

CHAPTER 4

AIRFIELD AND AIRSPACE MODELING

This chapter describes the methodologies, input data, review processes, and results of airfield and airspace simulations for this Environmental Assessment (EA) conducted using the Total Airspace and Airport Modeler (TAAM). These simulations were conducted by the City of Chicago's Consultant Team with direction, oversight, review, and approval by the Federal Aviation Administration (FAA). TAAM simulation experiments were conducted for the future Interim (2025) and Build Out (2032) Conditions for the No Action and Proposed Action Alternatives. (See **Chapter 3** for more detailed descriptions of each alternative.) Simulation modeling is used to assist airport operators, users, and the FAA in understanding operational issues in the airfield and airspace environments. It enables rapid analysis of how operations might differ due to changes to airfield infrastructure (e.g., runways, taxiways, gates, etc.) as well as changes to air traffic procedures and associated airspace. Simulation results become inputs to other models used to undertake environmental analysis for noise, air quality, and surface traffic.

4.1 TAAM MODEL INTRODUCTION

The TAAM¹ was used to obtain detailed flight information for the impact analysis for the Interim and Build Out Conditions. TAAM is an industry standard, rule-based, fast-time delay, and travel time computer simulation model. It is used in analysis of operational changes for airport and airspace improvement projects. For each arrival and departure flight, the model keeps track of key factors (e.g., taxi times, runway use, flight path, height above ground, engine type, etc.). These operational records provide key inputs to subsequent analyses of noise exposure, emissions levels, fuel burn, and other environmental factors. This EA used the same TAAM modeling process that was developed for the O'Hare Modernization Program (OMP) Environmental Impact Statement (EIS) and the 2015 and 2019 Written Re-Evaluations of the EIS. An FAA Air Traffic Workgroup, consisting of senior FAA air traffic representatives from Chicago Air Traffic Control facilities (O'Hare Air Traffic Control Tower, Chicago TRACON, and Chicago Center), was assembled to provide assumptions for, review the modeled configurations for, and approve all configurations modeled.²

This EA used the current version of the modeling tool at the time of the analysis, TAAM Version v2019.2.0, which has added capabilities to accommodate complex operating procedures at O'Hare International Airport (O'Hare or the airport). Improvements to this version from prior versions are documented in **Appendix D**.

Appendix D also presents the calibration process completed on the model prior to processing the EA conditions. Modeling conditions for the TAAM simulations were developed for this EA.

¹ TAAM is a product of Jeppesen.

² The Air Traffic Workgroup is comprised of representatives from O'Hare Tower (ORD ATCT), Chicago TRACON (C90), Chicago ARTCC (ZAU), the National Air Traffic Controllers Association (NATCA), the FAA Central Service Center (AJV-C25), the FAA Airports Great Lakes Region (AGL-600), the FAA Chicago Airports District Office (ADO-CHI-600), the FAA's third-party contractor Harris Miller Miller & Hanson (HMMH), and Ricondo & Associates, Inc.

4.2 TAAM MODELING ASSUMPTIONS AND RESULTS

This section defines the modeling assumptions and a summary of the results for the four future conditions evaluated in TAAM for airfield and airspace analysis. The four future conditions are:

- Interim No Action,
- Build Out No Action,
- Interim Proposed Action, and
- Build Out Proposed Action.

4.2.1 General Assumptions

The runway layout for each future simulated condition is based on the completion of the OMP with a total of eight runways (six east-west parallel runways and two southwest-northeast parallel runways). The future runway layout for this EA, compared to the existing layout in 2018, includes the completion of Runway 9C/27C and the Runway 9R/27L extension. The runways modeled in TAAM are the same for all simulated conditions.

All future conditions include the existence of the following changes to the terminal layout from the Existing Condition: the Terminal 3 Concourse L Stinger,³ which adds two gates, and the Terminal 5 Concourse M extension.⁴ Both changes were approved through separate National Environmental Policy Act reviews and documents.

