O'HARE MODERNIZATION PROGRAM
CONCEPT DEVELOPMENT/REFINEMENT
(DRAFT)

Submitted to FAA for Review and Comment

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I. Introduction and Background

1.1 Introduction

This document presents the planning effort that led to the O'Hare Modernization Program (OMP) concept. Specifically, the analysis of facility requirements and the concept development/refinement effort that led to the concept presented on the draft Airport Layout Plan (ALP) dated December 2002 is presented. The following sections are included:

- Airfield Development Plan
- Terminal Plan Development
- Support/Ancillary Facility Plan Development
- Surface Transportation/Parking Plan Development
- Integrated Plan

Each of these sections is subdivided as necessary to address specific issues. The following section presents background on development issues at O'Hare and defines the basic concept of the preferred OMP plan.

1.2 Background

Delays at O'Hare peaked in 1990 and subsided slightly for the majority of the decade. However, in the late 1990s delays rose substantially as the result of the changes in the use of Land and Hold Short Operations (LAHSO) and increased use of Regional Jet (RJ) aircraft that impacted airspace capacity. Due to weather and airline labor issues, the summer of 2000 was a particularly delay prone period at O'Hare and throughout the national airport system, and resulted in national attention on airport delay issues. In response to the system-wide increases in delay experienced in the summers of 1999 and 2000 and in spite of Federal Aviation Administration (FAA) initiatives to mitigate those delays, Congress requested FAA to undertake the task of developing capacity benchmarks for the busiest airports in the nation. The following are excerpts from the FAA Benchmarking Study released in May 2001 relative to O'Hare:

- The current capacity benchmark at Chicago O'Hare is 200-202 flights per hour in good weather.
- Current capacity decreases to 157-160 flights (or fewer) per hour in adverse weather conditions, which may include poor visibility, unfavorable winds, or heavy precipitation.
- In 2000, O'Hare was ranked the third most delayed airport in the country. Overall, slightly more than six percent of all flights were delayed significantly (i.e., more than 15 minutes).
- On good weather days, scheduled traffic is at or above the capacity benchmark for 3 ½ hours of the day and about two percent of the flights are delayed significantly.
- In adverse weather, capacity is lower and scheduled traffic exceeds capacity for eight hours of the day. The number of significantly delayed flights jumps to 12 percent.
- Technology and procedural improvements are expected to increase O'Hare's capacity benchmark in good weather by six percent (i.e., 211-213 flights per hour) over the next 10 years.

- The adverse weather capacity benchmark will increase by a total of 12 percent (i.e., 176-179 flights per hour) compared to today.
- Demand at Chicago O'Hare is projected to grow by 18 percent over the next decade. This imbalance between capacity and demand growth is expected to significantly increase delays at O'Hare.

In response to the national interest in the issue of airport capacity and delay in Chicago, the U.S. Senate Committee on Commerce, Science and Transportation held a field hearing in Chicago on June 15, 2001, on Air Traffic Congestion and Capacity in the Chicago, Illinois Region and Its Effects on the National Air Traffic System. Testimony was provided by proponents of a third airport in the Peotone area, proponents of O'Hare expansion, and opponents of O'Hare expansion. While the Committee did not take specific actions, it made clear its desire that local and State officials act soon on the issue of aviation capacity, or face the possibility of federal intervention.

In response to the Committee's challenge, the City presented its proposal for the future of O'Hare on June 29, 2001. The proposal provided for the addition of one new runway and the relocation of three runways, resulting in an airfield configuration providing six runways in the east-west direction. Additionally, the plan included the development of new terminal facilities on the west side of the Airport and associated ground transportation access. Subsequent to the City's proposal, the State of Illinois held hearings on the proposed plan in the communities surrounding O'Hare. In December 2001, the City and the State agreed on the future proposed development concept.

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The following sections of this document present the analysis undertaken in the development and refinement of the plan issued by the City in June 2001, and the subsequent official submittal (the draft ALP) to the FAA in December 2002.

