast/southbound departure City Pairs	
Issue Location	ZAU Sectors 43/44/57/50/58/TMU
TRACON Impacts	Coordination
ARTCC Impacts	Coordination, workload, automation
Industry Impacts	Cockpit workload (route changes)
Possible Design Solution	SIDs that tie into all five departure tracks

Issue: SSA/IGQ/GYY operational impacts (approx. 11 NM apart)	
Issue Location	C90 Sectors 1/4 ZAU Sector 57
TRACON Impacts	Coordination, workload, holding, missed approach procedures
ARTCC Impacts	Coordination, workload, holding, missed approach procedures
Industry Impacts	N/A
Possible Design Solution	N/A
Issue: Experimental Aircraft Assn (EAA) flows to Osh Kosh	
Issue Location	ZAU Sectors 57/50/ SBN TRACON
TRACON Impacts	N/A
ARTCC Impacts	Workload, coordination, SSA Arrival/Departure flow impacts (V38)
Industry Impacts	Delays, excessive vectoring, longer routes
Possible Design Solution	Route design
Issue: NASCAR Airspace boundary (C90 KLOT)	
Issue Location	C90 Sectors 1/2/LOT ZAU Sectors50/57/44/43
TRACON Impacts	Workload, coordination, Temporary ATCT
ARTCC Impacts	Workload, coordination, flow configuration (Temp LOA)
Industry Impacts	Delays, excessive vectoring, longer routes, forced to lower altitudes earlier and held down on departures
Possible Design Solution	N/A
Issue: EON VOR Relocation to SSA	
Issue Location	ZAU Sectors 32/50/57/44/43 SBN TRACON C90 Sectors 1/2/South Departures/Chicago area ATCTs
TRACON Impacts	Non-RNAV use, impacts most south ORD/MDW SIDS
ARTCC Impacts	Non-RNAV use, impacts most south ORD/MDW SIDS
Industry Impacts	Equipage
Possible Design Solution	There is an FAA program on VOR retention and the SSA Analysis Team will evaluate EON in its current state.

Issue: IAF fix names for GPS Rwy09 SSA (OCEDO vs ACITO)	
Issue Location	C90 Sectors1/2/3 ZAU Sector 57
TRACON Impacts	N/A
ARTCC Impacts	Route/fix confusion
Industry Impacts	Route/fix confusion
Possible Design Solution	Rename GPS fix
Issue: SSA radar coverage southbound	
Issue Location	N/A
TRACON Impacts	Is there sufficient coverage southbound?
ARTCC Impacts	N/A
Industry Impacts	N/A
Possible Design Solution	C90 airspace design considered current radar coverage limitations
Issue: DNV re-sectorization	
Issue Location	N/A
TRACON Impacts	N/A
ARTCC Impacts	Split sector to handle SSA flows
Industry Impacts	N/A
Possible Design Solution	Hybrid of IKK and DNV sectors
Issue: RFD SE arrivals and departures (JOT..QUOTE)	
Issue Location	N/A
TRACON Impacts	N/A
ARTCC Impacts	ZAU Sector 51 and 77. Traffic opposite direction with SSA depts.
Industry Impacts	N/A
Possible Design Solution	ATC vectors

Appendix G: I-SIM Technical Data

Scenario Definitions and Metrics

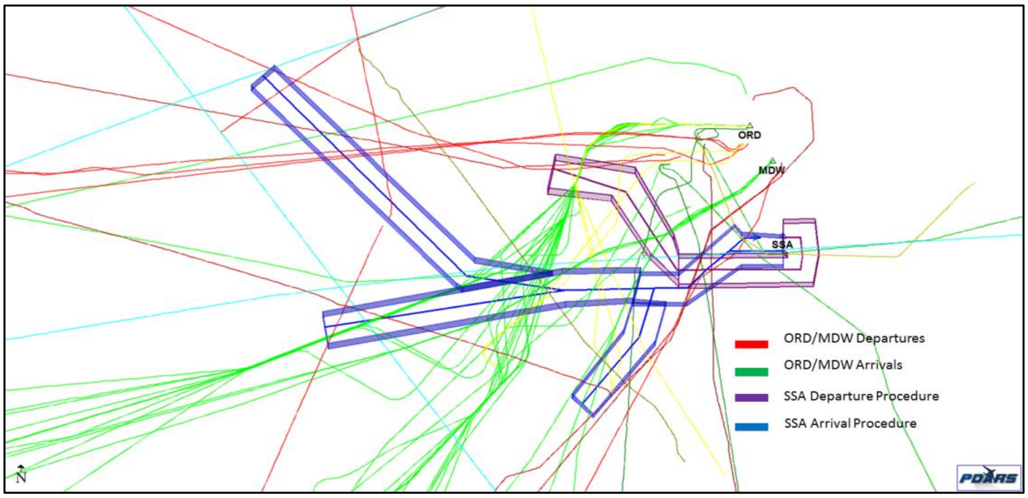
Using the elements described in the previous sections, scenarios were built and evaluated. The individual scenario definitions and a table detailing the arrivals, departures, internals, and overflights are shown below:

Scenarios A and D

Departure Procedure: RWY09R WEST SID

Arrival Procedure: WEST STAR

Existing Traffic Flow: East Flow 5/6/2014 22:51-23:30Z



Note: Scenario D is a modification of scenario A which the historical traffic is put on the BENKY and TRTLL

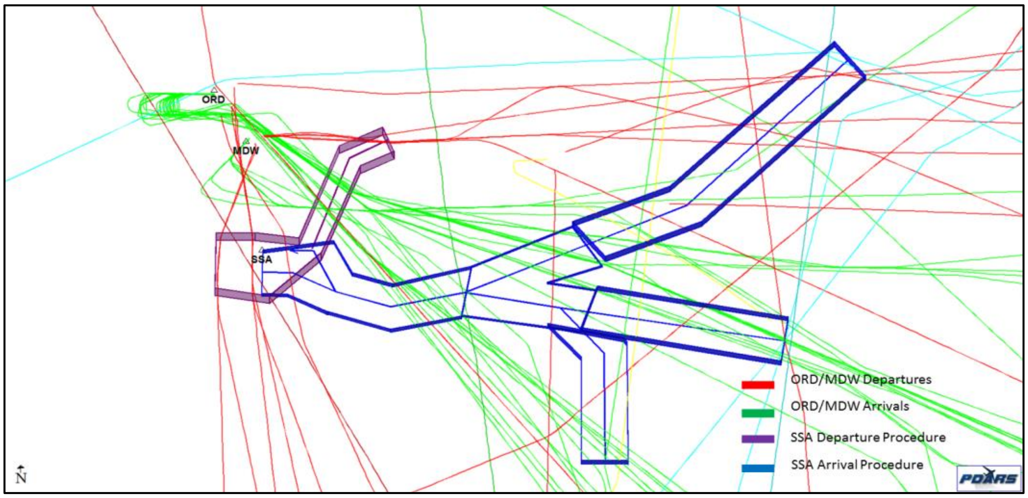
Arrivals		**Departures**		**Intraflights**		**Overflights**	
Arrival Airport		Departure Airport		Arrival Airport		Departure Airport	
ARR	3	DPA	2	DPA	1	KATL	1
KBGM	1	KARR	1	KBMI	1	KCLE	1
KSDL	1	KBMI	1	KDBQ	1	KDSM	1
KSGF	1	KCID	1	ORD	2		3
MDW	7	KMDW	1	PIA	2		
ORD	22	KMLI	2		7		
	35	KORD	3				
		PWK	1				
		SPI	1				
			13				

Scenario B

Departure Procedure: RW09R EAST SID

Arrival Procedure: EAST STAR

Existing Traffic Flow: East Flow 5/6/2014 10:47-11:17Z



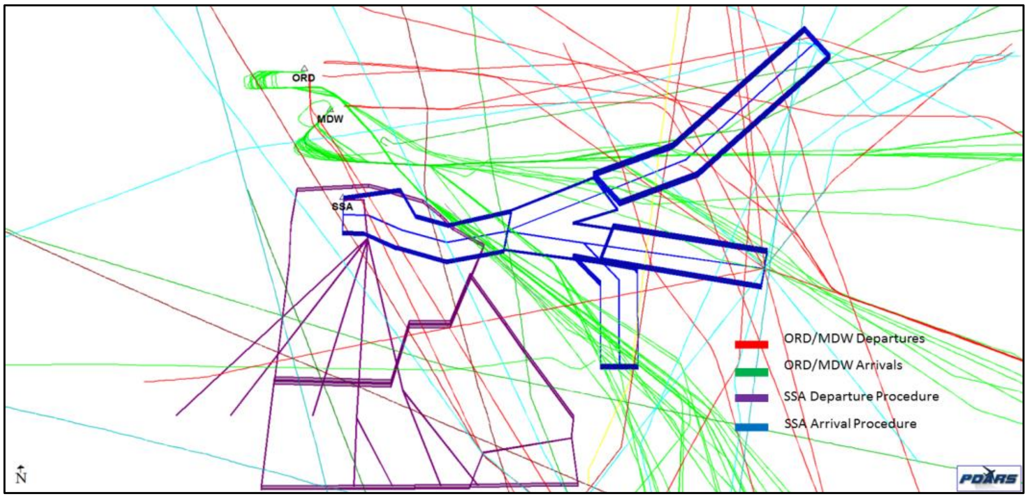
Arrivals		**Departures**		**Intraflights**		**Overflights**	
Arrival Airport		Departure Airport		Arrival Airport		Departure Airport	
GRR	1	KCMI	1	SBN	1	KBAK	1
KOSU	1	KGRR	1	TYQ	1	KFOE	1
MDW	6	KGSH	1		**2**	KIND	1
MKE	1	KMDW	7			KLAN	1
ORD	24	KMKE	1			KTOL	1
	33	KMSN	1				**5**
		KORD	4				
		KSBN	2				
			18				

Scenario C

Departure Procedure: RWY09R SOUTH SID

Arrival Procedure: EAST STAR

Existing Traffic Flow: East Flow 5/6/2014 11:30-12:00Z



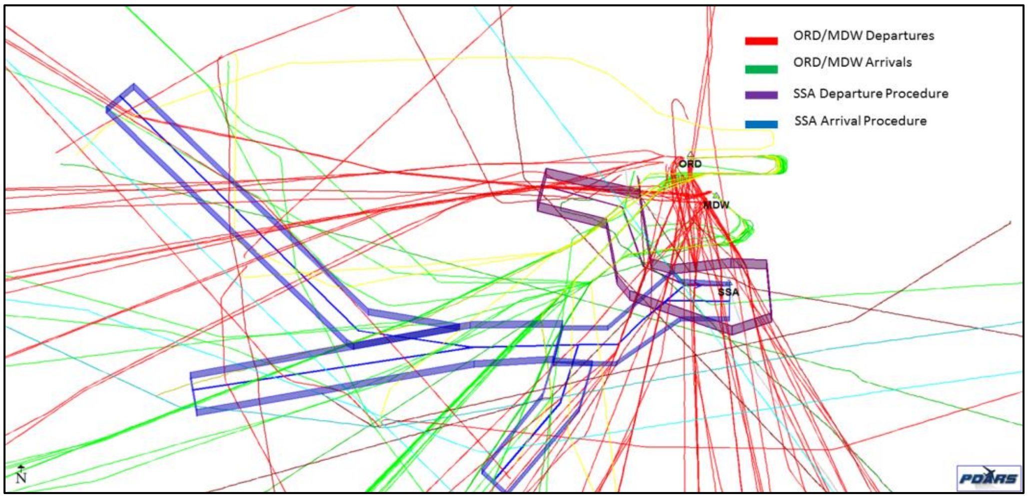
Arrivals		Departures		Intraflights		Overflights	
Arrival Airport		Departure Airport		Arrival Airport		Departure Airport	
CID	1	IND	2	TYQ	1	CVG.	1
GYY	1	KBEH	1		**1**	IND	1
HUF.	1	KBMI	1			KDAY	1
MDW	22	KFWA	1			KIND	1
MKE	1	KGRR	3			KLAN	1
ORD	17	KGSH	1			KMCI	1
PHNL	1	KMDW	2			KMQJ	1
	44	KMSN	1			KSTL	1
		KORD	4			KTOL	1
		KSBM	1			RRL.	1
		KUGN	1			SDF.	1
		MLI	1				**11**
			19				

Scenario E

Departure Procedure: RW27 WEST SID

Arrival Procedure: WEST STAR

Existing Traffic Flow: West Flow 6/11/2014 11:30-12:30Z



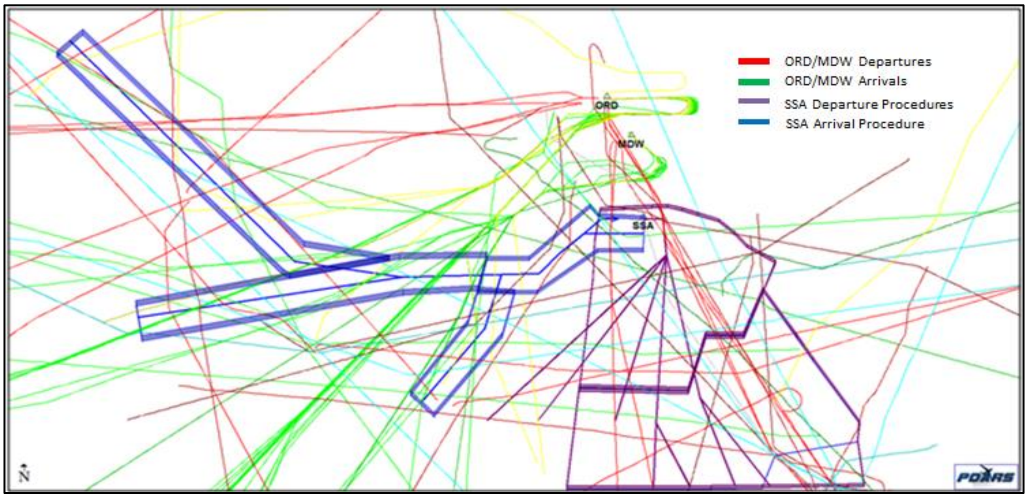
Arrivals		Departures		Intraflights		Overflights	
Arrival Airport		Departure Airport		Arrival Airport		Departure Airport	
ARR	1	DPA.	1	MDW	1	IND	1
CID	1	IND	1	ORD	7	KDSM	1
DBQ	1	KBMI	1		**8**	KIND	1
DPA	2	KCID	1			SUX.	1
MDW	12	KDBQ	1				**4**
ORD	22	KDPA	3				
	39	KEKM	1				
		KLOT	1				
		KMDW	22				
		KMKE	3				
		KMLI	2				
		KMSN	1				
		KORD	29				
		KPIA	2				
		KPWK	1				
			70				

Scenario F

Departure Procedure: RWY27L SE SID/RWY27L SW SID

Arrival Procedure: WEST STAR

Existing Traffic Flow: West Flow 6/11/2014 11:30-12:30Z



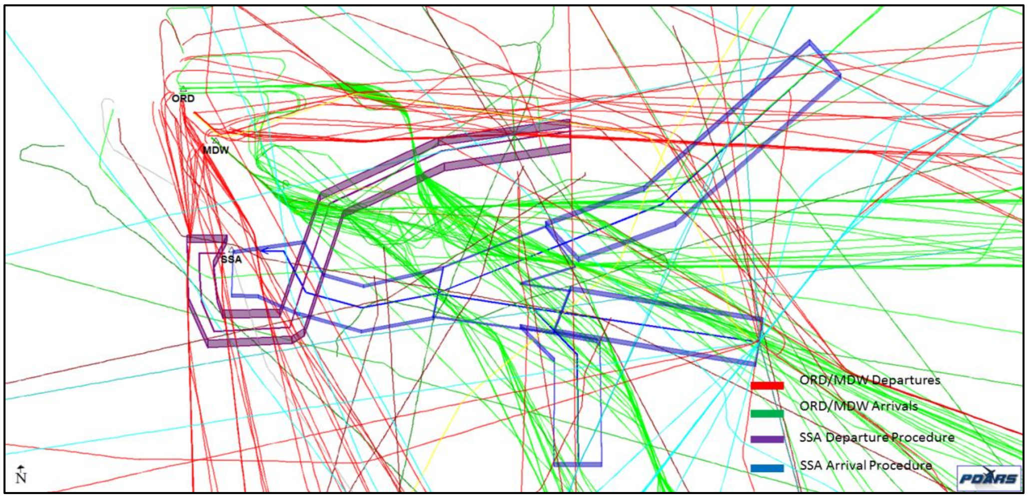
Arrivals		Departures		Intraflights		Overflights	
Arrival Airport		Departure Airport		Arrival Airport		Departure Airport	
ARR	1	DPA	4	MDW	1	IND	1
CID	1	IND	1	ORD	7	KDSM	1
DBQ	1	KBMI	1		**8**	KIND	1
DPA	2	KCID	1			SUX.	1
MDW	12	KDBQ	1				**4**
ORD	22	KEKM	1				
	39	KLOT	1				
		KMDW	22				
		KMKE	3				
		KMLI	2				
		KMSN	1				
		KORD	29				
		KPIA	2				
		KPWK	1				
			70				

Scenario G

Departure Procedure: RWY27L EAST SID

Arrival Procedure: EAST STAR

Existing Traffic Flow: West Flow 6/11/2014 11:30-12:30Z



Arrivals		Departures		Intraflights		Overflights	
Arrival Airport		Departure Airport		Arrival Airport		Departure Airport	
AFJ.	1	ASW.	1	BTL	1	IND	1
ANE.	1	AZO.	1	FWA	2	IND.	1
ARR	1	DPA.	1	MDW	1	KBAK	1
BIV	1	HFY	1		**4**	KBHM	1
CID	1	IND	2			KCVG	1
DET.	1	KBMI	1			KDAY	1
DPA	1	KEKM	1			KDSM	1
GYY	2	KFWA	1			KEVV	1
KCFE	1	KGRR	1			KIND	2
KEHR	1	KMDW	16			KMCI	1
MDW	39	KOEB	1			KOKC	1
ORD	44	KORD	25			KRQB	1
PWK	1	KPIA	1			KSTL	1
SBN	1	KUGN	3			KTOL	1
	96	MWC.	2			KTUL	1
		PWK.	2			KXNA	1
		SBN.	4			SUX.	1
		VPZ.	1				**18**
			65				

Evaluation Process and Standards

Scenarios were evaluated for safety, efficiency, workload, and scenario realism by assigning a rating to questions that included comments on observed benefits and challenges. The Analysis Team formulated questions.