The Air Traffic Group conducted analyses of wind and weather data to determine the percent occurrence of major operating configurations and weather conditions and to determine which operating configuration would cover over 98 percent of possible operating conditions. The previous 10 full calendar years (2009 to 2018) of weather data before modeling commenced were used for the analysis and were assigned to either Visual Flight Rules (VFR) or Instrument Flight Rules (IFR) conditions. IFR conditions result from low cloud ceiling heights and/or visibility conditions. The conditions for VFR and IFR are as follows:

- VFR includes weather conditions where the cloud ceiling height is equal to or greater than 1,000 feet above ground level (AGL) and visibility is three statute miles or greater.
- IFR includes weather conditions where the cloud ceiling height is less than 1,000 feet AGL and/or visibility is less than three statute miles.⁵

This review resulted in 99.3 percent of the analyzed historical data fitting within the criteria for six operating configurations. The six operating configurations to be simulated for each alternative—two VFR configurations and one IFR configuration in each direction—are as follows:

- VFR West with Land and Hold Short Operations (LAHSO),
- VFR West without LAHSO,
- IFR West,
- VFR East with LAHSO,

³ OMP EIS Re-Evaluation Memo: Terminal 3 Concourse L Stinger Two-Gate Addition and Associated Apron Pavement, Approved 7/20/2020

⁴ OMP EIS Re-Evaluation Memo: Terminal 5 East Expansion and Associated Apron Pavement, Approved 8/2/2018

⁵ Title 14 Code of Federal Regulations Part 91.155, Basic VFR Weather Minimums

- VFR East without LAHSO, and
- IFR East.

A 24-hour design day flight schedule (DDFS) was created for each future year and was incorporated into the TAAM model. Simulations for the No Action and the Proposed Action use the same schedule and number of operations for each future condition. (Details about the forecast can be found in **Attachment D-2** to **Appendix D**.)

A gating analysis (contained in **Appendix D**) was conducted to assign a terminal contact gate to air carrier arrival and departure operations. Gate assignments considered factors such as gate allocation and gauge, aircraft turn times (time necessary to load and/or unload aircraft), and gate separation times (time between one aircraft departing a gate and another subsequently arriving at the same gate).

In addition, some arriving and departing operations were assigned repositioning movements, which are when air carrier aircraft not carrying passengers are moved between two gates or moved between a remote location and a gate. Simulated repositioning movements replicate additional aircraft activity that currently occurs at O'Hare and is anticipated to continue in the future. Simulated movements include overnight aircraft parking and maintenance, gate availability, and aircraft switches and maintenance. (More details on gating positions and repositioning locations can be found in **Appendix D**.)

The TAAM simulations are consistent with the existing Fly Quiet Program preferred runways and procedures. The Chicago Department of Aviation (CDA) and the FAA provided guidance on the times that the existing Fly Quiet Program procedures should be included in the model. Fly Quiet Program procedures start at or after 10:30 p.m. and stop at or prior to 5:30 a.m., based on the air traffic demands for each scenario.

4.2.2 Interim No Action

The simulation modeling for the Interim No Action includes elimination of the offset air traffic approaches for Runway 10R/28L, and the DDFS includes 2,820 daily operations (arrivals and departures) and reflects an annual demand of 952,489 operations. The Interim No Action operating configuration analysis results in 56.5 percent west flow and 43.5 percent east flow as shown in **Table 4-1**.

Exhibit 4-1 displays each of the six modeling configurations for the Interim No Action. All west flow operating configurations use six runways. Runways 27R, 27C, and 28C are predominantly for arrivals, whereas Runways 27L, 28R, and 22L are predominantly for departures.

Both VFR East operating configurations use five runways. Runways 9L, 9C, and 10C are predominantly for arrivals, whereas Runways 9R and 10L are predominantly for departures. The IFR East operating configuration uses five runways. Runways 9L, 9C, 10C, and 10R are predominantly for arrivals (triple arrivals either using Runways 9L/9C/10C or using Runways 9L/9C/10R), whereas Runways 9R and 10L are predominantly for departures. Runway 10R is used for arrivals only in IFR East conditions and not when Runway 10C is in use. The weighted use of each operating configuration is provided in **Table 4-1** and on **Exhibit 4-1**.

4.2.3 Build Out No Action

The simulation modeling for the Build Out No Action includes elimination of the Runway 10R/28L offset air traffic approaches, and the DDFS includes 2,993 daily operations (arrivals and departures) and reflects an annual demand of 1,013,856 operations. The Build Out No Action operating configuration analysis results in 56.5 percent west flow and 43.5 percent east flow as shown in **Table 4-1**.

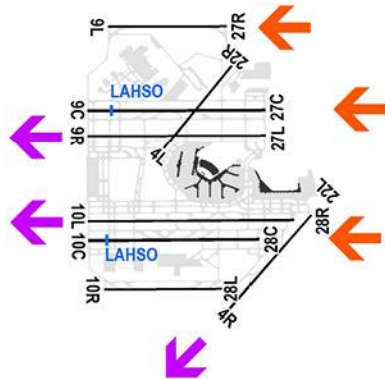
Exhibit 4-2 displays each of the six modeling configurations for the Build Out No Action. The west flow operating configurations all use six runways. Runways 27R, 27C, and 28C are predominantly for arrivals, whereas Runways 27L, 28R, and 22L are predominantly for departures.