II. Airfield Development Plan

In June 2001, the City of Chicago released a concept for the redevelopment of O'Hare International Airport. The concept envisions the redevelopment of O'Hare's airfield through construction of a new north Runway 9L-27R and the relocation of three existing runways (18-36, 14L-32R and 14R-32L) resulting in an airfield configuration consisting of six parallel runways in the east-west direction and two runways in the 4-22 direction. This concept was subsequently refined and evolved into the O'Hare Modernization Program (OMP). This section presents the planning and analyses that culminated with preparation of the draft ALP set submitted to the FAA in December 2002. The following sections are provided:

- Airfield Facility Requirements
- Base Concept Description
- Concept Alternatives
- Concept Refinements
- Selection and Refinement of Preferred Alternative

Each of these sections is further subdivided as appropriate, to address specific issues.

2.1 Airfield Facility Requirements

Airfield facility requirements were defined to provide the basis for the development of airfield concepts and to confirm that the facilities provided under the OMP meet anticipated needs and FAA requirements. The following facility requirements are discussed:

- Wind/Weather Analysis
- Airport Design Group VI Requirements
- Runway Length Requirements

The requirements defined here provide the basis for the concept refinements presented in the remainder of this section.

2.1.1 Weather Analysis

The following sections present weather analyses performed to ensure that the various airfield concepts provide appropriate wind and weather coverage.

2.1.1.1 Wind Analysis

An assessment of wind coverage under various airfield configurations was performed to determine the implications of the reorientation of runways at the Airport. Based on FAA *Advisory Circular 150/5300-13, Airport Design*, it is desirable to provide at least 95 percent wind coverage for any aircraft that are forecast to use the airport on a regular basis, based on its allowable crosswind component. The Advisory Circular establishes recommendations for runway wind coverages and for allowable crosswind components for various aircraft categories. Generally, larger aircraft with higher approach speeds are capable of operating in higher crosswind conditions. The majority of aircraft at the Airport (including narrowbody and widebody aircraft) have allowable crosswind components of 16 knots or greater based on FAA criteria. It is important to recognize that crosswind criteria discussed here are based exclusively on FAA guidelines. These criteria may not reflect individual airline operating practices or pilot preferences, which are addressed later in this section.

Additionally, operating practices typically specify different allowable crosswind components for dry pavement conditions and wet pavement conditions. **Table II-1** depicts Airport Reference Codes, representative aircraft, allowable crosswind components, and annual operations in the year 2000 at O'Hare.

Table II-1

Aircraft Operations by Allowable Crosswind

Airport Reference Code	General Description	Sample Aircraft	Allowable Crosswind	Annual Operations	Percent of Ops
A-I and B-I	Small General Aviation	Cessna 172, Piper 310	10.5	5,454	0.6%
A-II and B-II	GA and Small Turboprop	BAE 31, EMB 120	13	49,790	5.6%
A-III-B-III and C-I through D-III	RJ and Narrow Body Jets	B733, A320, CRJ	16	670,670	75.9%
A-IV through D-VI	Wide Body Jets	B763, B747, B777	20	147,788	16.7%
Unidentified				9,464	1.1%
			Total	**883,166**	**100%**

Source: Landrum & Brown, Inc. Operations by category compiled from O'Hare ANOMS for year 2000.
Note: Aircraft groupings and wind limitations based on FAA Advisory Circular 150/5300-13.
Prepared by: Ricondo & Associates, Inc.

O'Hare's airfield currently includes six operational air carrier runways with six distinct runway orientations[1]. Runways designated 9-27 are aligned 090 and 270 degrees, Runways 4-22 are aligned 040 and 220 degrees and Runways 14-32 are aligned 140 and 320 degrees. With the existing runway layout, combined wind coverage approaches 100percent for crosswinds not exceeding 10.5 knots which significantly exceeds FAA coverage requirements for air carrier aircraft. In order to assess the potential impacts of various airfield concepts on wind coverage, a study was conducted to determine the impact of various runway layout concepts that may exclude existing runways.