Scenarios Evaluation process

- Evaluation responses were rated on a scale of 1 to 5. With 1 being the lowest and five the highest
- SMEs were asked to contribute comments on specific challenges to include;
  - Which routes, if any need to be changed
  - Which procedures, if any, need to be changed
  - List traffic impacts
  - List airspace impacts
  - Additional comments
- Comments were compiled and scored
- Relevant scores were averaged for each scenario

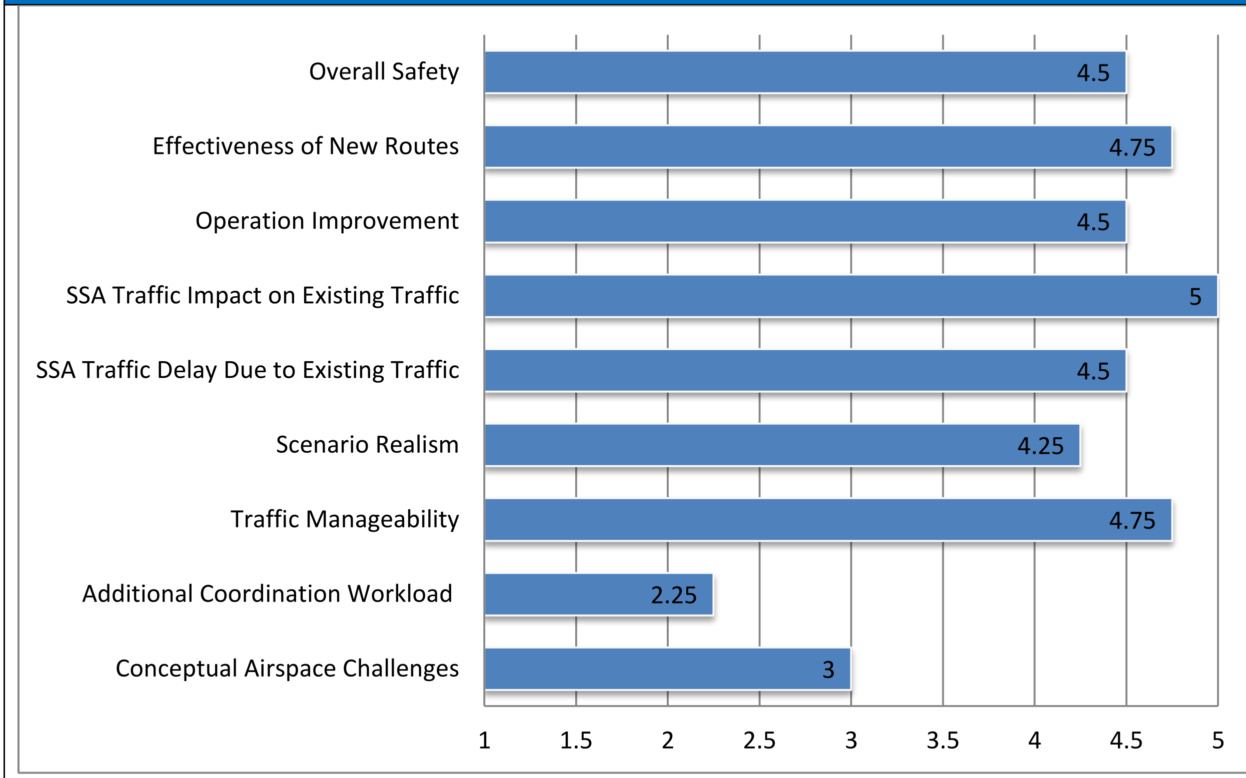
Evaluation Standards Table			
Evaluation Category:	Evaluation Question:	Evaluation Criteria:	Evaluation Scale (1 to 5)
Safety	How safe was the overall operation?	Overall Safety	Not Safe to very safe
Efficiency	How well did the new routes work?	Effectiveness of new routes	Poorly to very well
Efficiency	How has the operation improved?	Operation improvement	Worse to Better
Efficiency	How much did traffic flows from SSA impact ORD & MDW traffic?	SSA traffic impact on existing traffic	Big impact to little impact
Efficiency	How much of a delay did SSA get, due to ORD or MDW Traffic?	SSA traffic delay due to existing traffic	Big delay to little delay
Scenario Realism	How realistic was the traffic?	Scenario realism	Not realistic to very realistic

Evaluation Standards Table			
Evaluation Category:	Evaluation Question:	Evaluation Criteria:	Evaluation Scale (1 to 5)
Workload	Was the traffic manageable?	Traffic manageability	Less manageable to very manageable
Workload	How much additional coordination (Pointouts, Apreqs, Handoffs) would be required?	Additional coordination workload	Increased coordination to minor coordination
Workload	Are there a lot of conceptual airspace issues for these operations?	Conceptual airspace challenges	Big issues to minor issues

Evaluation Ratings and Key Findings by Scenario

Average scores and edited comments for each scenario in the tables below:

Scenarios A & D- RWY09R West SID/West STAR



Specific Challenges

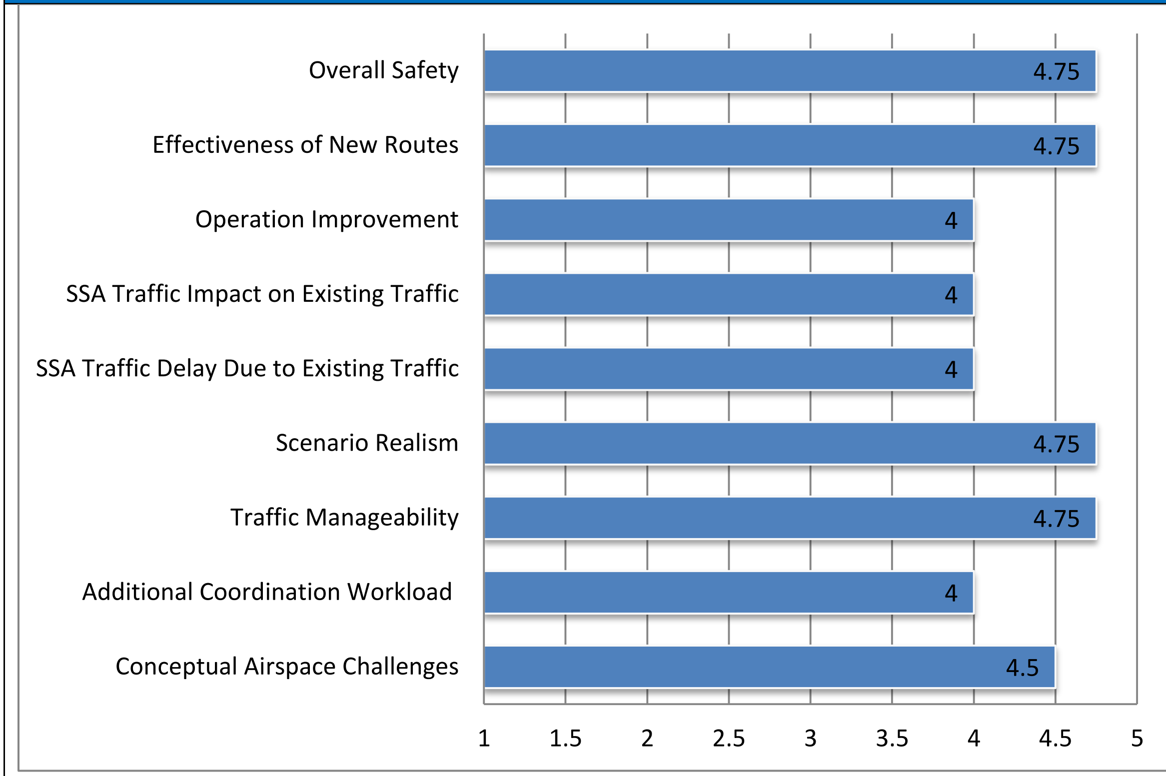
- Add additional lower level altitude for slow climbing or restricted westbound departures.
- Lower level props out of C90's airspace could conflict with new SID.
- Altitude restriction at WP1082 of 10,000 feet seems restrictive
- SSA arrivals are at 11,000 feet for extended period due to ORD/MDW southwest rush.
- Increased coordination with multiple sectors /aircraft, arrivals and departures, within 25NM of airport
- SSA traffic over QUOTE in high altitude were in confliction with west departures off ORD
- Increased coordination with ZAU sectors 43,51,77,83,92 (E.g. point-outs to 43 handoff to 51, approval request
- Scenario D
- SSA departures held down for C90 south bound departures. C90 satellite traffic a factor for SSA traffic
- SSA departures met all crossing restrictions over TRTLL and BENKY while ORD is on a modified east flow

Scenario B - RWY09 East SID/East STAR

Specific Challenges

- With any substaintial traffic this will be extremely difficult to sequence SSA departures with the ORD and MDW traffic. A route southeast would be the best
- It is not realistic for every departure to climb as well as depicted in simulation. Also climbing through arrival gaps sometimes head on with ORD eastbound is not feasible
- The climbs and vectors between MDW ORD AND SSA would be excessive
- SSA departures would most times level at 7,000 feet or below until 20 miles east of MDW. Expect in trail off MDW and SSA to make this procedure work
- The restriction at 7,000 could be an issue due to SBN feeding MDW arrivals at 6,000 and 7,000 feet from the southeast
- West flow at ORD, the LOOP sector could see sequencing issues with MDW and SSA departures over the LEWKE track
- Props/slow climbing aircraft will need to be off-loaded into SBN
- Departures from MDW and SSA departures have the potential for impacting each other near LEWKE. One may be held down for the other. Depending on the arrival push, aircraft climb rate will determine the efficiency of route.
- If conceptual ZAU works SSA, this SID is a coordination nightmare. Within 3 minutes of departure, fast climbers, will need point outs to multiple sectors C90, ZAU 44, approval request /Hand off from ZAU sector 35.
- The SSA departures were held down for long period of time. Extensive coordination (e.g. Point-outs, approval request) required to SBN approach, ZAU sectors 32, 35. SSA traffic delayed in flight levels due to ORD,MDW eastbound departures

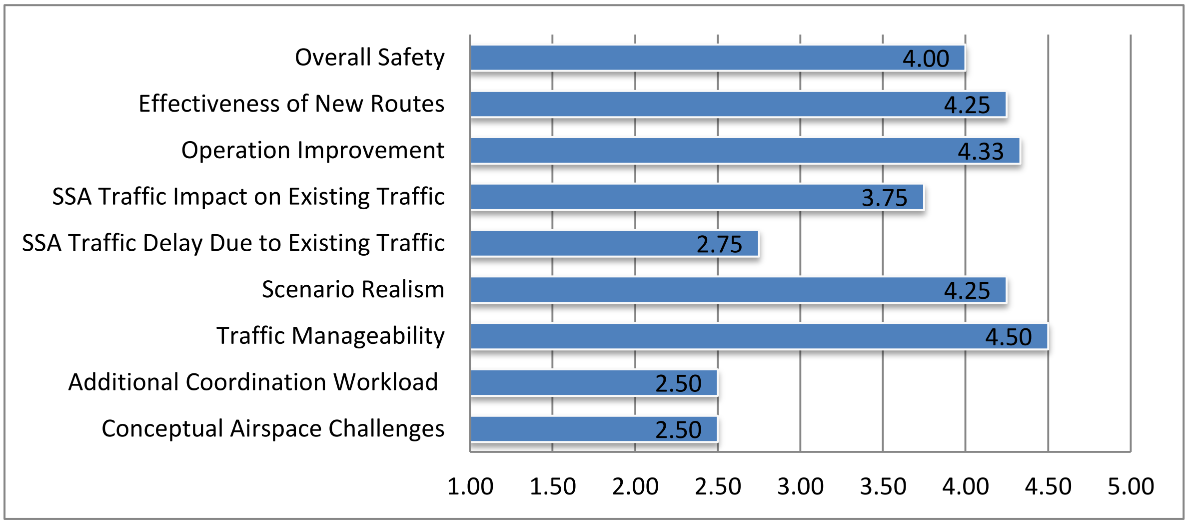
Scenario C - RWY09R 09R South SID/East STAR



Specific Challenges

- I think these routes work extremely well
- SSA departures will get held down due to downwind, overflights and ORD/MDW departure traffic. The impacts to SSA departures would occur in the flight levels, in ZAU's airspace
- SSA arrivals may have some impact on MDW arrivals from the southeast
- No issues directly involving airspace. Requires 3nm separation in en route environment
- No coordination required
- Only issue is the blending of SSA south departures into the C90 south departure tracks at high altitude
- No adverse impact, worked well

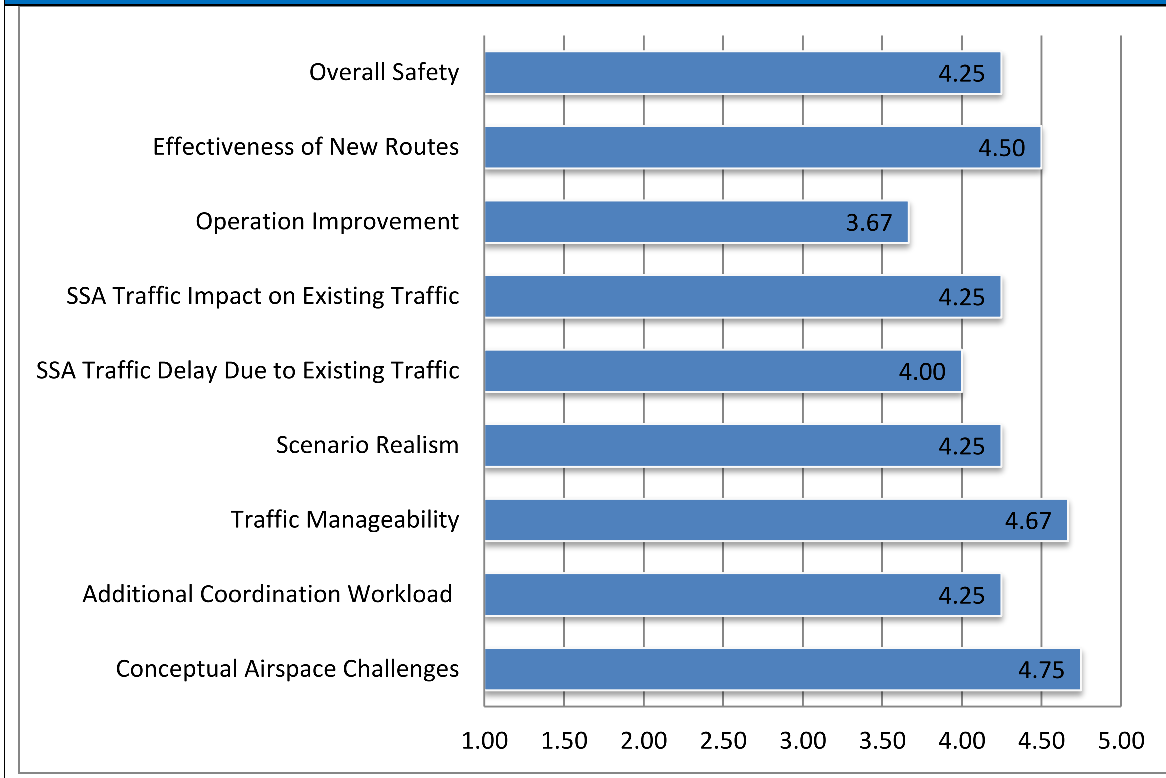
Scenario E - RWY27L 27L West SID/West STAR



Specific Challenges

- Safe and manageable. Additional traffic needed to evaluate effects of aircraft below 10,000 feet south out of C90
- The 7,000 altitude restriction could be a factor because MDW arrivals are entering C90 at 6,000 and 7,000 feet from the southwest.
- Low level prop departures off of MDW and ORD southbound(RBS/ACITO/BACEN) could conflict with new SID
- PEKUE is a heavy departure fix already adding more traffic to that track would increase the delay to ORD and MDW
- C90 satellite arrivals will conflict with SSA departures
- SSA departures need to climb well in order to top ORD and MDW arrivals.
- SSA departures may need to be held down due to ORD arrivals. SSA arrivals seemed to work fine, however they are restricted to a lower altitude in order to remain below MDW/ORD arrivals
- SSA departures, if not worked by C90, need to be handed off quickly to C90 due to multiple arrival and departure streams (ORD, MDW, satellite)
- SSA arrivals need to be coordinated early in order to have an effective sequence
- Extensive coordination involved (e.g. approval requests, point-outs) All departures would require approval request with C90 for departure release
- Most departures required point-outs to ZAU sectors 43,51
- The SSA departures over PEKUE will get held down and sequenced with both ORD and MDW departures
- SSA traffic will be delayed on the ground or C90 satellite arrivals will be vectored for the SSA departures and arrivals