Both VFR East operating configurations use five runways. Runways 9L, 9C, and 10C are predominantly for arrivals, whereas Runways 9R and 10L are predominantly for departures. The IFR East operating configuration uses five runways. Runways 9L, 9C, 10C, and 10R are predominantly for arrivals (triple arrivals either using Runways 9L/9C/10C or using Runways 9L/9C/10R), whereas Runways 9R and 10L are predominantly for departures. Runway 10R is used for arrivals only in IFR East conditions and not when Runway 10C is in use. The weighted use of each operating configuration is provided in **Table 4-1** and displayed in **Exhibit 4-2**.

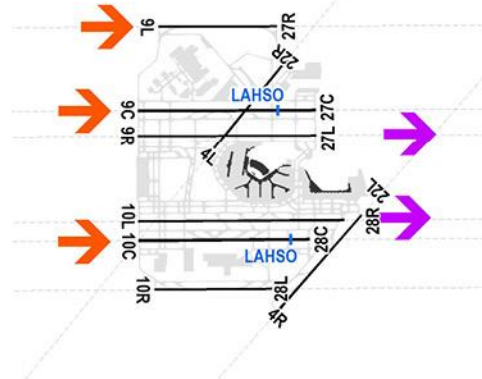
TABLE 4-1
TAAM MODELED OPERATING CONDITIONS

	Interim No Action	Interim Proposed Action	Build Out No Action	Build Out Proposed Action
VFR West with LAHSO	37.7%	37.7%	37.7%	37.2%
VFR West without LAHSO	14.5%	14.5%	14.5%	14.2%
IFR West	4.3%	4.3%	4.3%	2.2%
Total West Flow	56.5%	56.5%	56.5%	53.6%
VFR East with LAHSO	24.3%	24.3%	24.3%	24.6%
VFR East without LAHSO	16.1%	16.1%	16.1%	16.6%
IFR East	3.1%	3.1%	3.1%	5.2%
Total East Flow	43.5%	43.5%	43.5%	46.4%
Total	100.0%	100.0%	100.0%	100.0%
Sources: CDA Simulation Data Packages, November 2020 Notes: IFR – Instrument Flight Rules VFR – Visual Flight Rules LAHSO – Land and Hold Short Operations Additional operating configurations are anticipated to be used at O'Hare that were not modeled as part of this process. The estimated annual occurrence of these operating configuration (0.7 percent) was not high enough to justify modeling. This includes configurations involving only the use of Runway 4L/22R and Runway 4R/22L.				

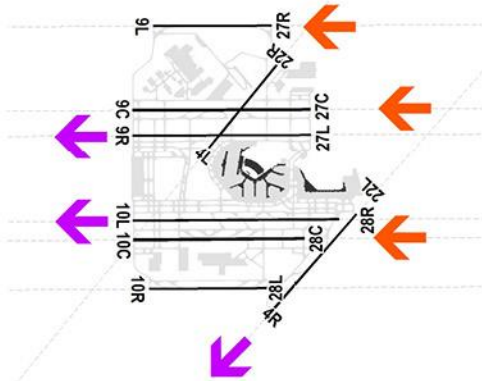
VFR West with Land and Hold Short Operations (LAHSO) - (37.7%)



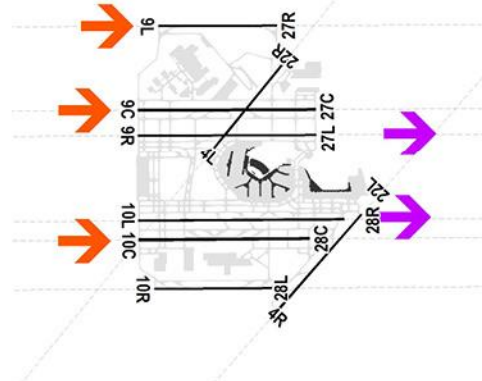
VFR East with Land and Hold Short Operations (LAHSO) - (24.3%)



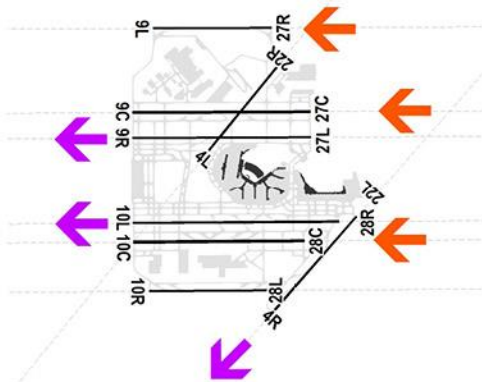
VFR West without LAHSO - (14.5%)