Weather data collected from the National Oceanographic and Atmospheric Administration (NOAA) was analyzed to determine wind coverage for various runway layout options. Wind data covering the period 1991 through 2000 was analyzed to assess the coverages under various allowable crosswind components and weather conditions. Wind coverages were analyzed for both a 24-hour day, and separately for the hours between 6:00 a.m. and 10:00 p.m., the Airport's primary operating hours.

Specifically, assessments of layouts without either runways in the 14-32 orientation, or 4-22 orientation were performed. The analyses were performed for All Weather conditions, Instrument Meteorological Conditions (IMC), Visual Meteorological Conditions (VMC), and for observations

[1] Existing Runway 18-36 is not included in this analysis since it does not currently serve significant activity, or activity by air carrier aircraft.

when some form of precipitation was experienced. **Table II-2** presents wind coverages for the combined Runway 4-22 and Runway 9-27 configurations, and the combined Runway 14-32 and Runway 9-27 configurations for both the 24-hour day and primary operating hours (6:00 a.m. to 10:00 p.m.). As shown, under all crosswind conditions, Runway 9-27 coupled with Runway 4-22 provides better coverage than Runway 9-27 coupled with Runway 14-32. Additionally, the analysis of primary operating hours provides the more conservative assessment of wind coverages under all conditions. As such, the remainder of this section focuses on the analysis of the wind coverage during the primary operating hours. Runway 9-27 coupled with Runway 4-22 meets the All Weather, VFR and IFR coverage requirement of 95 percent for all crosswind components, whereas Runway 9-27 coupled with Runway 14-32 meets the requirement for all conditions except the 10.5 crosswind limitation.

Table II-2 also presents wind coverages for the various configurations under various crosswind components during precipitation events. As shown, the combination of Runway 9-27 and Runway 4-22 provides greater coverage during precipitation events than that provided by Runway 9-27 and Runway 14-32.

Airlines' Flight Operations and Operational Engineering Departments provided aircraft performance data used to confirm the assessment of wind coverage. The performance data provided show maximum acceptable crosswind components for air carrier aircraft departures range from 30 to 35 knots during dry runway conditions and 20 to 25 knots during wet runway conditions depending on aircraft type. Maximum acceptable crosswind components for arrivals depend on weather conditions, runway conditions, aircraft type, and aircraft braking action. When the braking action of the runway is reported as "Fair" to "Good", the maximum acceptable landing crosswind component is 20 to 30 knots depending on aircraft type. During weather conditions where runway contamination exists and the braking action is reported as "Poor" or "Nil" (i.e., standing water, slush, packed snow, ice, etc.), the maximum acceptable crosswind component for landings, reported from airline data, is 10 to 15 knots depending on aircraft type.

Based on this information, nearly 100 percent wind coverage exists for air carrier operations under conditions when braking action is reported as "Fair" or better, while approximately 98.3 percent and 95.2 percent wind coverage exists for air carrier operations under conditions when braking action is reported as poor or worse for Runway 9-27 coupled with Runway 4-22 and Runway 14-32, respectively (assuming a 13 knot allowable crosswind during these conditions). Based on this analysis, an airfield layout plan that includes a 9-27 orientation and either runways in the 4-22 orientation or 14-32 orientation will meet FAA wind coverage criteria. Of these combinations, the 9-27 and 4-22 orientations provide the better combined wind coverage level.