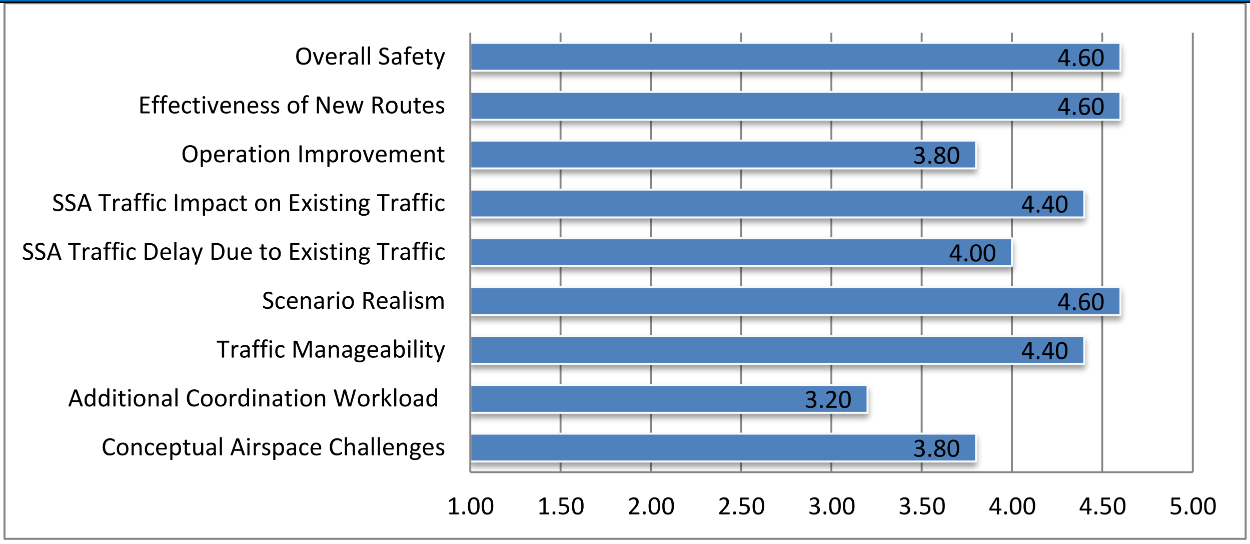
Scenario F - RWY27L 27L South SID/West STAR



Specific Challenges

- Requires more structured route and possible altitude assignments to accomplish all the crossing.
- SSA Departures are held down for C90 satellite traffic and SSA arrivals on the downwind. SSA arrivals are pushed down early for MDW/ORD arrivals from the southwest. Increased coordination, either point-outs, early handoffs, or approval request, from high sector to conceptual airspace
- Southbound departures off SSA will get held down or turned for prop departures from C90 AOB 11,000ft
- SSA traffic will need to be put in trail or stacked with MDW, ORD southbound traffic
- Possible point-out to Sectors 43, 57

Scenario G - RWY27L 27L East SID/East STAR



Specific Challenges

- This SID provides the greatest amount of flexibility and use of non-saturated airspace in the initial climb
- This procedure allows for almost unrestricted climbs out of TRACON airspace
- Might need to look at modifying C90's existing and conceptual airspace to reduce possible coordination. Point outs/handoff to BEARZ and/or EON sector could be eliminated
- If a SSA departure gets held down due to downwind or overflight traffic, there could be an issue with topping ORD arrivals from the southeast. Handoffs would become a factor. If conceptual C90 or ZAU airspace altitude was raised to 15,000 feet this could mitigate these issues.
- SSA Departures may be held down for SSA arrivals on downwind and again around 15,000 feet underneath C90 departures on the "E" Track. SSA arrivals will be pushed down early to ensure they enter SBN airspace for sequencing prior to being handed off.
- Possible right turns off SSA into C90 to lessen miles flown and stay away from being held down for downwind traffic
- All SSA traffic needs to be blended with the ORD/MDW east of LEWKE, most in the flight levels
- Traffic will need sequenced with ORD/MDW traffic east of LEWKE. SSA departures that climb extremely slow, or held down for overflights, would have to be stopped below 11,000 feet and handed off to SBN approach
- Extensive coordination (e.g. point-outs to ZAU sector 32/44/83 and a handoff to sector 35). Approval request for stacks with adjacent high sector

Appendix H: Procedure Confliction/Hot Spots

Procedures	Transition	Merge/Confliction Points	Impacted Flows	Altitudes	Hotspot
RWY09R EAST SID	LEWKE	WP836-WP942-GERMN	ORD arrivals, MDW/south satellite departures	100-150	
		GERMN-LEWKE	MDW/South Satellite departures	150-300	GIJ-EVOTE
RWY27L WEST SID	PEKUE	WP838-WP839-WP843-LEEDN	ACITO departures off ORD/MDW, ORD arrivals	100-130	JOT
		LEEDN-PEKUE	MDW\ORD\SOUTH SAT DEPT(WESTBOUND)	100-200	PEKUE
RWY09R SOUTH SID	ARLYN	WP836-WP848-WP849 (use for all trans)	V38, C56 downwind, SAT arrivals from South southeast, GYY STAR.	AOB 100	LUCIT
		WP849-ARLYN	BMI departures, CMI arrivals, merge with ORD\MDW departures, GYY STAR, IKK para-jump.	050-240	10nw RBS
	BEKKI	WP849-BEKKI	BMI departures, CMI arrivals, merge with ORD\MDW departures, GYY STAR, IKK para-jump.	050-240	RBS
	CYBIL	WP849-CYBIL	BMI departures, CMI arrivals, merge with ORD\MDW depts. IND arrivals, GYY STAR.	050-240	15-20NM east RBS
	DONVE	WP849-DREGS (DONVE)	BMI departures, CMI arrivals, merge with ORD\MDW depts. IND arrivals, GYY STAR.	050-240	25NM east RBS
	DUMGE	WP849-DREGS (DUMGE)	BMI departures, CMI arrivals, merge with ORD\MDW depts. IND arrivals, GYY STAR	050-240	25NM east RBS

Procedures	Transition	Merge/Confliction Points	Impacted Flows	Altitudes	Hotspot
	ERECO	WP849-EMMLY(ERECO)	BMI departures \arrivals, CMI departures \arrivals, merge with ORD\MDW depts. IND departures \arrivals, CVG arrivals GYY STAR, GUS arrivals.	050-240	10NM west of BVT
	ETAME	WP849-EMMLY (ETAME)	BMI departures \arrivals, CMI departures \arrivals, merge with ORD\MDW depts. IND departures \arrivals, CVG arrivals, GYY STAR, GUS arrivals, C90 SAT arrivals from SE, C56 arrivals.	050-240	10NM southwest of BVT
RWY27L SOUTH SID	ARLYN	WP838-WP846-WP850 (use for all transition)	V38, C56 downwind, SAT arrivals from South southeast	AOB 050	
		WP850-ARLYN	BMI departures, CMI arrivals, merge with ORD\MDW depts. CMI departures over PNT, GYY STAR, and IKK Skydive operation.	050-240	10nw RBS
	BEKKI	WP850-BEKKI	BMI departures, CMI arrivals, merge with ORD\MDW depts. CMI departures over PNT, GYY STAR, IKK para-jump	050-240	RBS
	CYBIL	WP850-WP1995-CYBIL	BMI departures, CMI arrivals, merge with ORD\MDW depts. IND arrivals, GYY STAR, IKK para-jump.	050-240	15NM east of RBS
	DONVE	WP850-WP1995-DREGS (DONVE)	BMI departures, CMI arrivals, merge with ORD\MDW depts. IND arrivals, GYY STAR, IKK para-jump.	050-240	15-20 NM east of RBS

Procedures	Transition	Merge/Confliction Points	Impacted Flows	Altitudes	Hotspot
	DUMGE	WP850-WP1995-DREGS (DUMGE)	BMI departures, CMI arrivals, merge with ORD\MDW depts. IND arrivals, GYY STAR, IKK para-jump.	050-240	15-20 NM east of RBS
	ERECO	WP850-WP1995-EMMLY(ERECO)	BMI departures \arrivals, CMI departures \arrivals, merge with ORD\MDW depts. IND departures \arrivals, CVG arrivals GYY STAR, IKK para-jump, GUS arrivals.	050-240	10NM west of BVT
	ETAME	WP850-WP1995-EMMLY (ETAME)	BMI departures \arrivals, CMI departures \arrivals, merge with ORD\MDW depts. IND departures \arrivals, CVG arrivals, GYY STAR, IKK para-jump, GUS arrivals, C90 SAT arrivals from SE, C56 arrivals.	050-240	10NM south of BVT
WEST STAR	ET10(CVA)	WP1086-WP1087	ENDEE STAR, MLI-ORD, satellite arrivals from southwest, MLI/CID arrivals from east, RFD arrivals from west, RST arrivals, ORD/MDW/Satellite departures AOB 240	240-150	BDF, MONNY, CVA
		WP1087-WP1088	ENDEE STAR, RFD arrivals from southwest, satellite arrivals from southwest, PIA-ORD traffic, PIA arrivals from north.	190-110	PURTY, MANIA
		WP1088-WP1400-WP1054 - WP864(for all west transitions)	ENDEE STAR, satellite arrivals from southwest, PIA\BMI-ORD traffic, PIA\BMI arrivals from north.	110-090	MANIA, MOTIF
		WP864-WP1056-WP845/WP864-WP1057-WP865-WP866	Satellite arrivals from Southeast, V38	090-030	20NM SE JOT

Procedures	Transition	Merge/Confliction Points	Impacted Flows	Altitudes	Hotspot
	WEST	WP1103-WP1088-WP1400	ENDEE STAR, RFD arrivals from southwest, satellite arrivals from southwest, PIA-ORD traffic, PIA arrivals from north.	240-110	BDF, MANIA
	ZAU SW (POOGY)	POOGY-WP1084-WP1400	ENDEE STAR, BMI-ORD, satellite arrivals from south	190-110	PNT, MANIA
RWY27L EAST SID		WP838-WP788-WP837	V38, Satellite arrivals from southeast	AOB 040	EON
		WP837-WP1995-WP1042	Satellite arrivals, GGY STAR,	040-100	LUCIT
		WP1042-WP1046-WP2457	ORD\MDW south departures (E-TRACK), satellite arrivals, GGY arrivals, ORD\MDW arrivals from southeast.	100-190	VPZ
		WP2457-WP1051-WP1050	ORD\MDW east departures	170-290	GIJ
RWY09R WEST SID	QUOTE	WP836-WP848-WP1398	SAT ARR, GGY arrivals, V38, GGY\IGQ departures southbound.	AOB 060	LUCIT
		WP1398-WP1082	Satellite arrivals, GGY arrivals, ORD\BMI, MDW departures southbound	060-100	EON

Procedures	Transition	Merge/Confliction Points	Impacted Flows	Altitudes	Hotspot
		WP1082-WP797	Satellite arrivals, MDW\ORD departures (TRACK A)	100-170	WP1082
		WP797--WP798-WP800	ORD arrivals from southwest, RFD departures southeast, RFD arrivals southwest, MLI arrivals from east.	130-220	TRTLL, KELSI
		WP800-QUOTE	ORD west departures, southeast departures RFD, southwest arrivals RFD, east arrivals MLI	160-260	QUOTE
EAST STAR	FWA AREA	WP1150-WP1721	MDW arrival PANGG STAR, holding pattern at FISKK	240-110	WP1721, WP1150
		WP1721-WP1718	MDW arrivals FISKK STAR, holding pattern at FISKK	110-080	WP1718
	FOR ALL TRANS	WP1718-WP1720-WP868	MDW arrivals FISKK STAR	100-080	WP1720
		WP868-WP869/WP868-WP871-WP866	GYY STAR, satellite departures southbound, V38	AOB 080	WP868
	GOTNE AREA	WP1722-TROLY-GOTNE	MDW arrivals on FISKK STAR	240-110	WP1722, GOTNE
		GOTNE-WP1721-WP1718	MDW arrivals FISKK STAR, holding pattern at FISKK	110-080	WP1718, WP1721
	LFD AREA	WP1132-WP1719-WP1841	MDW arrivals PANGG STAR	240-100	WP1719
		WP1841-WP1718	MDW ARRIVALS PANGG/FISKK STAR	110-080	WP1718

Appendix I: Abbreviations and Acronyms

Abbreviation	Definition
3CK	Lake In The Hills Airport
3KK	Kankakee Airport
AC	Advisory Circular
ADO	Airport District Office
AGL	Above Ground Level
AirTOp	Air Traffic Optimization
ARR	Aurora Municipal Airport
ARTCC	Air Route Traffic Control Center
ASR	Airport Surveillance Radar
ATC	Air Traffic Control
ATM	Air Traffic Management
ATCT	Airport Traffic Control Tower
ATO	Air Traffic Organization
C09	Morris Municipal Airport- James R. Washburn Field
C56	Bult Field Airport
C90	Chicago TRACON
CAT	Category
Chicago TRACON	Chicago Terminal Radar Approach Control
CAASD	Center for Advanced Aviation System Development
Class D	Surface to 2500 feet above the airport elevation (Only surrounds airports that have an operational control tower)
CSA	Central Service Area
DBO	Date of Beneficial Occupancy
DOT	Department of Transportation
DPA	DuPage Airport
EIS	Environmental Impact Statement
EON	Peotone
FAA	Federal Aviation Administration
FL	Flight Level
FP	Flight Plan
GA	General Aviation
GPS	Global Positioning System
GYY	Gary/Chicago International Airport
HQ	Head Quarters
IDOT	Illinois Department of Transportation
IFR	Instrument Flight Rules

Abbreviation	Definition
IGQ	Lansing Municipal Airport
IKK	Greater Kankakee Airport
ILS	Instrument Landing System
JOT	Joliet Regional Airport
LOT	Lewis University Airport
MDW	Chicago Midway International Airport
MEL	Multi Engine Land Piston Aircraft
MKE	Chicago Mitchell International Airport
MOA	Military Operations Area
MSL	Mean Sea Level
NATCA	National Air Traffic Controller Association
NextGen	Next Generation Air Transportation System
NM	Nautical Miles
NAS	National Airspace System
OMP	O'Hare Modernization Program
ORD	Chicago O'Hare International Airport
PDARS	Performance Data Analysis Reporting System
PWK	Chicago Executive Airport
RA	Reimbursable Agreement
RFD	Rockford International Airport
RNAV	Area Navigation
RWY	Runway
SBN	South Bend Airport
SEL	Single Engine Land Piston Aircraft
SIDs	Standard Instrument Departures
SME	Subject Matter Expert
SSA	South Suburban Airport
STARs	Standard Terminal Arrival Routes
SUA	Special Used Airspace
TARGETS	Terminal Route Generation Evaluation, and Traffic Simulation
TFM	Traffic Flow Management
UGN	Waukegan Regional Airport
VFR	Visual Flight Rules
VOR	VHF Omnidirectional Range
WP	Waypoint
ZAU	Chicago Air Route Traffic Control Center

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Attachment 1: Proposed South Suburban Airport (SSA) Feasibility Analysis AirTOp Modeling

MP140762

MITRE PRODUCT

South Suburban Airport (SSA) Feasibility Analysis AirTOp Modeling

Dr. John Kuchenbrod
Rodolfo Canales
Robert Kluttz

December 2014

Sponsor: The Federal Aviation Administration
Dept. No.: F071
Project No.: 0214LA03-CH
Outcome No.: 3
PBWP Reference: 3-4.B.1-2, “Simulation Modeling of Chicago SSA Initial Airspace and Procedures”

McLean, VA

Center for Advanced Aviation System Development

Abstract

In May 2014, the Federal Aviation Administration's (FAA) Air Traffic Organization (ATO), at the request of the Illinois Department of Transportation (IDOT), agreed to evaluate the feasibility of air traffic delivery to and from the expanded South Suburban Airport (SSA) at Bult Field in Will County, Illinois. As a member of the SSA Analysis Team, The MITRE Corporation's Center for Advanced Aviation System Development (MITRE CAASD) built fast-time simulations to quantitatively evaluate the impact of SSA operations on other flights in the Chicago Terminal Radar Approach Control and Chicago Air Route Traffic Control Center airspaces. The simulations showed that SSA operations had minimal impact on flights arriving to or departing from Chicago area airports.

Acknowledgments

The authors thank the other members of the South Suburban Airport (SSA) Analysis Team for their guidance on and refinement of arrival and departure procedures for the Chicago area airports. The authors also thank John Brandt and Jeff Shepley for their review of this work and Angela Signore for her editing of this document.

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1 Introduction

In May 2014, the Federal Aviation Administration (FAA) Air Traffic Organization (ATO), at the request of the Illinois Department of Transportation (IDOT), agreed to evaluate the feasibility of air traffic delivery to and from the expanded South Suburban Airport (SSA) at Bult Field (C56) in Will County, Illinois. The ATO assembled the SSA Analysis Team, consisting of certified professional controllers (CPCs) from Chicago Terminal Radar Approach Control (TRACON) (C90) and Chicago Air Route Traffic Control Center (ZAU) along with The MITRE Corporation's Center for Advanced Aviation System Development (MITRE CAASD), CSSI Incorporated, ATAC, and Human Solutions Inc. As a member of the Analysis Team, MITRE CAASD built fast-time simulations to quantitatively evaluate the impact of SSA operations on other flights in C90 and ZAU.

1.1 South Suburban Airport

SSA is an airport to be expanded from Bult Field, located 38 nautical miles (NM) south-southeast of Chicago O'Hare International Airport (ORD). IDOT purchased Bult Field in July 2014 and refers to the airport as "Bult Field at South Suburban Airport." Figure 1-1 shows the location of SSA with respect to ORD, Midway International Airport (MDW), and the C90 airspace boundary. Note that SSA is located 3 NM outside of C90 airspace.