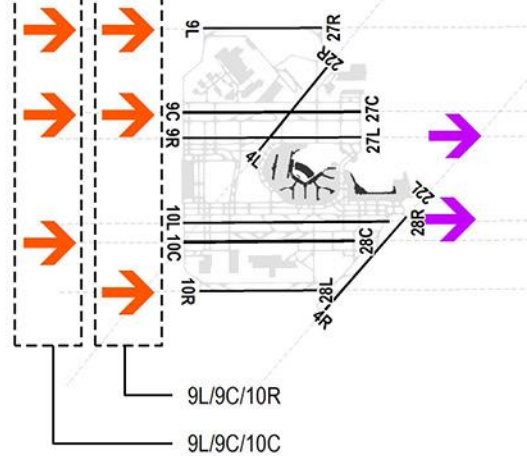
VFR East without LAHSO - (16.1%)



IFR West - (4.3%)



IFR East - (3.1%)



➔ Typical Arrivals
➔ Typical Departures



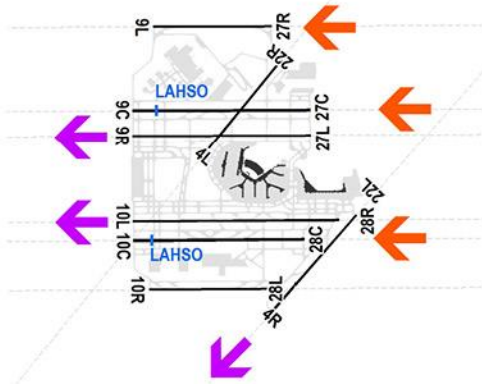
Chicago O'Hare International Airport
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Procedures Environmental Assessment**

Interim No Action Simulated
Operating Conditions

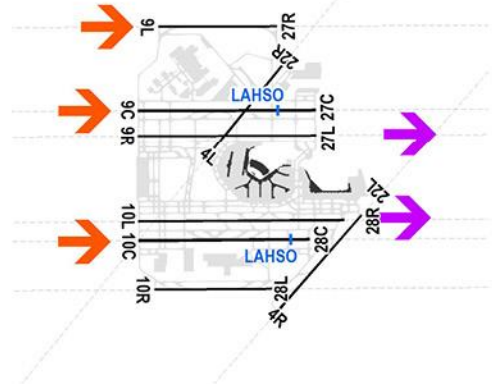
Source: HMMH, Ricondo & Associates, Almay

► Exhibit 4-1

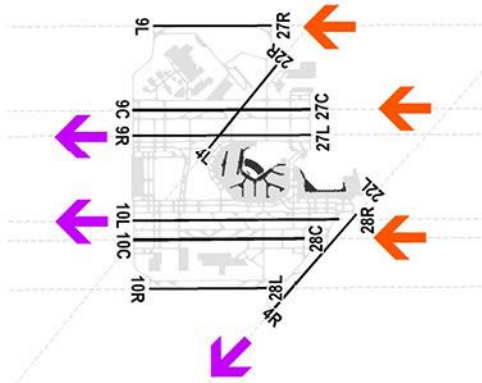
VFR West with Land and Hold Short Operations (LAHSO) - (37.7%)



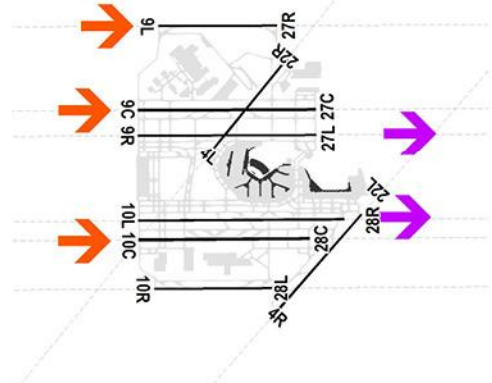
VFR East with Land and Hold Short Operations (LAHSO) - (24.3%)



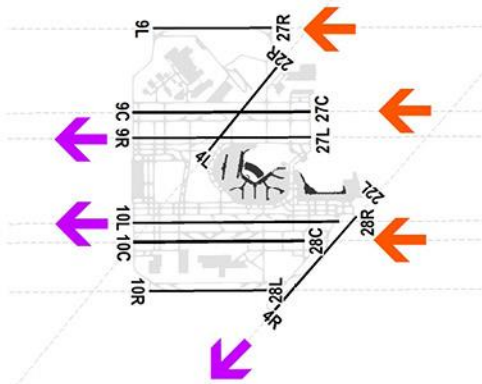
VFR West without LAHSO - (14.5%)