Table II-2

Wind Coverage

Daytime Operating Hours 06:00 - 22:00

10.5-knot Crosswind

	Occurrences	RW 9-27 & RW 4-22	RW 9-27 & RW 14-32
All Weather	58,365	96.3%	92.6%
VFR	53,034	96.3%	92.9%
IFR	5,331	96.0%	89.7%
Precipitation	4,224	94.0%	88.8%

16-knot Crosswind

	Occurrences	RW 9-27 & RW 4-22	RW 9-27 & RW 14-32
All Weather	58,365	99.8%	99.2%
VFR	53,034	99.8%	99.3%
IFR	5,331	99.6%	98.4%
Precipitation	4,224	99.6%	98.3%

13-knot Crosswind

	Occurrences	RW 9-27 & RW 4-22	RW 9-27 & RW 14-32
All Weather	58,365	98.9%	97.2%
VFR	53,034	98.9%	97.3%
IFR	5,331	98.7%	95.4%
Precipitation	4,224	98.3%	95.2%

20-knot Crosswind

	Occurrences	RW 9-27 & RW 4-22	RW 9-27 & RW 14-32
All Weather	58,365	100.0%	99.9%
VFR	53,034	100.0%	100.0%
IFR	5,331	100.0%	99.9%
Precipitation	4,224	100.0%	99.9%

All Hours 00:00 - 24:00

10.5-knot Crosswind

	Occurrences	RW 9-27 & RW 4-22	RW 9-27 & RW 14-32
All Weather	87,543	96.7%	93.5%
VFR	79,442	96.7%	93.8%
IFR	8,101	96.3%	90.4%
Precipitation	6,534	94.0%	89.0%

16-knot Crosswind

	Occurrences	RW 9-27 & RW 4-22	RW 9-27 & RW 14-32
All Weather	87,543	99.8%	99.3%
VFR	79,442	99.8%	99.4%
IFR	8,101	99.7%	98.7%
Precipitation	6,534	99.6%	98.5%

13-knot Crosswind

	Occurrences	RW 9-27 & RW 4-22	RW 9-27 & RW 14-32
All Weather	87,543	99.0%	97.6%
VFR	79,442	99.0%	97.7%
IFR	8,101	98.8%	95.7%
Precipitation	6,534	98.3%	95.2%

20-knot Crosswind

	Occurrences	RW 9-27 & RW 4-22	RW 9-27 & RW 14-32
All Weather	87,543	100.0%	100.0%
VFR	79,442	100.0%	100.0%
IFR	8,101	100.0%	99.9%
Precipitation	6,534	100.0%	99.9%

Source: National Oceanic and Atmospheric Administration; Asheville, North Carolina, 1991 through 2000
Prepared by: Ricondo & Associates, Inc.

2.1.1.2 Category II/III IMC Weather Analysis

The existing airfield is equipped with Category II/III coverage on Runways 14R and 14L. With the addition of new and/or realigned runways, a weather analysis was conducted to determine what runways would need to be equipped with Category II/III approach lighting and equipment. Physical constraints of the airfield, cost considerations and weather data may not support the installation of Category II/III approach lighting systems on all runways. Data collected from NOAA was studied to assist in determining runway wind coverage during weather conditions requiring Category II/III approaches.

Instrument Meteorological Conditions (IMC) exist when ceilings fall below 1,000 feet or the visibility is reduced to less than 3 statute miles. IMC are classified under three approach categories. Category (CAT) I approach weather criteria include IMC weather down to minimum ceilings of 200 feet and visibility of at least ½ statute mile. CAT II approach criteria includes ceilings below 200 feet and/or visibility less than ½ statute mile down to and including a ceiling height of 100 feet and Standard CAT II Runway Visual Range (RVR) minimums of 1,200 feet. CAT III approach weather criteria include ceilings and visibility less than CAT II approach minimums. It is also worth noting that Surface Movement Guidance and Control System (SMGCS) is required to conduct ground movement of aircraft below 1,200 feet RVR with additional specialized lighting systems and/or vehicle guidance requirements below 600 feet RVR.

An analysis of weather and wind data for the period 1991 through 2000 was performed to determine runway coverage during Category II/III conditions for the various runway options. **Table II-4** presents the results of this analysis. In total, IMC Category II/III weather occurred in 434 or 0.7 percent of all 58,365 observations over the 10-year period.