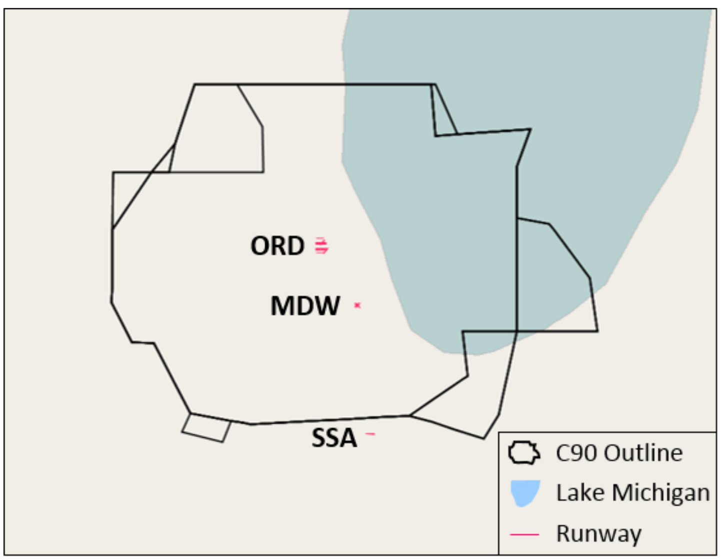

Figure 1-1. SSA and its position in relation to ORD, MDW, and the C90 Boundary

The expanded airport includes the current 5,001 foot general aviation runway (currently Runway 9/27, to be Runway 9L/27R) and a planned 9,500 foot commercial runway (to be Runway 9R/27L) to the southwest of the current runway. Since no date has been set for the opening of the new runway, the Analysis Team in conjunction with the Chicago Airports District Office estimated an opening date that is referred to as the Date of Beneficial Occupancy (DBO).

This study considers scenarios associated with the first year of occupancy (denoted DBO+1) and the fifth year of occupancy (DBO+5).

1.2 AirTOp

The Air Traffic Optimization Fast Time Simulator (AirTOp) provides discrete-event, gate-to-gate, fast time simulation for high-fidelity modeling and quantitative analysis of ground, terminal, and en route airspace operations. AirTOp was first developed in 2007 by the Belgian company AirTOpSoft and has been used extensively by air navigation service providers, research institutions, and the consultant community.

2 Modeling Parameters, Techniques, and Assumptions

The modeling parameters include the airspace elements and airports that define the study area. The modeling techniques explain how the capabilities of AirTOp were leveraged to determine feasibility of operations as measured by key metrics. Finally, the modeling assumptions cover the details needed to properly handle the modeling inputs.

2.1 Experimental Design

Eight scenarios were analyzed in AirTOp, reflecting all possible combinations of three modeling variables: traffic levels, the presence of SSA operations, and runway flow direction as shown in Figure 2-1.

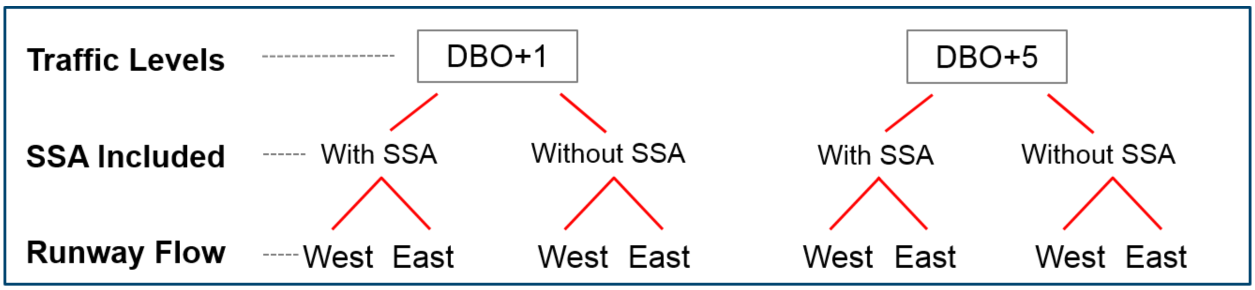

Figure 2-1. AirTOp Experimental Design

The traffic levels correspond to the first and fifth years of commercial operations, DBO+1 and DBO+5. In order to measure the impact of SSA operations, one set of scenarios used a traffic file containing SSA operations while the other set had the SSA operations removed, leaving only the other C90 operations. Finally, the runway flow direction allowed the Analysis Team to evaluate SSA impacts with respect to the primary operating directions at C90 airports.

For simulation purposes, the runway flow direction at SSA was assumed to mirror the runway flow direction at ORD. The Analysis Team recognized that in certain conditions with a light east wind, ORD could operate in a west flow to maximize throughput while SSA may prefer to operate in an east flow. Initially the Analysis Team requested that this combination of runway flows be included in the experimental design. Due to the infrequency of this scenario and limitations on modeling resources, this scenario was not modeled.

Each of the eight scenarios was run eleven times for the quantitative analysis. The arrival or departure times of the aircraft were the only changes among the eleven runs; the changes were generated from a uniform distribution of plus or minus ten minutes.

2.2 Key Metrics

All metrics in this study are comparative metrics; that is, the difference between a measurement taken in a scenario containing SSA operations and in the corresponding scenario without SSA operations. Hence, all metrics show the impact that SSA operations had on other operations in the airspace. The quantitative metrics derived from the AirTOp simulations are:

- Throughput by airport

- Ground delay by airport
- Time in level flight by airport
- Change in flight time by airport
- Potential conflicts requiring air traffic control (ATC) resolution
- Prearranged coordination climb operations involving SSA departures
- Distance in level flight for SSA departures

A potential conflict requiring ATC resolution occurs when two departures desire paths that violate ATC separation standards. AirTOp detects these potential conflicts and alters the course of one of the involved aircraft to avoid a loss of separation. In this study, AirTOp alters the course with a change in altitude or speed, or with a ground delay. Because the metrics are comparative, a reported conflict involves either an SSA departure or a departure from another airport whose course was altered due to a conflict with an SSA departure. Note that all conflicts resolved by AirTOp also result in a change in the other comparative metrics if a non-SSA flight is impacted. For example, if due to a conflict, AirTOp changes the altitude of a departure and holds it down, the time in level flight metric for that flight changes as well.

SSA Runway 9R departures traveling to the east procedurally pass below an ORD arrival corridor in the southeast corner of C90, and similarly SSA Runway 27L departures traveling to the west pass under ORD arrivals in the southwest corner of C90. In each case, if no arrivals are in the corridor to ORD, ATC will have “prearranged coordination” to allow the SSA departures to climb through the empty ORD arrival corridor. The number of these prearranged coordination climb operations is reported as a metric.

2.3 Airspace

As noted in the airport description, SSA is located 3 NM south of the current C90 boundary. In addition, the boundary between low sectors ZAU50 and ZAU57 is 12 NM west of SSA, as displayed in Figure 2-2.

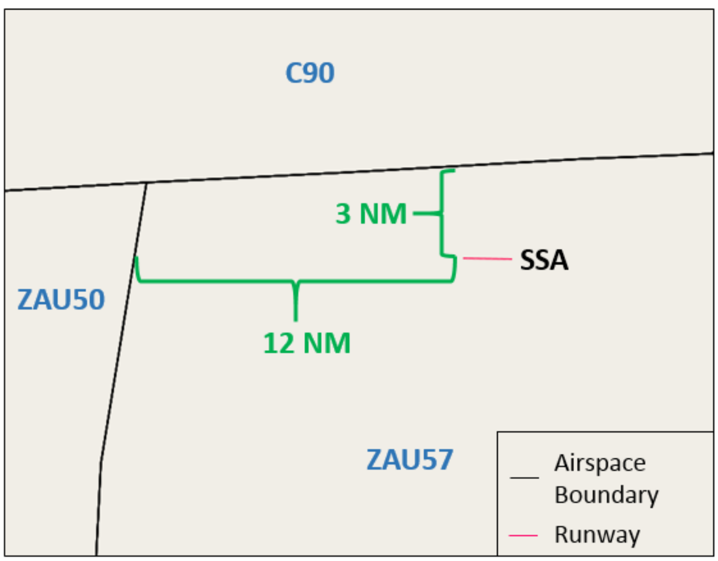

Figure 2-2. Location of SSA with Respect to Airspace Boundaries

The proximity of C90 to SSA is not an issue today due to SSA operations primarily observing Visual Flight Rules (VFR), where separation assurance is the responsibility of the pilot. As more SSA operations observe Instrument Flight Rules (IFR) with separation assurance being the responsibility of air traffic control, an aircraft on final approach or initial departure will be flying parallel and too close to the C90 airspace boundary. The proximity of ZAU50 to SSA is an issue for aircraft on final approach to Runway 9R or on initial departure off of Runway 27L since a change in frequency and control will be required for all flights. In addition, an arrival from the east on an extended final approach could pass from ZAU57 to ZAU50 and then back into ZAU57 before landing.

To mitigate these issues the Analysis Team proposed two conceptual airspace designs: The ZAU Conceptual Airspace Design and the C90 Conceptual Airspace Design. In the ZAU Conceptual Airspace Design, a new sector draws airspace from the northern portion of ZAU57 and the eastern portion of ZAU50, essentially moving the airspace boundary further west to ensure that an extended final approach remains in the same sector. In the C90 Conceptual Airspace Design, the northern portion of ZAU57 extending 22 NM south of SSA and from ground level to 10,000 feet falls under C90 jurisdiction. By placing the airspace surrounding SSA in C90, separation minima is reduced from 5 NM to 3 NM, and departure procedures to the east and west remain under TRACON control until reaching their respective departure fix. The C90 Conceptual Airspace Design appears in Figure 2-3.

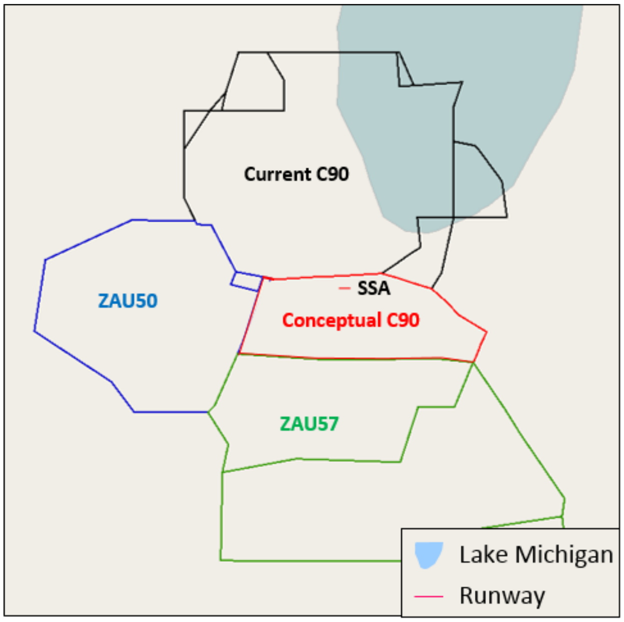

Figure 2-3. C90 Conceptual Airspace Design

Initially the Analysis Team elected to evaluate the DBO+1 traffic level with the ZAU Conceptual Airspace Design and the DBO+5 traffic level with the C90 Conceptual Airspace Design. After further deliberation with focus on the goal of determining feasibility of SSA operations, and due to limited resources, the Analysis Team chose the C90 Conceptual Airspace Design for use throughout the experimental design. The Analysis Team independently evaluated the ZAU Conceptual Airspace Design qualitatively.

2.4 Airports

Figure 2-4 depicts the airports modeled in this analysis.

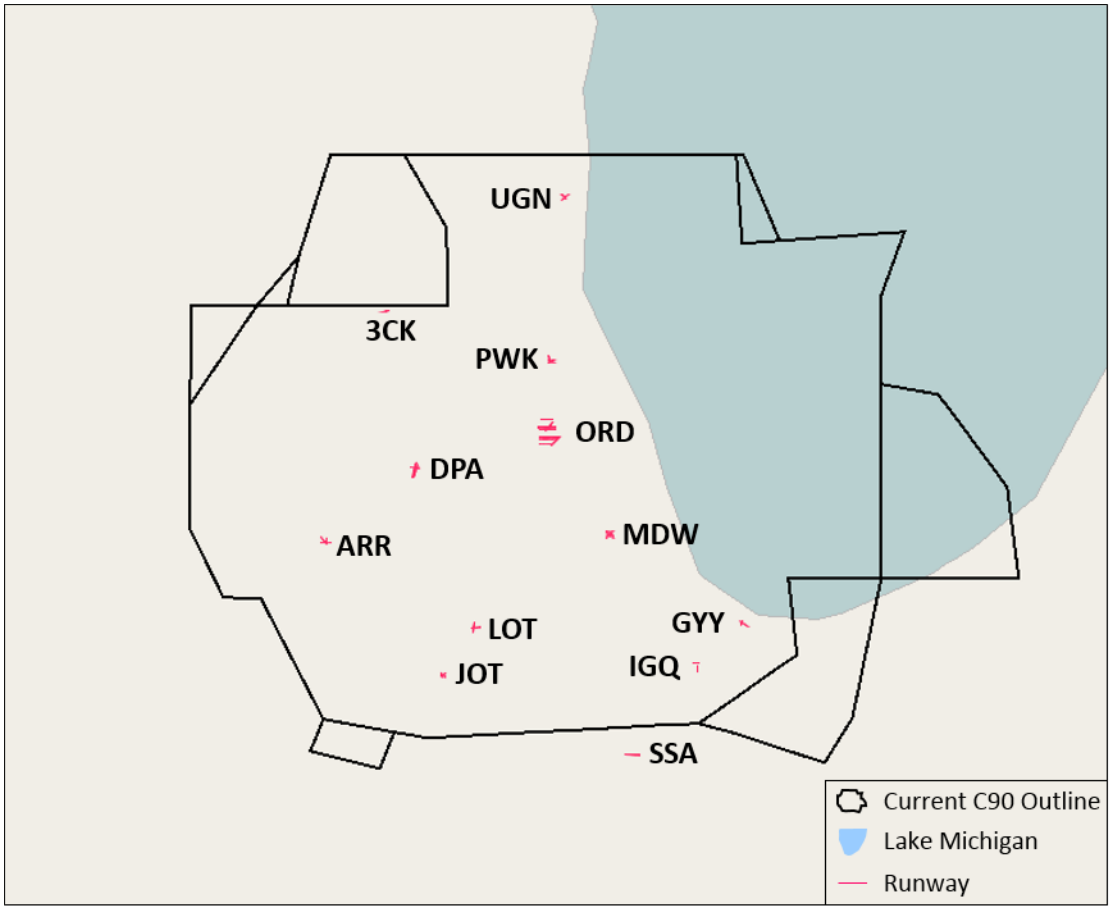

Figure 2-4. Modeled Airports

In AirTOp, the analyst may model airports with a full ground layout in which flights start or finish at a gate, with runways only in which flights start or end on the runway, or as a point. All airports in C90 that regularly deliver IFR flights were modeled with runways only; other airports in C90 were not modeled.

The modeled airports were:

- SSA, with the proposed commercial runway in operation
- ORD, modeled as anticipated in DBO+1 with the full build of runways prescribed in the O'Hare Modernization Program (OMP): six east-west runways and two crosswind runways
- MDW
- Aurora Municipal Airport (ARR)
- Chicago Executive Airport (PWK)

- DuPage Airport (DPA)
- Gary/Chicago International Airport (GYY)
- Joliet Regional Airport (JOT)
- Lake in the Hills Airport (3CK)
- Lansing Municipal Airport (IGQ)
- Lewis University Airport (LOT)
- Waukegan Regional Airport (UGN)

2.5 Modeling Techniques

Modeling techniques are divided into arrival flights and departure flights. The techniques describe the level of detail applied to flight paths in C90 and ZAU as well as the source of the procedural information. The techniques also cover traffic flow management and separation concepts as applied in AirTOp.

2.5.1 Arrival Flights

All arrival flights originate at a waypoint on their route that is outside of ZAU. Arrival procedures in AirTOp are paths along which specific altitude and speed intervals are required of the flight. The arrival procedure into the respective airport begins at a point on the Standard Terminal Arrival Route (STAR) that is inside ZAU. The specific arrival procedures are discussed further in Section 3.

AirTOp's net queue structure regulates the flow on arrival routes into ORD and MDW. In a net queue, the model limits the number of arrivals on a flow over a period of time while also applying miles-in-trail separation at the beginning of each arrival procedure. For ORD, the limit is 43 arrivals per hour for each runway, with 5 NM separation on all arrival fixes to the north and south runways and 8 NM separation on the arrival procedure for the center runway. The difference in separation requirements is a result of the lack of vectoring area for the center runway, while the multiple flows feeding the north and south runways have large vectoring areas. The limit of 43 arrivals per hour per runway is consistent with the arrival throughput for ORD in the OMP Final Environmental Impact Statement (FEIS). For MDW, the limit is 40 arrivals per hour for the one arrival runway, with 5 NM separation on all arrival fixes. No net queue is needed for the other airports in the study due to the sparse traffic demand for those airports.

Arrival flights into ORD followed procedures derived from STARs as charted in July 2014 with an adjustment for final approach to match the runway configuration in the OMP FEIS. Up to final approach, each current STAR mirrors the corresponding arrival procedure in the OMP FEIS. The CPCs on the Analysis Team provided altitude and speed guidance on each STAR.

Arrival flights into MDW followed procedures derived from STARs as charted in July 2014. CPCs provided altitude and speed guidance on the MDW STARs. The CPCs provided all details for the STARs into the other airports, including the notional STARs into SSA.

2.5.2 Departure Flights

Standard Instrument Departures (SIDs) from airports in C90 deliver aircraft from the airport to a departure fix on the C90 boundary. The specific SIDs are discussed further in Section 3 as well. Departure flights terminate at a waypoint on their route outside of ZAU.

SIDs from ORD were derived directly from the OMP FEIS. The departure separation standards for ORD were derived from the OMP FEIS as well. Departures from the same runway that use a fix in the same cardinal direction (north, south, east, or west) required 3 NM separation at the runway; those departing in other directions may start their takeoff roll when the previous departure is airborne. Departures from the same runway that use the same fix require 4 NM separation at the runway. These standards were used at all airports in this study.

The CPCs provided all details for the SIDs out of the other airports, including the notional SIDs out of SSA.

AirTOp's conflict detection and resolution methods ensure separation among departures on SIDs as well as aircraft in the en route environment. In conflict detection, AirTOp considers pairs of aircraft whose trajectories pass within separation standards. In conflict resolution, AirTOp applies a decision tree to determine the best action to apply to one (or both) of the aircraft to properly separate the pair, including speed control, stopping climbs, and vectoring aircraft when appropriate. If two aircraft violate separation standards by no more than 100 feet vertically or by nor more than 0.5 NM laterally, AirTOp will not resolve the conflict. The results in Section 4 include all conflicts, resolved and unresolved, since all conflicts will need the attention of the CPCs.