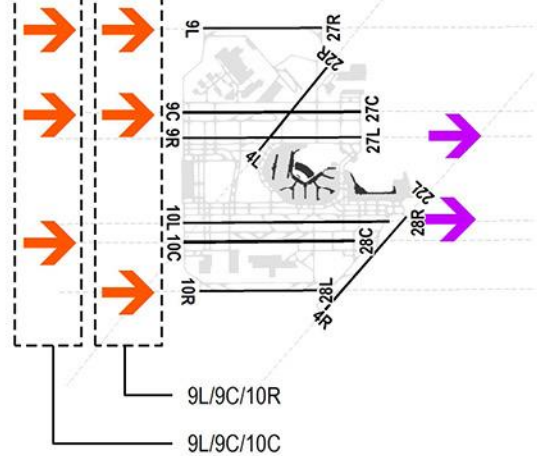
VFR East without LAHSO - (16.1%)



IFR West - (4.3%)



IFR East - (3.1%)



➔ Typical Arrivals
➜ Typical Departures



Chicago O'Hare International Airport
**Terminal Area Plan and Air Traffic
Procedures Environmental Assessment**

**Build Out No Action Simulated
Operating Conditions**

Source: HMMH, Ricondo & Associates, Almay

► Exhibit 4-2

4.2.4 Interim Proposed Action

The simulation modeling for the Interim Proposed Action includes:

- Modified taxiway geometry south of the Terminal 5 expansion,
- Modified taxiway geometry and addition of a construction work area south and west of the Runway 4L threshold,
- Operation of existing Terminal 2 and Concourses E and F, and
- Retention of the Runway 10R/28L offset air traffic approaches.

The Interim Proposed Action DDFS includes 2,820 daily operations (arrivals and departures) and reflects an annual demand of 952,489 operations. The Interim Proposed Action operating configuration analysis results in 56.5 percent west flow and 43.5 percent east flow as shown in **Table 4-1**.

Exhibit 4-3 displays each of the six modeling configurations for the Interim Proposed Action. The west flow operating configurations all use six runways. Runways 27R, 27C, and 28C are predominantly for arrivals, whereas Runways 27L, 28R, and 22L are predominantly for departures.

The VFR East with LAHSO operating configuration uses a maximum of five runways simultaneously. Runways 9L, 9C, and 10C are predominantly for arrivals, whereas Runways 9R and 10L are predominantly for departures. The VFR East without LAHSO operating configuration uses five runways. Runways 9L, 9C, 10C, and 10R are predominantly for arrivals (triple arrivals using Runways 9L/9C/10C, Runways 9C/10C/10R, or Runways 9L/10C/10R), whereas Runways 9R and 10L are predominantly for departures. Runway 10R with the offset air traffic approach can be used for arrivals in these configurations with Runway 10C.

The IFR East operating configuration uses a maximum of five runways simultaneously. Runways 9L, 9C, 10C, and 10R are predominantly for arrivals (triple arrivals either using Runways 9L/9C/10C or Runways 9L/9C/10R), whereas Runways 9R and 10L are predominantly for departures. Runway 10R with the offset air traffic approach is used independently of Runway 10C. The weighted use of each operating configuration is provided in **Table 4-1** and shown in **Exhibit 4-3**.

4.2.5 Build Out Proposed Action

The simulation modeling for the Build Out Proposed Action includes:

- Terminal 5 expansion and associated taxiway geometry,
- O'Hare Global Terminal and Concourse,
- Satellite 1 and Satellite 2 Concourses and associated taxiway geometry,
- The addition of two Runway 9L/27R high speed exit taxiways, and
- Retention of the Runway 10R/28L offset air traffic approaches.

The Build Out Proposed Action DDFS includes 2,993 daily operations (arrivals and departures) and reflects an annual demand of 1,013,856 operations. The Build Out Proposed Action operating configuration analysis results in 53.6 percent west flow and 46.4 percent east flow as shown in **Table 4-1**.

Exhibit 4-4 displays each of the six modeling configurations for the Build Out Proposed Action. All west flow operating configurations use a maximum of six runways simultaneously. The following runway configurations were evaluated:

- One runway configuration where arrivals use four runways simultaneously (quadruple simultaneous independent arrivals) with two departure runways and
- One runway configuration where arrivals use three runways simultaneously (triple simultaneous independent arrivals) and three departure runways.