Table II-4

CAT II/III Wind/Weather Coverage

	Crosswind Component			
Runway	**10.5 knots**	**13 knots**	**16 knots**	**20 knots**
Runway 9	72.4%	76.5%	77.4%	78.1%
Runway 27	28.8%	31.6%	32.0%	33.0%
Runway 9-27	89.9%	96.8%	98.2%	99.3%
Runway 4	65.0%	66.1%	68.4%	69.1%
Runway 22	36.9%	38.0%	38.0%	38.0%
Runway 4-22	94.7%	97.0%	99.3%	100.0%
Runway 14	55.5%	60.4%	64.1%	65.4%
Runway 32	41.9%	47.9%	50.5%	50.9%
Runway 14-32	83.2%	91.9%	97.9%	99.5%

Source: National Oceanic and Atmospheric Administration; Asheville, North Carolina, 1991 through 2000
Prepared by: Ricondo & Associates, Inc.

The data suggest that for crosswind limitations of 13 knots or greater, either a 9-27 or 4-22 orientation provides coverage over 95 percent. None of the orientations meet 95 percent coverage for 10.5 knots crosswind. Based on the weather data, provision of CAT II/III approaches in the 9-27 or 4-22 direction would provide the best coverage for these conditions.

2.1.2 Airport Design Group VI - New Large Aircraft (NLA) Requirements

Airbus Industrie, the European manufacturer of large commercial aircraft, plans to introduce the Airbus A380 New Large Aircraft (NLA) and A380F Freighter to commercial service in 2006. It is anticipated that these aircraft will operate at U.S. airports beginning in this year. The A380, with a wingspan of 262 feet and maximum gross takeoff weight of 1.23 million pounds, will be categorized in the Airplane Design Group (ADG) VI classification. Chicago O'Hare International Airport is a likely candidate to accommodate this aircraft based on the current list of potential operators. Although Chicago O'Hare was built prior to the introduction of the largest aircraft types currently in commercial service (i.e., B747-400, B777, A340, etc.), the Airport can accommodate these ADG V aircraft with a minimum of modification to FAA standards. With the introduction of the Airbus A380, new facilities and airport upgrades would be provided to accommodate the NLA. While the OMP will provide an opportunity to meet growing passenger demands of the future, it also will provide an opportunity to meet the demands of future aircraft.

To minimize the infrastructure costs associated with ADG VI airport design, one of the objectives of the OMP is to make reasonable accommodation for the NLA without restricting the movement of other aircraft on the airfield or reconstructing all existing airport facilities. Under the OMP, specific runways will be designated to support NLA operations. These runways will be built to ADG VI standards and equipped with Category II/III ILS. Based on preliminary data from the Airbus A380 Airplane Characteristics Manual, runway length should be provided to support maximum gross takeoff weight of 1.23 million pounds at temperatures of 84 degrees Farenheit (ISA + 15 degree C). To preserve engine life of this aircraft, ADG VI runways with departure lengths greater than 10,300 feet should be provided where practicable. Parallel taxiways 100 feet in width would be separated 600 feet from the runway centerlines. Parking positions would be provided at International Terminal 5 and at new international arrival facilities. New taxilanes and taxiways should be constructed at the West Terminal to ADG VI standards to facilitate efficient movement of NLA without restricting the movement of other aircraft. Because not all new taxiways would be built to ADG VI standards, the NLA would be restricted to designated taxiways. Although existing Taxiways A and B will not accommodate the NLA without operational restrictions due to insufficient separation distances, widths, fillet design, bridge and pavement strength limitations, etc., ADG VI taxi routes should be provided to and from designated ADG VI runways, parking positions, hangar and cargo areas by way of new parallel taxiways and strategically placed crossover taxiways.

2.1.3 Runway Length Requirements

Runway length requirements were developed based on the existing fleet operating at the Airport and the assumption that future operations would include the A380. The initial assessment of runway length requirements was based primarily on manufacturer's information, with FAA methodologies presented in Advisory Circular 150/5325-4A, *Runway Length Requirements for Airport Design*, providing additional information where necessary. **Table II-5** presents the results of this analysis.