2.6 Other Assumptions

The first two assumptions described below apply to aircraft that were included in the initial modeling inputs but would not be accommodated by the arrival and departure procedures as designed. The final assumption addresses the weather conditions assumed in the model.

- No flights with both origin and destination airports within C90 were modeled. These infrequent operations would have no impact on SSA operations.
- VFR operations in and out of SSA began and ended, respectively, within 10 NM of the airport. These flights occur in the model solely to account for runway occupancy and throughput at SSA.
- Visual Meteorological Conditions (VMC) were in effect for all airports in the study. VMC allows for increased throughput at airports, which increases the probability of interaction of operations in the airspace.

3 Modeling Inputs

Modeling inputs include traffic demand, arrival and departure procedures, runway information, and waypoint definitions.

3.1 Traffic Demand

AirTOp simulation requires a traffic schedule, complete with aircraft type, origin and destination airport, route of flight, and estimated time of operation for each flight. Arrival flights into C90 require an estimated time of arrival, and departure flights out of C90 require an estimated time of departure.

Two traffic schedules were generated for quantitative analysis. The level of traffic for the DBO+1 and DBO+5 timeframes were based on forecasts generated in 2004 by IDOT that were further verified in 2009 by IDOT and approved in 2011 by the FAA. The specific source of each type of operation varied by the airport in use and category of flight:

- IDOT provided a daily schedule with detailed information on **SSA commercial flights**, complete with aircraft type, origin and destination airport (or metropolitan area), and estimated time of operation. Since IDOT did not provide route information for commercial flights, the Analysis Team produced a route of flight that used an appropriate arrival or departure route based on direction of travel and waypoints used by ORD or MDW flights serving the same market.
- IDOT provided a daily schedule with less detailed information on **SSA corporate and general aviation flights**. They provided the engine type, estimated time of operation, a general sector of operation, and use of VFR or IFR. IDOT also provided candidate aircraft types for each engine type. The Analysis Team assigned aircraft types based on engine type and selected the origin or destination airport based on the sector of operation. The sector of operation is one of sixteen wedges of airspace based on the secondary-intercardinal directions depicted in Figure 3-1.

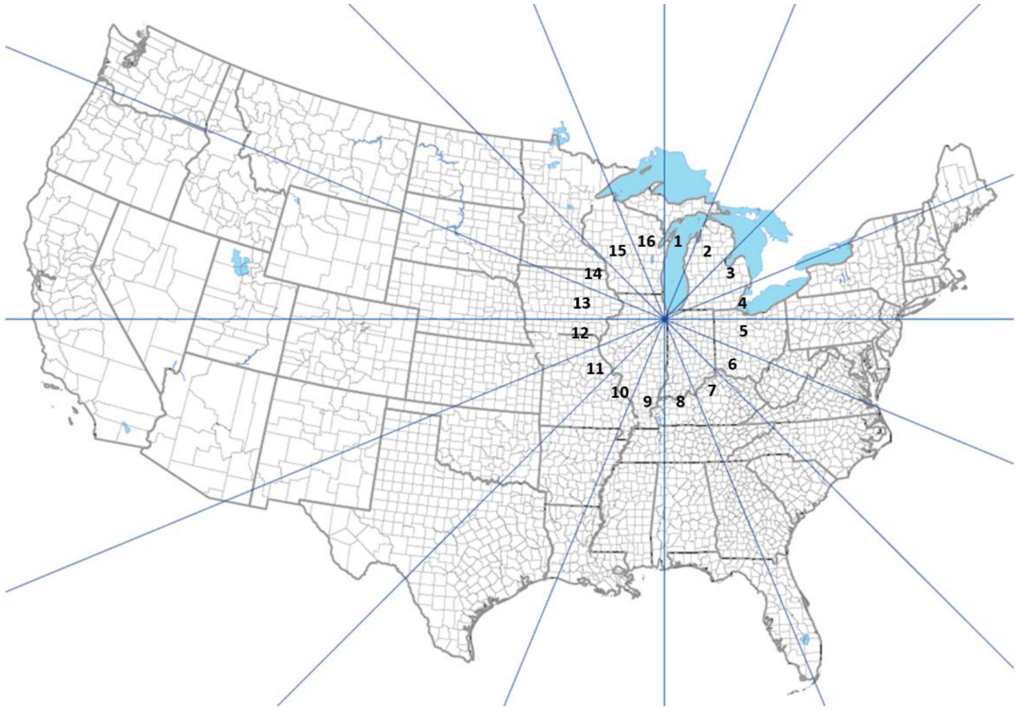

Figure 3-1. Sectors of Operation for SSA Corporate and General Aviation Flights

- The FAA's Forecast Analysis Group is the source of information for **all other flights in C90**. The Forecast Analysis Group annually selects sixteen days that as a group reflect the annual operations in the National Airspace System (NAS) and gathers flight information for all IFR flights in the NAS on those sixteen days. The group then generates forecast traffic files based on projections for traffic growth and changes in fleet composition. The result is a collection of files for multiple years, starting from 2014, with full information for each flight, including aircraft type, origin and destination airport, route of flight, and estimated time of operation. The SSA Analysis Team selected one of the sixteen days that best reflected operational levels at ORD and MDW with VFR conditions within 200 miles of C90 (10 October 2012) and, in conjunction with the Chicago Airports District Office, selected traffic levels in line with DBO+1 and DBO+5 operations as provided by IDOT.

Table 3-1 provides counts of the arrival and departure operations by airport and by date. All flights were IFR except for the SSA flights as noted.

Table 3-1. Modeled Daily Traffic Demand

Airport and Operation Type	DBO+1 Arrivals	DBO+1 Departures	DBO+1 Totals	DBO+5 Arrivals	DBO+5 Departures	DBO+5 Totals
SSA IFR	16	17	33	32	33	65
SSA VFR	50	51	101	55	53	108
SSA TOTAL	66	68	134	87	86	173
ORD	1470	1469	2939	1589	1598	3187
MDW	392	424	816	421	456	877
ARR	14	9	23	13	10	23
DPA	26	30	56	25	32	57
GYY	14	17	31	14	18	32
IGQ	1	1	2	1	1	2
JOT	0	1	1	0	1	1
LOT	6	7	13	6	7	13
PWK	47	48	95	47	50	97
UGN	16	19	35	17	20	37
3CK	2	4	6	2	4	6

3.2 Runway Use

The experimental design included a west flow and east flow configuration for each airport. Table 3-2 contains runway use information for each airport and configuration.

Table 3-2. Runway Use by Airport and Configuration

Airport	East Flow Arrivals	East Flow Departures	West Flow Arrivals	West Flow Departures
SSA	9R	9R	27L	27L
ORD	9L, 9C, 10C	9R, 10L, 10R	27C, 27R, 28C	22L, 27L, 28R
MDW	4R	31C	31C	22L
ARR	9	9	9	9
DPA	2L	2L	2L	2L
GYY	30	30	30	30
IGQ	36	36	36	36
JOT	13	13	13	13
LOT	2	2	2	2
PWK	16	34	16	34
UGN	5	5	5	5
3CK	26	26	26	26

3.3 Arrival Procedures

The following figures depict the arrival procedures for SSA, ORD, and MDW. Since the ORD and MDW arrival patterns greatly impact all other arrivals into C90, these arrival patterns are presented first.

3.3.1 ORD Arrivals

ZAU delivers ORD arrival traffic to C90 using a four cornerpost system with arrival runways primarily determined by the STAR used by the arrival and by the direction of runway flow.

3.3.1.1 ORD East Flow Arrivals

Figure 3-2 shows the arrival procedures that deliver aircraft to ORD in east flow.

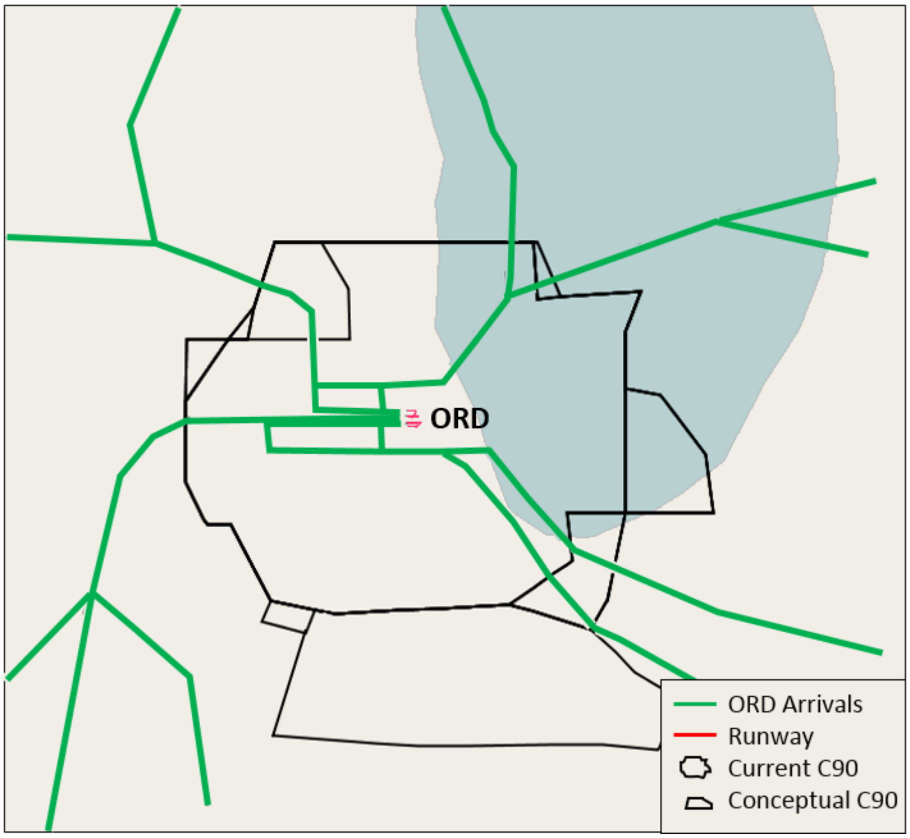

Figure 3-2. East Flow Arrivals to ORD

The northwest and northeast arrival procedures deliver aircraft to Runway 9L, the southwest arrival procedure delivers aircraft to Runway 9C, and the southeast dual arrival procedures deliver aircraft to Runway 10C.

3.3.1.2 ORD West Flow Arrivals

Figure 3-3 depicts the arrival procedures that deliver aircraft to ORD in west flow.

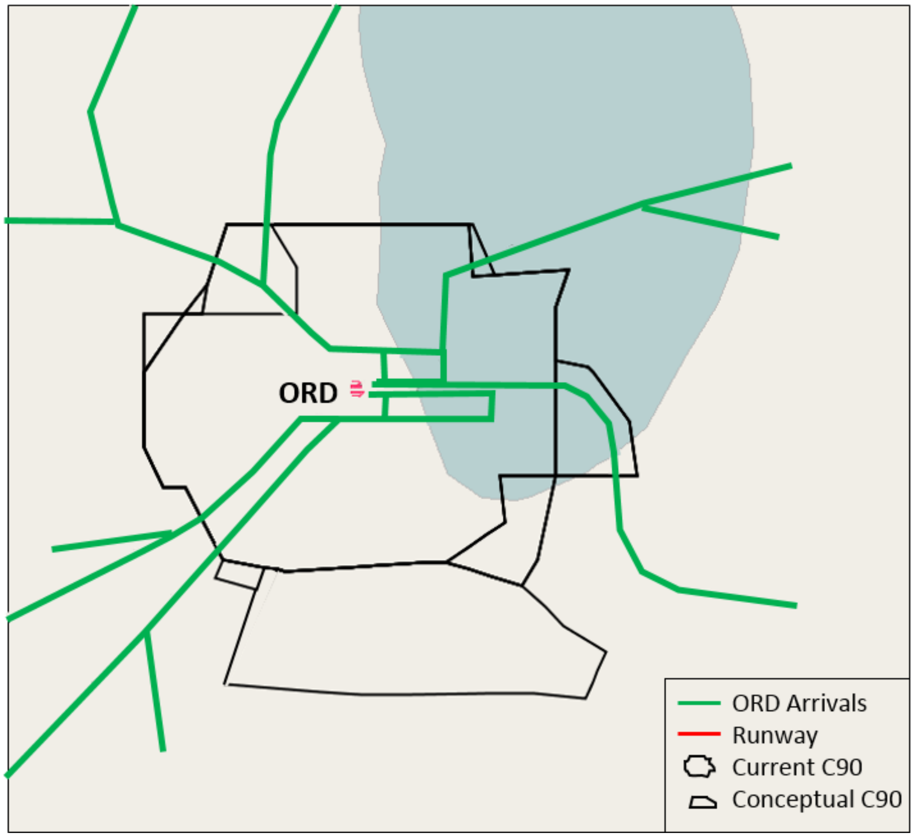

Figure 3-3. Arrivals to ORD West Flow

The northwest and northeast arrival procedures deliver aircraft to Runway 27R, the southeast arrival procedure delivers aircraft to Runway 27C, and the southwest dual arrival procedures deliver aircraft to Runway 28C.

3.3.2 MDW Arrivals

Due to the complexity of ORD operations within C90, ZAU delivers MDW arrival traffic to C90 using only two cornerposts from the southwest and southeast. Both arrival procedures feed the single arrival runway.

3.3.2.1 MDW East Flow Arrivals

Figure 3-4 shows arrival procedures that deliver aircraft to MDW in east flow. All procedures deliver to Runway 4R.

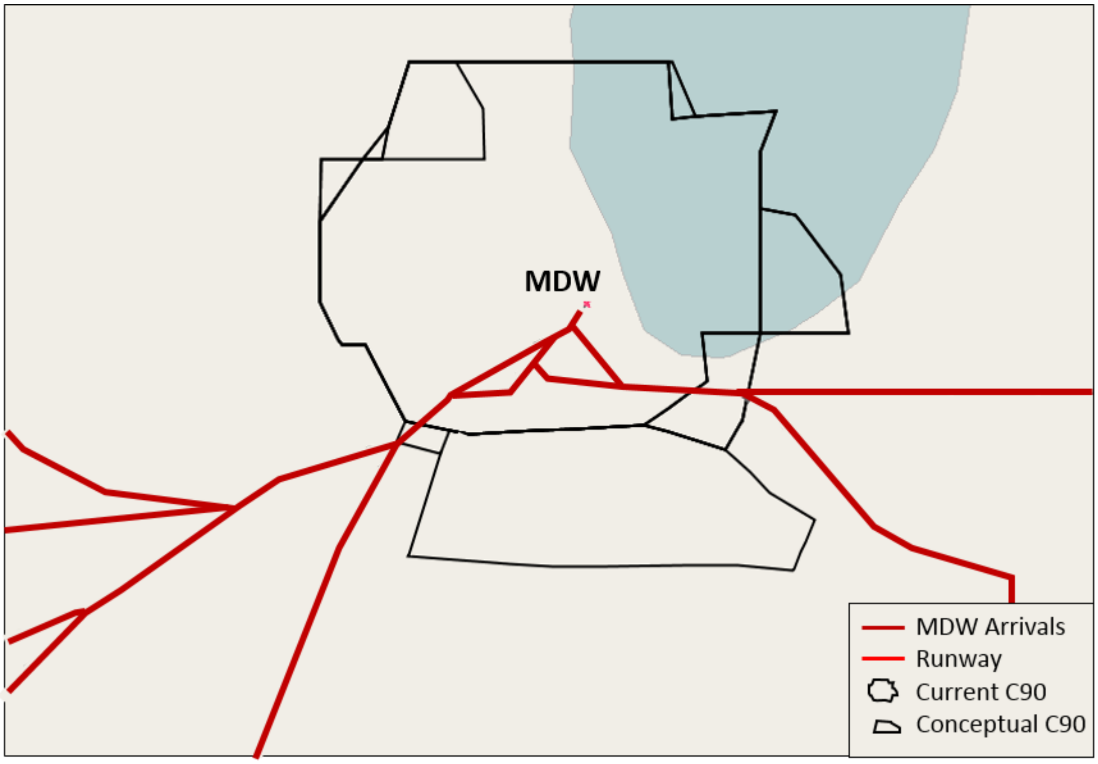

Figure 3-4. Arrivals to MDW in East Flow

3.3.2.2 MDW West Flow Arrivals

Figure 3-5 illustrates the arrival procedures that deliver aircraft to MDW in west flow, all to Runway 31C. The only change between east flow arrivals and west flow arrivals is the delivery to final approach.