Runways 27R, 27C, 28L, and 28C are predominantly for arrivals, whereas Runways 27L, 28R, and 22L are predominantly for departures. Runway 28L uses an offset air traffic approach, making it available when Runway 28C is also in use for arrivals. In the quadruple arrival configuration, Runway 22L is not available for departures because Runway 28L with the offset is being used for arrivals.

The east flow operating configurations use a maximum of six runways simultaneously. The following combinations were evaluated for each east flow operating configuration:

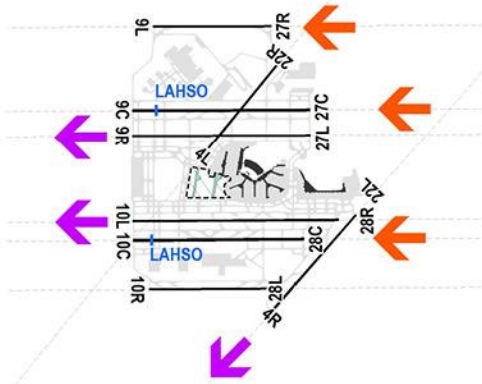
- One runway configuration using six runways, where arrivals use four runways simultaneously (quadruple simultaneous independent arrivals) with two departure runways and
- One runway configuration using five runways, where arrivals use three runways simultaneously (triple simultaneous independent arrivals) with two departure runways.

Runways 9L, 9C, 10C, and 10R with an offset air traffic approach are predominantly for arrivals, whereas Runways 9R and 10L are predominantly for departures.

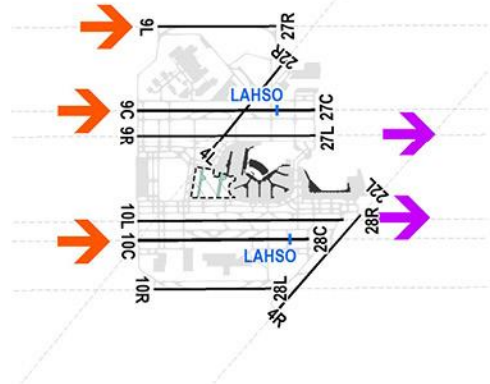
For the east flow triple arrival operating configurations, Runways 9L, 10C, and 10R with an offset air traffic approach are predominantly used for arrivals for IFR East and VFR East without LAHSO. For VFR East with LAHSO, Runways 9L, 9C, and 10C are used for arrivals, and Runways 9R and 10L are predominantly used for all east departures. For all east flow quadruple arrival operating configurations, Runways 9L, 9C, 10C, and 10R are predominantly for arrivals, and Runways 9R and 10L are predominantly for departures.

The weighted use of each operating configuration is provided in **Table 4-1** and displayed in **Exhibit 4-4**.

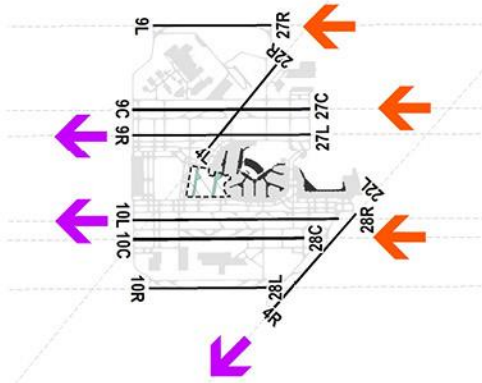
VFR West with Land and Hold Short Operations (LAHSO) - (37.7%)



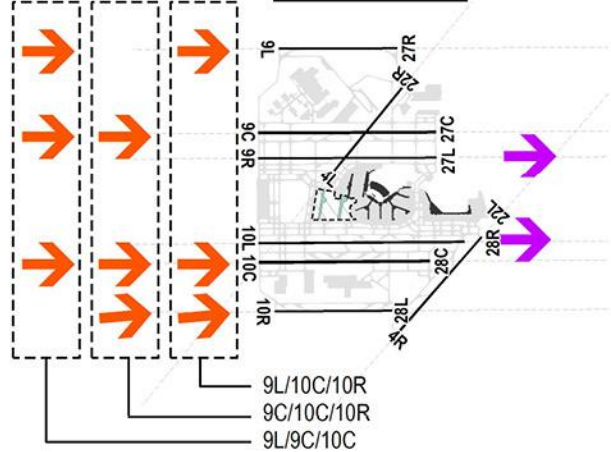
VFR East with Land and Hold Short Operations (LAHSO) - (24.3%)



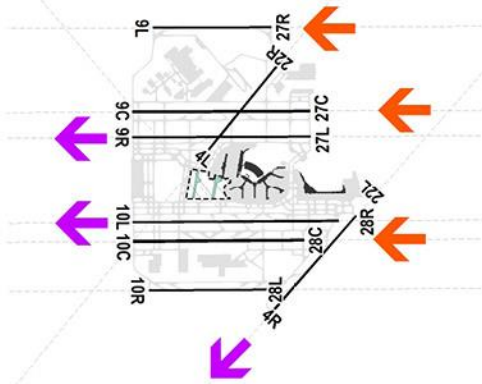
VFR West without LAHSO - (14.5%)



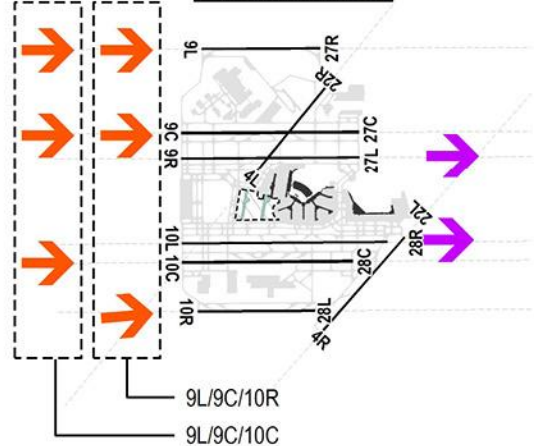
VFR East without LAHSO - (16.1%)



IFR West - (4.3%)



IFR East - (3.1%)



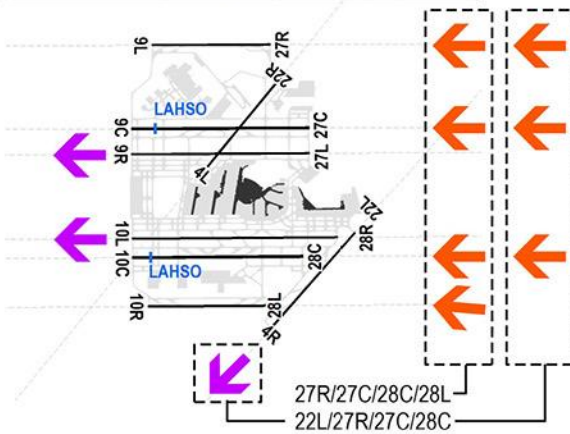
Chicago O'Hare International Airport
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 Procedures Environmental Assessment**

**Interim Proposed Action Simulated
 Operating Conditions**

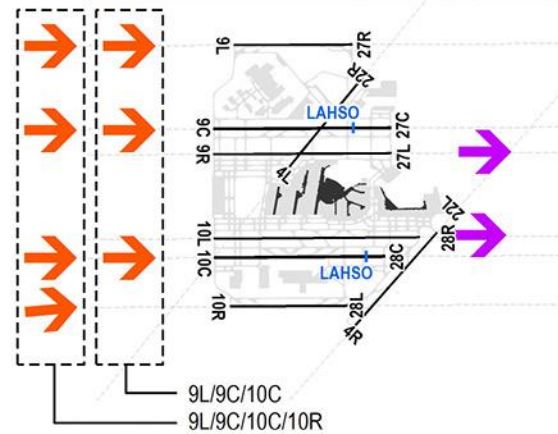
Source: HMMH, Ricondo & Associates, Almay

► Exhibit 4-3

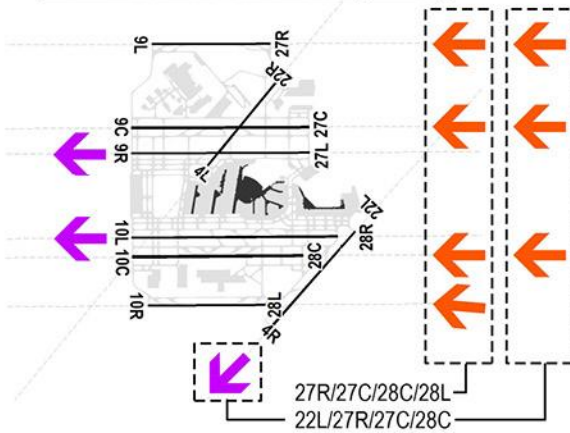
VFR West with Land and Hold Short Operations (LAHSO) - (37.2%)



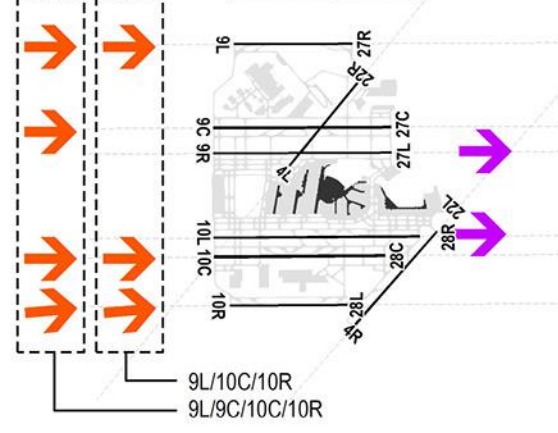
VFR East with Land and Hold Short Operations (LAHSO) - (24.6%)