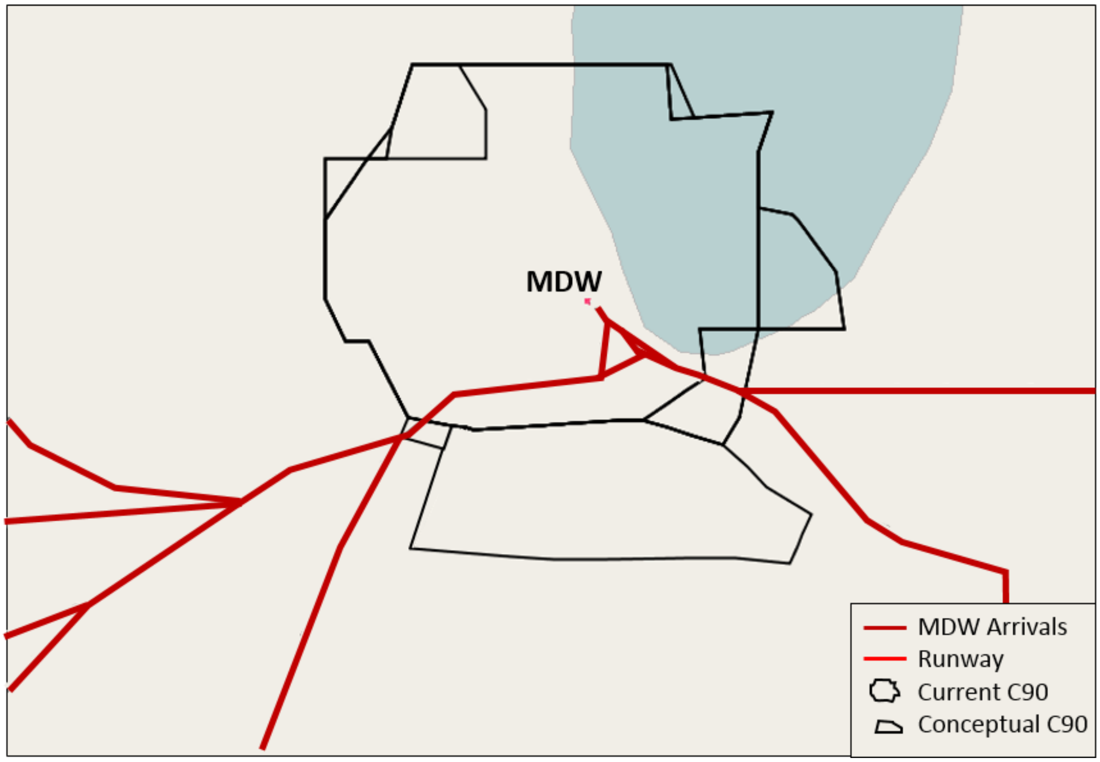

Figure 3-5. Arrivals to MDW in West Flow

3.3.3 SSA Arrivals

Due to the complexity of ORD and MDW operations within C90, the Analysis Team developed notional arrival procedures by which ZAU would deliver SSA arrival traffic to C90 via two arrival fixes on the boundary with the proposed C90 airspace shelf. Both arrival procedures feed the single commercial arrival runway. The Analysis Team designed the SSA arrival procedures to be segregated from the other C90 traffic flows.

3.3.3.1 SSA East Flow Arrivals

Figure 3-6 shows the arrival procedures that deliver aircraft to SSA in east flow.

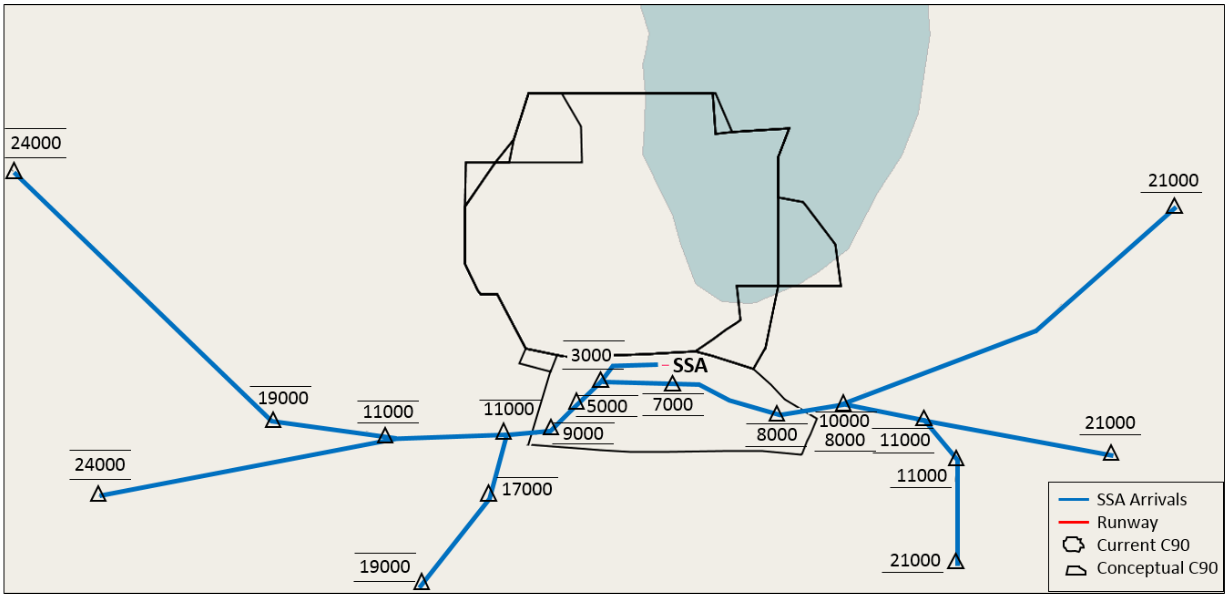

Figure 3-6. Arrivals to SSA in East Flow

The altitude restrictions on the transitions to the west at 11,000, 17,000, and 19,000 feet segregate the SSA arrivals from the ORD and MDW arrivals. The altitude restrictions on the transitions to the east at 8,000 to 10,000 feet and at 21,000 feet segregate the SSA arrivals from MDW arrivals, and the restrictions at 11,000 feet allow the SSA arrivals to transition to South Bend TRACON airspace. In the proposed C90 airspace shelf, the altitude restrictions at 7,000, 8,000, and 9,000 feet segregate the SSA arrivals from SSA departures. The altitude restrictions at 7,000, 5,000, and 3,000 feet segregate the SSA arrivals from other C90 satellite arrivals.

3.3.3.2 SSA West Flow Arrivals

Figure 3-7 shows the arrival procedures that deliver aircraft to Runway 27L. As with MDW, the only change between east flow arrivals and west flow arrivals is the delivery to final approach.

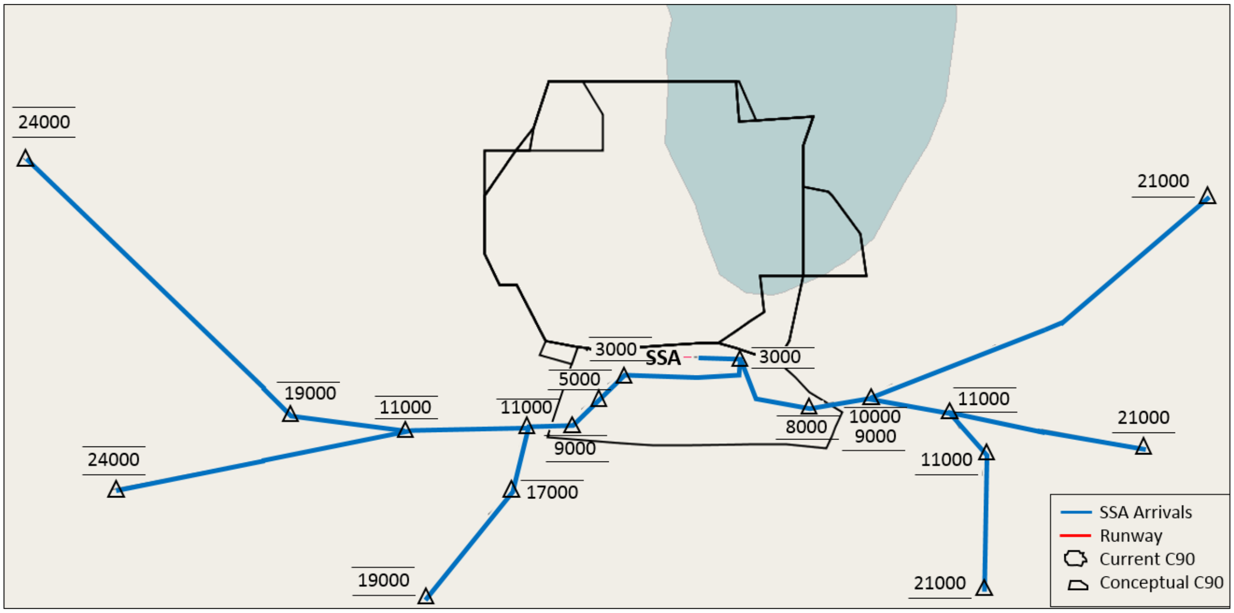

Figure 3-7. Arrivals to SSA in West Flow

The altitude restrictions on the transitions to the west at 11,000, 17,000, and 19,000 feet segregate the SSA arrivals from the ORD and MDW arrivals. The altitude restrictions on the transitions to the east at 9,000 to 10,000 feet and at 21,000 feet segregate the SSA arrivals from MDW arrivals, and the restrictions at 11,000 feet allow the SSA arrivals to transition to South Bend TRACON airspace. In the proposed C90 airspace shelf, the altitude restrictions at 8,000 and 9,000 feet segregate the SSA arrivals from SSA departures. The altitude restrictions at 5,000 and 3,000 feet segregate the SSA arrivals from other C90 satellite arrivals.

3.3.4 Satellite Arrivals

ZAU delivers satellite arrivals to C90 at various points around the boundary. C90 uses arrival procedures to the north, west, and south of ORD and MDW to avoid piston and turboprop operations over Lake Michigan whenever possible. In addition, flights passing to the west of ORD must remain 20 NM west of ORD in west flow and 30 NM west of ORD in east flow to avoid the downwinds and final approaches to ORD.

3.4 Departure Procedures

The following figures depict the departure procedures for SSA, ORD, and MDW. As with the arrivals, the ORD and MDW departure patterns are presented first. For all departures, the transfer of control from C90 to ZAU occurs at the departure fix only if the departure has not already climbed to 15,000 feet; otherwise the transfer of control occurs as the aircraft passes through the vertical boundary of C90 en route to the departure fix.

3.4.1 ORD Departures

C90 delivers ORD departure traffic to ZAU using 14 departure fixes located primarily on the C90 boundary. The departure runways were determined primarily by the SID used by the departure and by the direction of runway flow.

3.4.1.1 ORD East Flow Departures

Figure 3-8 shows the departure procedures that deliver aircraft from ORD in east flow.

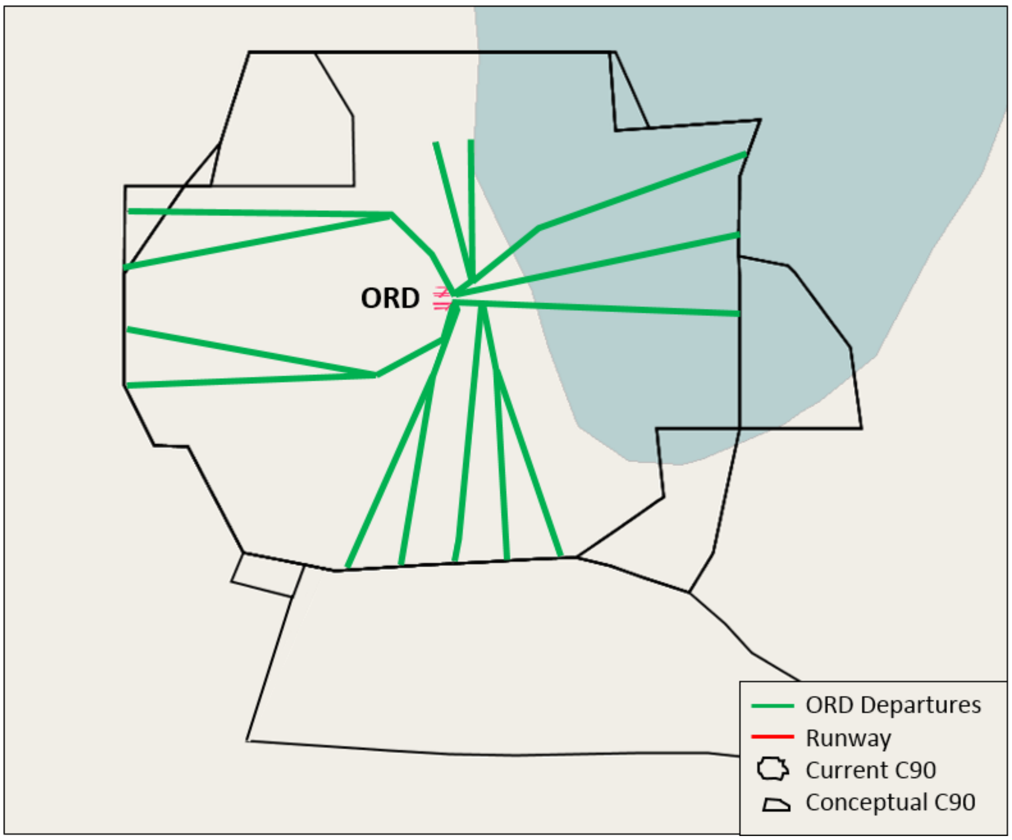

Figure 3-8. Departures from ORD in East Flow

Departures from Runway 9R travel to the northwest, north, and northeast. Departures from Runway 10L travel to the southeast, and departures from Runway 10R travel to the southwest.

3.4.1.2 ORD West Flow Departures

Figure 3-9 depicts the departure procedures that deliver traffic from ORD in west flow.

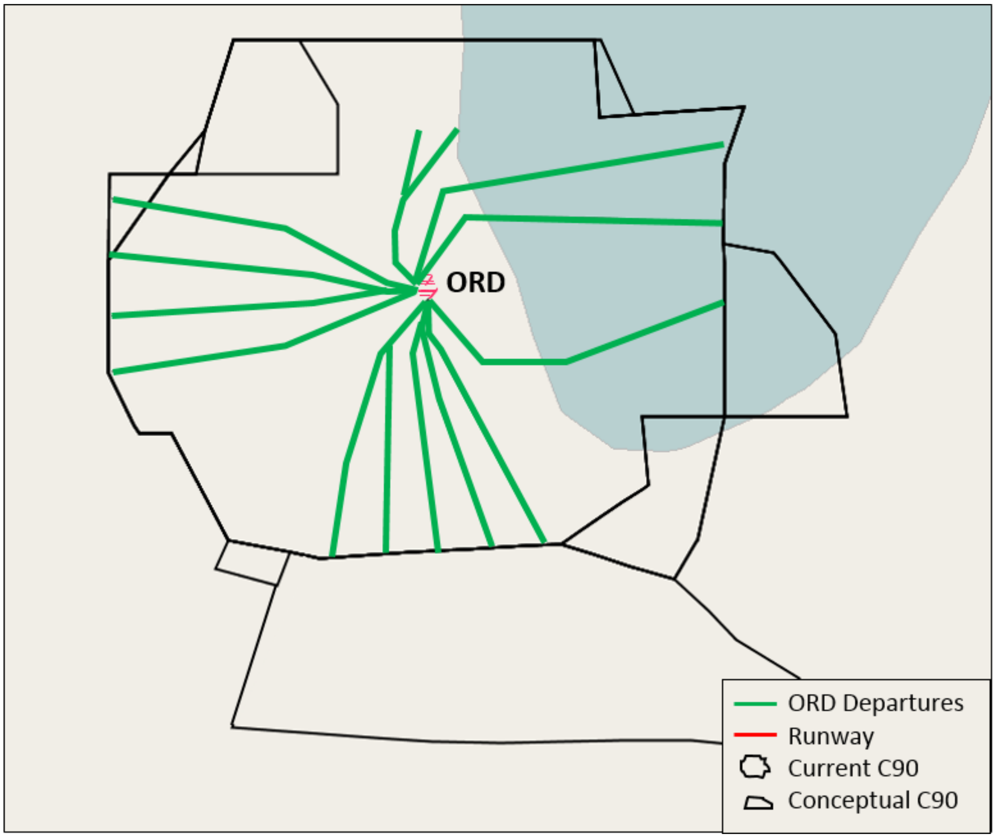

Figure 3-9. Departures from ORD in West Flow

Departures from Runway 27L travel to the north and northeast. Departures from Runway 28R travel to the west, and departures from Runway 22L travel to the south and southeast.

3.4.2 MDW Departures

ORD departures have exclusive use of its departure fixes to the east and of most of its departure fixes to the west. MDW departures may use the ORD departure fixes to the north and south as well as the southernmost west fix, PEKUE. In addition, MDW departures may use a fourth east departure fix, LEWKE, which is located to the south of the ORD departure fixes.

3.4.2.1 MDW East Flow Departures

Figure 3-10 shows the departure procedures that deliver departures from MDW in east flow, all from Runway 31C.

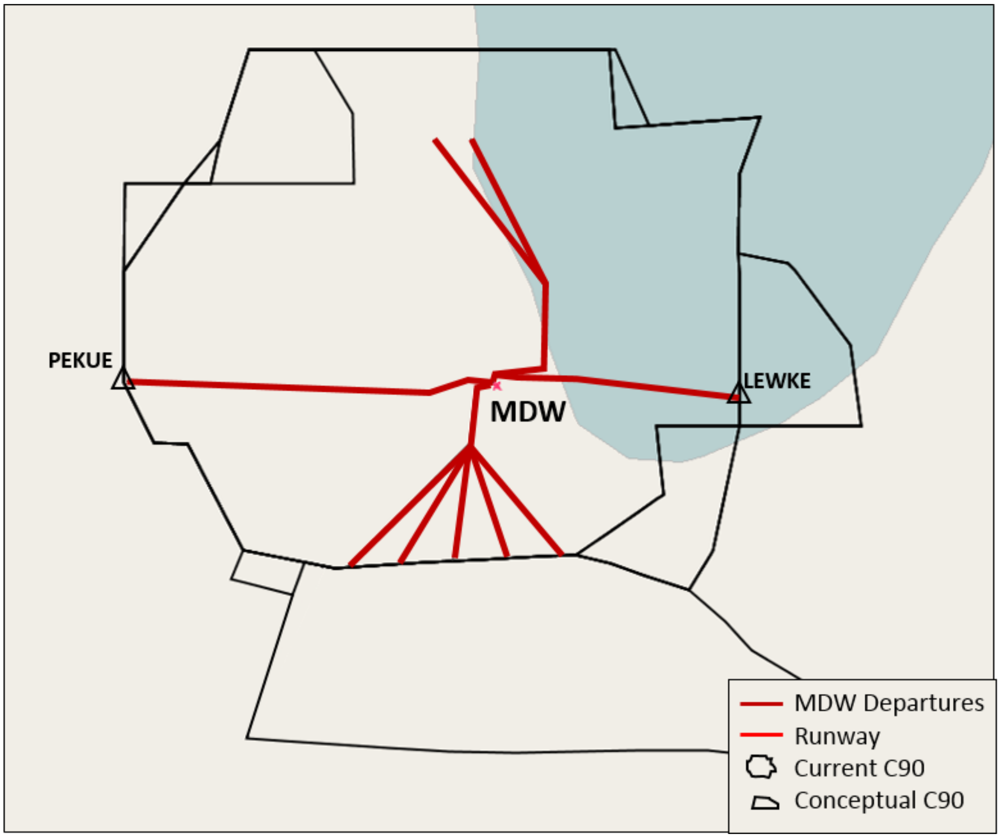

Figure 3-10. Departures from MDW in East Flow

MDW PEKUE departures are held below the ORD PEKUE departures during departure pushes; otherwise the C90 CPCs will resolve altitude conflicts tactically. The southbound MDW departures climb below the southbound ORD departures without intervention due to the shorter track length from MDW. The northbound MDW departures are cleared along the Lake Michigan coastline and held below the ORD departures, after which they are held below the northbound ORD departures.