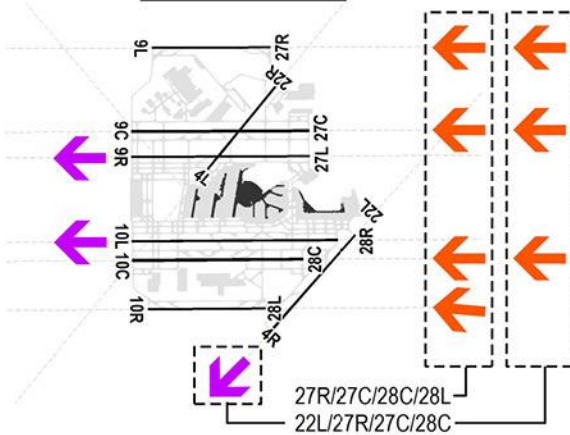
VFR West without LAHSO - (14.2%)



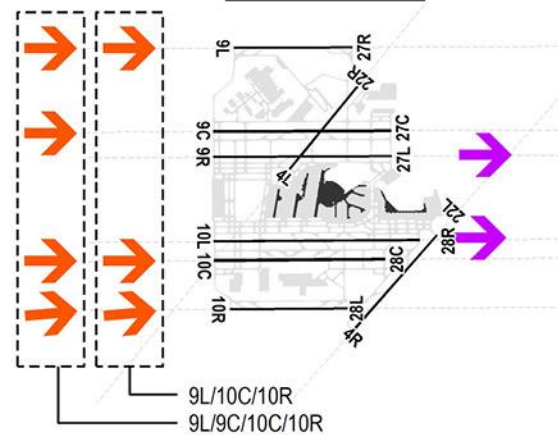
VFR East without LAHSO - (16.6%)



IFR West - (2.2%)



IFR East - (5.2%)



Typical Arrivals



Typical Departures



Chicago O'Hare International Airport

Terminal Area Plan and Air Traffic Procedures Environmental Assessment

Build Out Proposed Action
Simulated Operating Conditions

Source: HMMH, Ricondo & Associates, Almay

► Exhibit 4-4

4.2.6 Results

Airport efficiency can be evaluated in terms of delay. Delay is the additional operating time attributed to any impediment to the free flow of aircraft through the airport system. Unimpeded travel time is the time it would take an aircraft to travel from Point A to Point B if it were the only aircraft in the airport system. Increases in the travel time from Point A to Point B due to interactions with other aircraft in the airport system are considered delays.

Delays at O'Hare produce substantial costs to airlines, passengers, and residents of communities that surround the airport. Airlines experience additional operating costs. Passengers miss connecting flights and lose personal or work-related time. Communities experience increased environmental impacts as aircraft queue on taxiways, hold for available gates, or are assigned to other runways.

As seen in **Table 4-2**, the Build Out Proposed Action results in lower delay compared to the Build Out No Action in all configurations, especially in East Flow IFR, which is reduced by almost 11 minutes. The Interim Proposed Action condition results in small increases in delay compared to the Interim No Action in all configurations due to increased taxi times due to the construction areas and modified taxiway layout. Overall, the Interim Proposed Action results in 18 additional seconds of delay on average compared to the Interim No Action, while the Build Out Proposed Action results in 48 seconds less delay on average compared to the Build Out No Action.

TABLE 4-2
TAAM AVERAGE DELAY PER ALL AIRPORT OPERATIONS

	Interim No Action (minutes)	Interim Proposed Action (minutes)	Build Out No Action (minutes)	Build Out Proposed Action (minutes)
VFR West with LAHSO	3.7	3.9	4.1	3.7
VFR West without LAHSO	4.1	4.6	4.9	4.3
IFR West	6.8	8.5	10.5	9.0
VFR East with LAHSO	4.2	4.4	4.8	4.5
VFR East without LAHSO	4.5	4.4	5.5	4.8
IFR East	11.8	12.5	21.3	10.4
Total	4.4	4.7	5.4	4.6
Sources: CDA Simulation Data Packages, Table 2-8, November 2020				

Sources: CDA Simulation Data Packages, Table 2-8, November 2020

Additional results and modeling details are provided in **Appendix D**.