3.4.2.2 MDW West Flow Departures

Figure 3-11 shows the departure procedures that are delivered from MDW in west flow, all from Runway 22L.

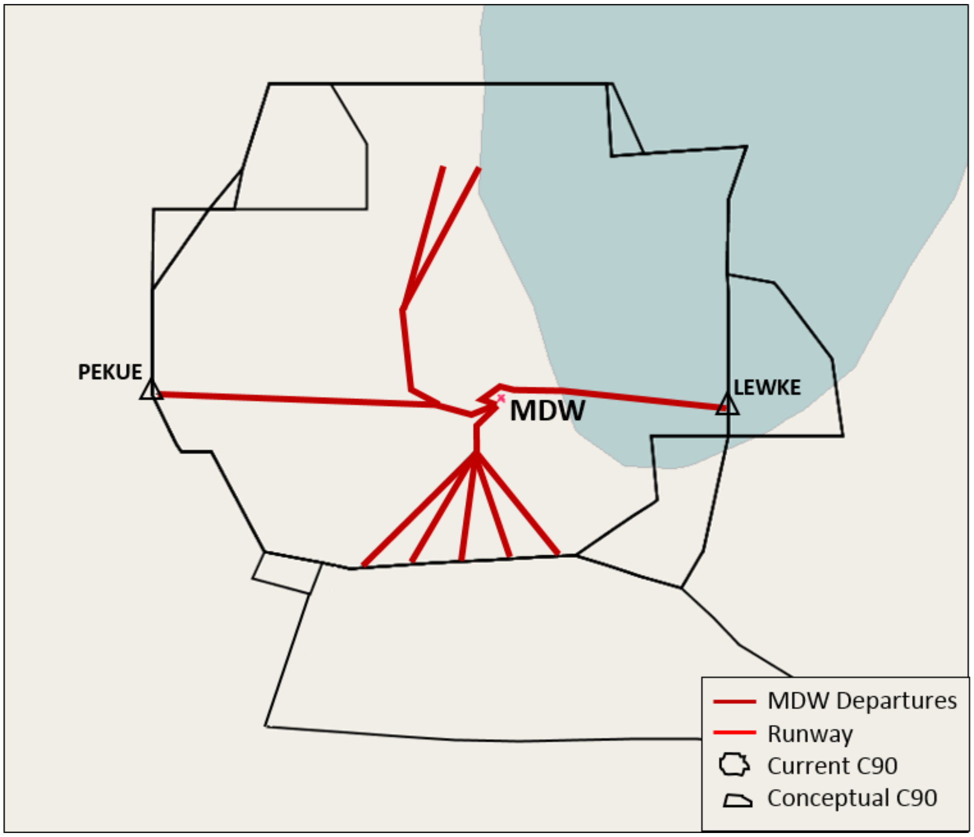

Figure 3-11. Departures from MDW in West Flow

As in east flow, MDW PEKUE departures are held below the ORD PEKUE departures during departure pushes; otherwise the C90 CPCs will resolve altitude conflicts tactically. The southbound MDW departures climb below the southbound ORD departures without intervention due to the shorter track length from MDW. The northbound MDW departures are cleared to the west of ORD, above the ORD departures but below the ORD arrivals, after which they are held below the northbound ORD departures. C90 CPCs controlling the MDW departures may coordinate with the ORD arrival CPC to allow the departures to climb through an empty arrival corridor.

3.4.3 SSA Departures

Due to the proximity of SSA to the lateral and vertical boundaries of C90, the departure procedures are highly dependent on runway flow direction.

3.4.3.1 SSA East Flow Departures

Figure 3-12 shows the departure procedures that start on Runway 9R.

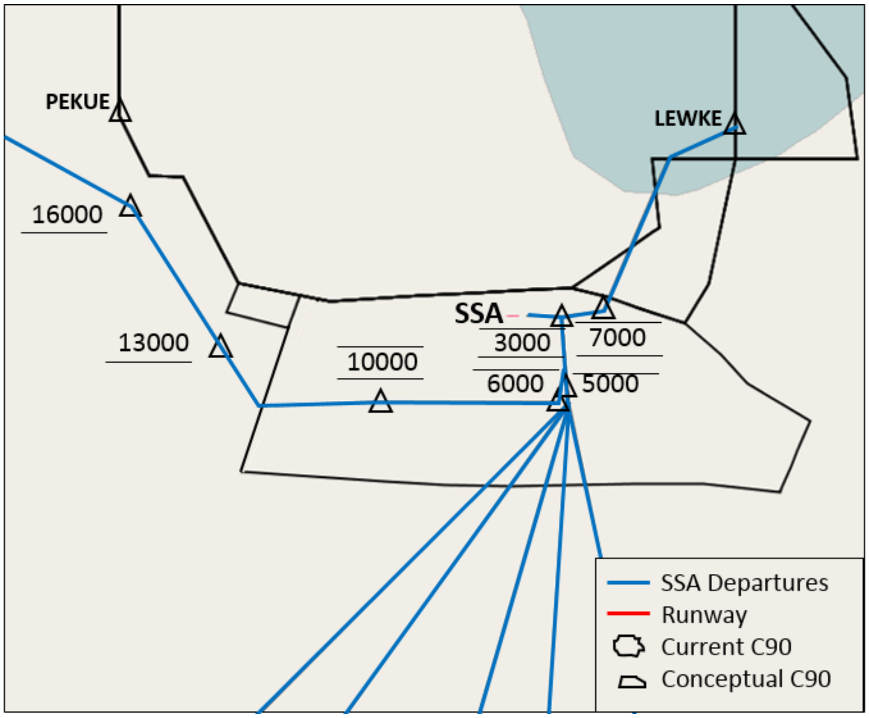

Figure 3-12. Departures from SSA in East Flow

The altitude restriction at 3,000 feet segregates SSA departures from C90 south satellite arrivals and departures. The altitude restriction at 6,000 feet segregates SSA departures from SSA arrivals. The altitude restriction at 10,000 feet segregates SSA departures from C90 departures and SSA arrivals. The altitude restriction at 13,000 feet segregates SSA departures from ORD arrivals. Finally, the altitude restriction at 16,000 feet provides for transitional separation between facilities.

The eastbound departures climb via the LEWKE fix, shared with MDW departures. As these departures turn from their initial runway heading to the northeast, they are assigned an altitude of 7,000 feet to remain above MDW arrivals and below ORD arrivals. A prearranged coordination climb may occur if there is no ORD arrival present. Additionally, these aircraft may conflict with MDW departures at LEWKE, potentially requiring the SSA departures to stop their climb. They may also conflict with ORD departures further east into ZAU.

The westbound departures exit the proposed C90 airspace and interact with MDW and ORD departures west of PEKUE. The southbound departures also exit the proposed C90 airspace and interact with MDW and ORD departures at their departure fixes and further south into ZAU. There is no departure procedure to the north; aircraft going north will use the westbound or eastbound departure procedures and then proceed north en route.

3.4.3.2 SSA West Flow Departures

Figure 3-13 shows the departure procedures that start on Runway 27L.

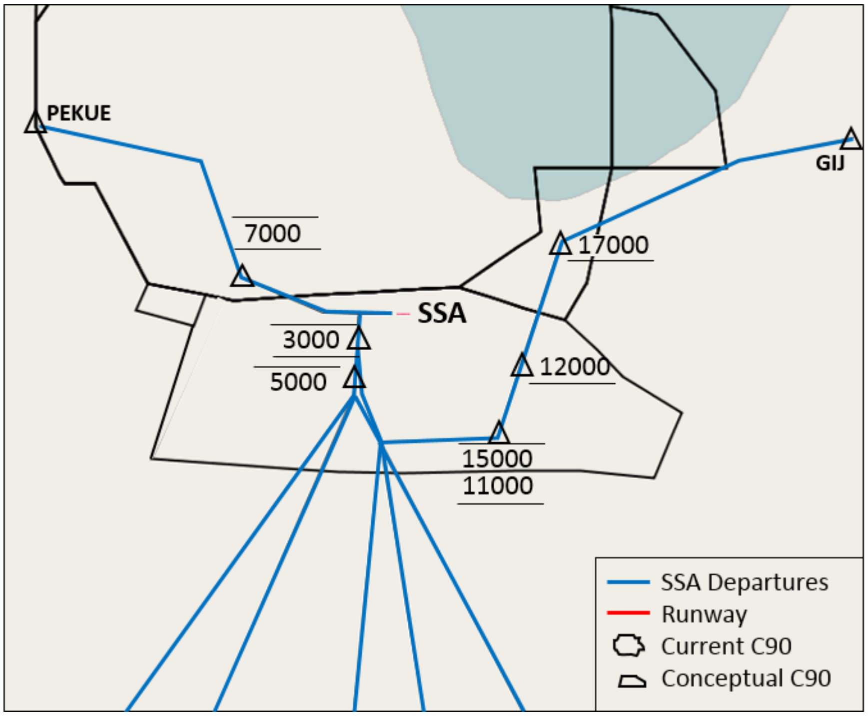

Figure 3-13. Departures from SSA in West Flow

The altitude restriction at 3,000 feet segregates SSA departures from C90 south satellite arrivals and SSA arrivals. The altitude restriction at 5,000 feet segregates SSA departures from C90 satellite arrivals and SSA arrivals. The altitude restrictions from 11,000 to 15,000 feet segregates SSA departures from ORD arrivals, satellite arrivals and departures, and C90 southbound departures. The altitude restrictions at 12,000 and 17,000 feet segregates SSA departures from ORD arrivals.

The westbound departures climb via the PEKUE fix, shared with ORD and MDW departures. As these departures turn from the west-northwest to the north-northwest, they are assigned an altitude of 7,000 feet to remain above MDW arrivals but below ORD arrivals. A prearranged coordinated climb may occur if there is no ORD arrival present. Additionally, as these departures proceed to PEKUE, they may conflict with MDW and ORD departures, potentially requiring the SSA departures to stop their climb. As the SSA departures travel further northwest into ZAU, they may interact with additional ORD departures from other fixes.

The eastbound departures exit the proposed C90 airspace south of LEWKE and interact with MDW and ORD departures at the GIPPER VORTAC (GIJ). The southbound departures exit the proposed C90 airspace and interact with MDW and ORD departures at their departure fixes and further south into ZAU. As with east flow, there is no departure procedure to the north; aircraft going north will use the westbound or eastbound departure procedures and then proceed north en route.

3.4.4 Satellite Departures

C90 delivers satellite departures to ZAU mostly through the departure fixes that are shared among MDW and SSA; some departures from the northernmost satellites may use ORD departure fixes to the northwest and northeast as well. As with arrivals, departures must avoid the airspace to the west and east of ORD, although aircraft able to climb above the downwind legs may pass over them.

3.5 Other Information

For each airport, the National Flight Data Center (NFDC) served as the source for runway locations and dimensions. The NFDC also provided waypoint definitions for all waypoints not defined by the Analysis Team.

4 Simulation Results

The presence of SSA operations had a minimal impact on surrounding C90 traffic at the DBO+1 and DBO+5 predicted traffic levels. There was no change in throughput or change in ground delay at any of the airports in C90. There was a change in the distance in level flight for a very small number of MDW, ORD and DPA departures, which also led to a slight a change in time flown for these flights.

There were no changes in metrics due to SSA arrivals. The Analysis Team designed the SSA arrival flows to be segregated completely from the other C90 traffic flows; therefore, the arrivals had no impact on surrounding traffic.

4.1 Potential Conflicts Requiring ATC Resolution

Table 4-1 shows a count of the daily conflicts per run per scenario along with summary metrics at the bottom of the table.

Table 4-1. Daily Conflicts by Run, Date, and Flow

Run Number	DBO+1 East Flow	DBO+1 West Flow	DBO+5 East Flow	DBO+5 West Flow
1	2	2	7	13
2	1	3	6	8
3	4	3	6	5
4	6	4	7	5
5	3	8	5	8
6	4	2	5	9
7	4	3	5	9
8	3	5	7	3
9	1	3	4	9
10	5	4	6	5
11	5	3	6	3
Average	3.5	3.6	5.8	7.0

Since SSA departures encountered more restrictive altitude restrictions farther from the airport than departures from other airports, the SSA departure approaching a conflict often was at a lower altitude than the other aircraft and typically had their climb stopped. The remaining conflicts were resolved by stopping the climb of the non-SSA departure. On average this occurred on less than two departures daily from any C90 airport.

In east flow, conflicts mostly occurred in ZAU77 due to westbound SSA departures interacting with PEKUE departures from ORD and MDW and in C90 due to eastbound SSA LEWKE departures interacting with LEWKE departures from MDW. Conflicts increased in ZAU89 and ZAU92 as traffic increased in the DBO+5 scenarios.

In west flow, conflicts occurred mostly in C90 due to the westbound SSA PEKUE departures interacting with ORD and MDW PEKUE departures, with additional conflicts in ZAU77, ZAU81, and ZAU92.

Figure 4-1 depicts the sectors in which conflicts primarily occurred.

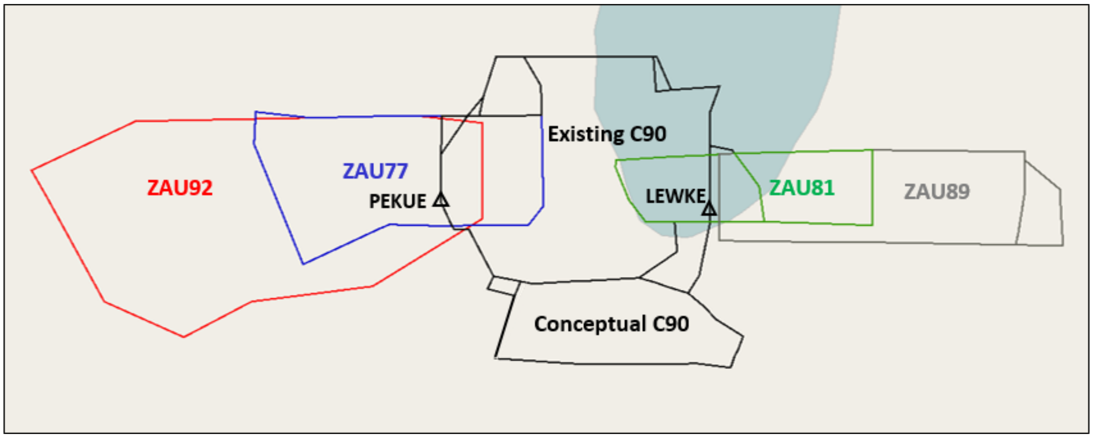

Figure 4-1. Sectors in which Conflicts Occurred

4.2 Time in Level Flight

Tables 4-2 through 4-4 describe the increase in time in level flight that resulted from non-SSA departure climbs being stopped due to a conflict with an SSA departure. These metrics are for all 11 simulation runs.

Table 4-2. Time in Level Flight Caused by a Conflict with an SSA Departure, ORD

Altitude	DBO+1 East Flow Count	DBO+1 East Flow Average Time (seconds)	DBO+5 East Flow Count	DBO+5 East Flow Average Time (seconds)	DBO+1 West Flow Count	DBO+1 West Flow Average Time (seconds)	DBO+5 West Flow Count	DBO+5 West Flow Average Time (seconds)
15,000ft	0	-	0	-	1	29	0	-
23,000ft	3	150	0	-	0	-	0	-
24,000ft	0	-	1	139	0	-	0	-
26,000ft	0	-	1	304	0	-	0	-
28,000ft	0	-	3	234	0	-	0	-
31,000ft	1	277	0	-	0	-	0	-
32,000ft	3	212	0	-	0	-	0	-

Table 4-3. Time in Level Flight Caused by a Conflict with an SSA Departure, MDW

Altitude	DBO+1 East Flow Count	DBO+1 East Flow Average Time (seconds)	DBO+5 East Flow Count	DBO+5 East Flow Average Time (seconds)	DBO+1 West Flow Count	DBO+1 West Flow Average Time (seconds)	DBO+5 West Flow Count	DBO+5 West Flow Average Time (seconds)
12,000ft	0	-	0	-	1	455	1	341
13,000ft	2	238	7	263	6	317	10	318
14,000ft	2	112	0	-	0	-	0	-
20,000ft	0	-	1	313	0	-	0	-
21,000ft	0	-	1	181	0	-	1	321
23,000ft	0	-	0	-	2	241	0	-
24,000ft	0	-	1	220	0	-	0	-
29,000ft	0	-	1	88	0	-	3	250
31,000ft	0	-	0	-	0	-	1	120
33,000ft	0	-	0	-	0	-	1	138

Table 4-4. Time in Level Flight Caused by a Conflict with an SSA Departure, DPA

Altitude	DBO+1 East Flow Count	DBO+1 East Flow Average Time (seconds)	DBO+5 East Flow Count	DBO+5 East Flow Average Time (seconds)	DBO+1 West Flow Count	DBO+1 West Flow Average Time (seconds)	DBO+5 West Flow Count	DBO+5 West Flow Average Time (seconds)
10,000ft	0	-	0	-	0	-	1	218
18,000ft	0	-	1	151	0	-	1	174
26,000ft	2	464	0	-	0	-	0	-

The ORD departure climbs were stopped when an SSA departure was heading north and crossed the ORD departure streams. MDW departure climbs were stopped primarily at the C90 boundary when there was an SSA departure already at 15,000 feet at the departure fix.

4.3 Total Flight Time

Due to the increase in level flight for departures there was also a slight increase in total time flown. Table 4-5 shows the total number of operations with an increase in time flown, and the average increase in time flown per affected flight at each airport over the 11 simulation runs.

Table 4-5. Increase in Time Flown by Airport

Airport	DBO+1 East Flow Count	DBO+1 East Flow Average Time (Seconds)	DBO+5 East Flow Count	DBO+5 East Flow Average Time (Seconds)	DBO+1 West Flow Count	DBO+1 West Flow Average Time (Seconds)	DBO+5 West Flow Count	DBO+5 West Flow Average Time (Seconds)
ORD	3	11	4	15	0	-	0	-
MDW	3	40	8	35	1	78	8	22
DPA	2	20	0	-	0	-	2	12

Note that these counts are totals of all 11 simulation runs, which equates to more than 16,000 ORD departures, more than 4,500 MDW departures and more than 300 DPA departures in both predicted traffic levels. Less than .1% of all C90 departure operations had an increase in time flown.

4.4 Prearranged Coordination Climb Operations

Tables 4-6 through 4-9 provide a detailed account of the daily number of prearranged coordination climb operations at SSA. Operations are enumerated by the location in the prearranged coordination climb segment where the aircraft started to climb, which is shown in Figure 4-2 for east flow operations and Figure 4-3 for west flow operations.

Table 4-6. Daily Prearranged Coordination Climb Operations at SSA for DBO+1, East Flow

Run Number	Beginning	During	Unable	Total
1	0	3	0	3
2	2	1	0	3
3	1	2	0	3
4	1	2	0	3
5	1	2	0	3
6	0	3	0	3
7	0	2	1	3
8	0	3	0	3
9	0	3	0	3
10	0	3	0	3
11	0	3	0	3
Average	0.5	2.5	0.1	3.0

Table 4-7. Daily Prearranged Coordination Climb Operations at SSA for DBO+5, East Flow

Run Number	Beginning	During	Unable	Total
1	3	6	3	12
2	4	7	1	12
3	2	9	1	12
4	2	7	3	12
5	3	9	1	12
6	3	9	0	12
7	1	10	1	12
8	4	8	0	12
9	2	10	0	12
10	3	7	2	12
11	3	9	0	12
Average	2.7	8.3	1.1	12.0

Table 4-8. Daily Prearranged Coordination Climb Operations at SSA for DBO+1, West Flow

Run Number	Beginning	During	Unable	Total
1	3	5	0	8
2	6	2	0	8
3	3	5	0	8
4	2	5	1	8
5	2	6	0	8
6	3	4	1	8
7	4	2	2	8
8	4	4	0	8
9	3	4	1	8
10	1	7	0	8
11	6	2	0	8
Average	3.4	4.2	0.5	8.0

Table 4-9. Daily Prearranged Coordination Climb Operations at SSA for DBO+5, West Flow

Run Number	Beginning	During	Unable	Total
1	6	7	0	13
2	6	7	0	13
3	5	8	0	13
4	8	4	1	13
5	6	6	1	13
6	6	7	0	13
7	4	8	1	13
8	8	5	0	13
9	4	8	1	13
10	3	10	0	13
11	5	7	1	13
Average	5.5	7.0	0.5	13.0

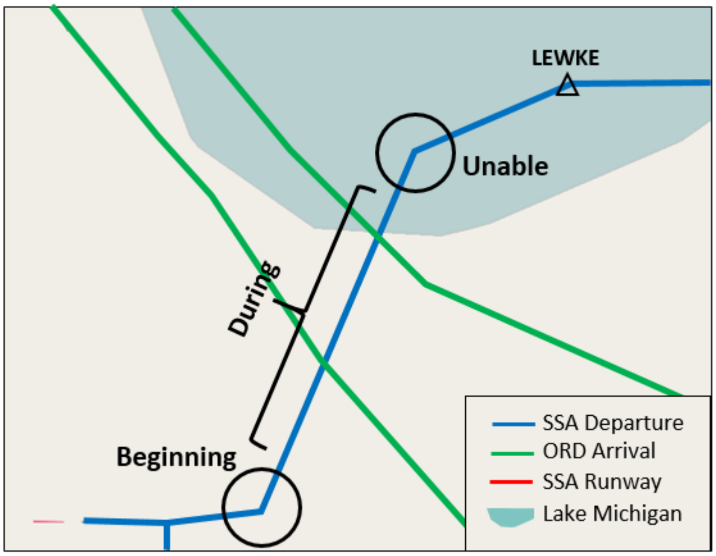

Figure 4-2. Prearranged Coordination Climb Operations for East Flow SSA Departures

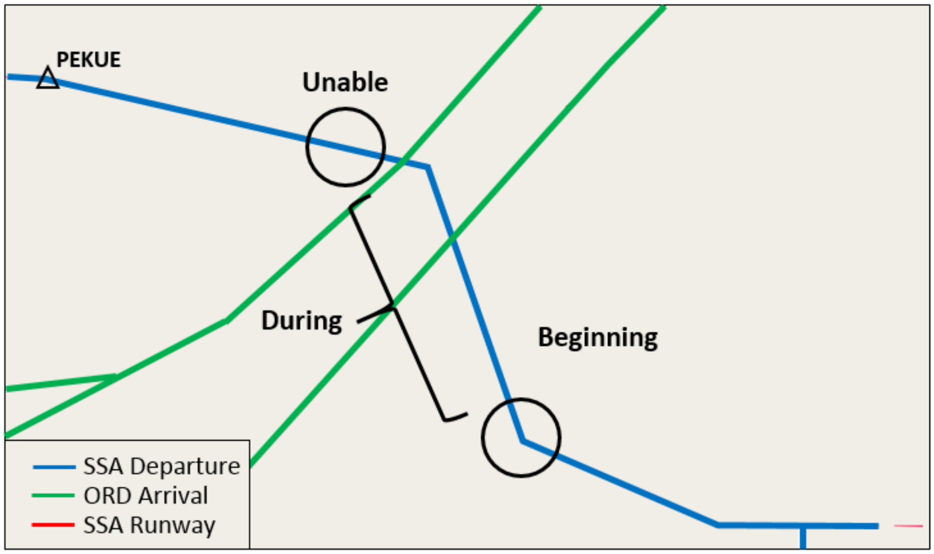

Figure 4-3. Prearranged Coordination Climb Operations for West Flow SSA Departures

In both time periods and both runway flows the majority of SSA flights were able to complete at least some portion of the prearranged coordination climb procedure. In east flow, the ORD arrival stream closest to the beginning of the procedure contained more arrival flights, so the majority of the departures that started their climb during the procedure passed by the first, busier stream and then found the second ORD arrival stream empty. The two ORD arrival streams involved in the west flow prearranged coordination climb procedure had fewer flights than the ORD arrival streams in the east flow. Because of this, more flights in the west flow started their climb at the beginning of the prearranged coordination climb procedure. Table 4-10 contains the average distance that a "during" flight traveled along the prearranged coordination climb corridor before receiving a clearance to climb.

Table 4-10. Average Distance before Commencing Climb for Flights that Climbed during the Prearranged Coordination Climb Procedure

Run Number	DBO+1 East Flow (NM)	DBO+5 East Flow (NM)	DBO+1 West Flow (NM)	DBO+5 West Flow (NM)
1	7.9	11.1	11.4	12.6
2	12.3	12.5	9.5	11.2
3	10.5	10.2	10.9	11.6
4	10.6	12.0	11.0	7.8
5	12.2	13.9	11.1	10.2
6	14.0	10.4	13.4	11.5
7	10.6	11.9	7.8	12.1
8	10.5	9.3	11.7	7.4
9	12.2	9.5	9.7	11.2
10	9.3	11.4	9.8	11.6
11	9.3	12.5	13.3	7.6
Average	10.9	11.3	10.9	10.4

The total distance flown from runway end until the aircraft climbed above 7,000 feet was approximately 20 NM for the SSA LEWKE departures in east flow and 29 NM for the SSA PEKUE departure in west flow on average.

4.5 SSA Distance in Level Flight

The Analysis Team placed altitude restrictions on the SSA departure procedures to avoid interactions with current C90 traffic as much as possible. As a result, SSA departures experienced substantial distance in level flight during climb out. Tables 4-11 through 4-14 present distance in level flight metrics for SSA departures caused by altitude restrictions on the departure procedures. Note there were 17 IFR SSA departures in the DBO+1 traffic file and 33 IFR SSA departures in the DBO+5 traffic file.

Table 4-11. Average SSA Departure Distance in Level Flight due to Procedure Restrictions, DBO+1, East Flow

Run Number	3,000 Feet		5,000 Feet		6,000 Feet		7,000 Feet		10,000 Feet	
	Count	Average Distance NM)	Count	Average Distance (NM)	Count	Average Distance (NM)	Count	Average Distance (NM)	Count	Average Distance (NM)
1	8	3.0	4	7.1	8	5.5	3	11.1	6	17.4
2	8	3.0	4	7.1	8	5.5	3	7.9	6	17.4
3	8	3.0	4	7.1	8	5.5	3	10.5	6	17.4
4	8	3.0	4	7.1	8	5.5	3	10.4	6	17.4
5	8	3.0	4	7.1	8	5.5	3	10.1	6	17.4
6	8	3.0	4	7.1	8	5.5	3	16.8	6	17.4
7	8	3.0	4	7.1	8	5.5	3	16.0	6	17.4
8	8	3.0	4	7.1	8	5.5	3	13.6	6	17.4
9	8	3.0	4	7.1	8	5.5	3	15.2	6	17.4
10	8	3.0	4	7.1	8	5.5	3	12.3	6	17.4
11	8	3.0	4	7.1	8	5.5	3	12.3	6	17.4
Average	8	3.0	4	7.1	8	5.5	3	12.4	6	17.4

Table 4-12. Average SSA Departure Distance in Level Flight due to Procedure Restrictions, DBO+5, East Flow

Run Number	3,000 Feet		5,000 Feet		6,000 Feet		7,000 Feet		10,000 Feet	
	Count	Average Distance NM)	Count	Average Distance (NM)	Count	Average Distance (NM)	Count	Average Distance (NM)	Count	Average Distance (NM)
1	13	2.6	6	6.9	13	5.4	12	11.4	12	17.9
2	13	2.6	6	6.9	13	5.4	12	9.1	12	17.9
3	13	2.6	6	6.9	13	5.4	12	11.5	12	17.9
4	13	2.6	6	6.9	13	5.4	12	11.8	12	17.9
5	13	2.6	6	6.9	13	5.4	12	12.8	11	18.0
6	13	2.6	6	6.9	13	5.4	12	10.5	12	17.9
7	13	2.6	6	6.9	13	5.4	12	13.4	12	17.9
8	13	2.6	6	6.9	13	5.4	12	8.9	12	17.9
9	13	2.6	6	6.9	13	5.4	12	10.6	12	17.9
10	13	2.6	6	6.9	13	5.4	12	11.4	12	17.9
11	13	2.6	6	6.9	13	5.4	12	12.1	12	17.9
Average	13	2.6	6	6.9	13	5.4	12	11.2	11.9	17.9

Table 4-13. Average SSA Departure Distance in Level Flight due to Procedure Restrictions, DBO+1, West Flow

Run Number	3,000 Feet		5,000 Feet		7,000 Feet		15,000 Feet	
	Count	Average Distance NM)	Count	Average Distance (NM)	Count	Average Distance (NM)	Count	Average Distance (NM)
1	3	5.3	4	7.3	8	21.0	3	11.3
2	3	5.3	4	7.3	8	17.3	3	11.3
3	3	5.3	4	7.3	8	19.3	3	11.3
4	3	5.3	4	7.3	8	20.3	3	11.3
5	3	5.3	4	7.3	8	21.9	3	11.3
6	3	5.3	4	7.3	8	23.2	3	11.3
7	3	5.3	4	7.3	8	21.0	3	11.3
8	3	5.3	4	7.3	8	18.4	3	11.3
9	3	5.3	4	7.3	8	21.6	3	11.3
10	3	5.3	4	7.3	8	18.6	3	11.3
11	3	5.3	4	7.3	8	18.4	3	11.3
Average	3	5.3	4	7.3	8	20.1	3	11.3

Table 4-14. Average SSA Departure Distance in Level Flight due to Procedure Restrictions, DBO+5, West Flow

Run Number	3,000 Feet		5,000 Feet		7,000 Feet		15,000 Feet	
	Count	Average Distance NM)	Count	Average Distance (NM)	Count	Average Distance (NM)	Count	Average Distance (NM)
1	12	4.9	6	7.2	13	19.7	12	10.9
2	12	4.9	6	7.2	13	19.3	12	10.9
3	12	4.9	6	7.2	13	21.3	12	10.9
4	12	4.9	6	7.2	13	18.7	12	10.9
5	12	4.9	6	7.2	13	21.0	12	10.9
6	12	4.9	6	7.2	13	19.4	12	10.9
7	12	4.9	6	7.2	13	22.9	12	10.9
8	12	4.9	6	7.2	13	17.6	12	10.9
9	12	4.9	6	7.2	13	22.3	12	10.9
10	12	4.9	6	7.2	13	22.8	12	10.9
11	12	4.9	6	7.2	13	20.2	12	10.9
Average	12	4.9	6	7.2	13	20.5	12	10.9

In east flow, SSA departures encounter altitude restrictions at 3,000, 5,000, 6,000, 7,000, and 10,000 feet. There were additional level-offs due to conflict resolutions, which are shown in Table 4-15.

Table 4-15. SSA Departure Distance in Level Flight due to Conflict Resolutions, East Flow

Traffic Level	Run Number	Altitude (Feet)	Distance Level (NM)
DBO+1	4	25,000	9.5
DBO+5	1	24,000	16.4
DBO+5	5	7,000	18.6
DBO+5	9	12,000	7.5
DBO+5	10	17,000	22.9
DBO+5	11	9,000	12.2
DBO+5	11	17,000	22.9
DBO+5	11	27,000	40.5

Recall that in west flow, SSA departures encounter altitude restrictions at 3,000, 5,000, 7,000, and/or 15,000 feet depending on the SID being flown. There were additional level-offs due to conflict resolutions, which are shown in Table 4-16.

Table 4-16. SSA Departure Distance in Level Flight due to Conflict Resolutions, West Flow

Traffic Level	Run Number	Altitude (Feet)	Distance Level (NM)
DBO+1	1	12,000	8.2
DBO+1	3	12,000	8.3
DBO+1	5	11,000	8.7
DBO+1	7	13,000	7.4
DBO+1	10	11,000	18.9
DBO+1	11	20,000	1.3
DBO+5	1	13,000	3.1
DBO+5	1	14,000	42.9
DBO+5	2	13,000	10.1
DBO+5	2	14,000	43.4
DBO+5	2	24,000	35.6
DBO+5	3	13,000	1.2
DBO+5	4	13,000	10.1
DBO+5	4	23,000	15.9
DBO+5	4	24,000	19.0
DBO+5	5	13,000	1.7
DBO+5	5	14,000	42.7
DBO+5	7	12,000	32.0
DBO+5	7	13,000	9.1
DBO+5	7	14,000	44.9
DBO+5	7	19,000	18.6
DBO+5	9	13,000	3.4
DBO+5	9	18,000	10.6
DBO+5	10	13,000	9.1
DBO+5	11	13,000	4.4

5 Conclusion

The AirTOp analysis found the addition of proposed SSA had minimal impact on the surrounding C90 traffic at the DBO+1 and DBO+5 predicted traffic levels. At the higher DBO+5 traffic levels, which included 65 IFR SSA operations and over 4,000 C90 operations, there were on average less than 7 conflicts daily involving proposed SSA operations that required ATC action to maintain separation. Each conflict involved a proposed SSA departure and the majority was resolved by stopping the climb of the proposed SSA departure. On average, less than two departures daily from an airport other than proposed SSA had their climb stopped due to a proposed SSA departure. Proposed SSA departures experienced substantial distance in level flight during their climb out.

There were no changes in metrics due to proposed SSA arrivals. The Analysis Team designed the proposed SSA arrival flows to be completely segregated from the other C90 traffic flows; and therefore, they had no impact on the surrounding traffic.

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Appendix A List of Abbreviations

Acronym	Definition
3CK	Lake in the Hills Airport
AirTOp	Air Traffic Optimization Fast Time Simulator
ARR	Aurora Municipal Airport
ATC	Air Traffic Control
ATO	Air Traffic Organization
C56	Bult Field
C90	Chicago TRACON
CAASD	Center for Advanced Aviation System Development
CPC	Certified Professional Controllers
DBO	Date of Beneficial Occupancy
DPA	DuPage Airport
FAA	Federal Aviation Administration
FEIS	Final Environmental Impact Statement
GYY	Gary/Chicago International Airport
IDOT	Illinois Department of Transportation
IFR	Instrument Flight Rules
IGQ	Lansing Municipal Airport
JOT	Joliet Regional Airport
LOT	Lewis University Airport
MDW	Midway International Airport
MITRE	The MITRE Corporation
NAS	National Airspace System
NFDC	National Flight Data Center
NM	Nautical Mile/s
OMP	O'Hare Modernization Program
ORD	Chicago O'Hare International Airport
PWK	Chicago Executive Airport
SID	Standard Instrument Departure
SSA	South Suburban Airport
STAR	Standard Terminal Arrival Route

Acronym	**Definition**
TRACON	Terminal Radar Approach Control
UGN	Waukegan Regional Airport
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
ZAU	Chicago Air Route Traffic Control Center

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