Table II-5

Runway Length Requirements

	Aircraft Weight (Pounds)		FAR Runway Length Requirements (Feet)		
	Maximum Design Takeoff Weight	Maximum Design Landing Weight	Takeoff[1/]	Wet Landing [2/]	Aircraft Powerplant
Small Narrow Body					
A319	141,096	134,481	6,150	5,200	CFM56-5A
A320	162,037	142,196	8,100	5,850	IAE V2500
B737-200	128,100	107,000	8,550	5,700	JT8D-17R/17AR
B737-300	138,500	115,800	7,850	5,400	CFM 56-3B2
B737-500	133,500	110,000	9,250	5,250	CFM 56-3B-1 (20, 000 LB SLST)
B737-800	174,200	146,300	8,400	6,300	CFM 56-7B26
DC9-41	114,000	102,000	7,400	5,650	JT8D-15
MD87	149,500	130,000	8,200	5,600	JT8D-217C
CRJ 100ER	51,000	47,000	7,200	5,000	2 GE CF 34-3A1
CRJ 200ER	53,000	47,000	7,400	5,750	2 GE CF 34-3B1
EMB-145ER	45,415	41,226	6,950	5,250	AE3007A
Fokker-100 (Version II) [3/]	98,000	88,000	6,725	5,400	TAY MK 650
Medium Narrow Body					
B757-200 [4/]	255,000	210,000	7,350	5,750	RB211-535E4B
Medium Wide Body					
B767-300ER	407,000	320,000	9,900	6,075	CF6-80C2-B6, PW4060, RB211-524H
B777-200 (Baseline Aircraft)	535,000	445,000	8,000	5,950	Pratt & Whitney Engines
B777-200 (High Gross Weight)	632,500	460,000	10,900	6,100	Pratt & Whitney Engines
Large Wide Body					
B747-400 [5/]	875,000	630,000	11,000	8,000	RB211-524G2
New Large Aircraft					
A380-800	1,234,588	850,9846[6/]	10,300	6,400	TRENT 970/GP 7270
A380-800F	1,300,727	941,374[6/]	9,500	6,900	TREMT 977/GP7277

Notes:

1/ Takeoff runway length requirements based on 83.5° F (unless otherwise indicated), calm winds, dry pavement conditions, maximum allowable flaps setting, and maximum certified takeoff weight.
2/ Landing distance requirements based on ISA conditions, calm winds, wet pavement conditions, maximum allowable flaps setting, and maximum certified landing weight.
3/ Fokker-100 takeoff distance required is estimated under 92.5°F.
4/ B757-200 takeoff distance required is estimated under 81.7°F.
5/ B747-400 takeoff distance required is estimated under 89.4°F.
6/ A380 landing distance required is estimated under dry conditions.

Source: Aircraft Characteristics Manuals for Airport Planning; FAA AC 150/5325-4A, *Runway Length Requirements for Airport Design. Airbus A380 Airplane Characteristics for Airport Planning- Preliminary Issue.*
Prepared by: Ricondo & Associates, Inc.

In addition to this initial analysis, Airlines' Flight Operations and Operational Engineering Departments provided aircraft performance data used to assist in the confirmation of the runway length requirements. The performance data show that a runway length of 12,250 feet should be sufficient for all aircraft types and markets (90 degree F temperatures were assumed). Additionally, comments received from Advisory Sessions held with FAA, airlines and others indicated a preference to preserve the existing maximum runway length of 13,000 feet currently provided by Runway 14R. For the majority of existing aircraft and markets, the minimum acceptable arrival runway length was reported as 6,000 feet for dry runway conditions and 7,000 feet for wet runway conditions.

Runway 4L-22R, 7,500 feet in length, is the shortest operational runway on the existing airfield. Aircraft performance data specific to this runway were provided by several airlines for use in the development of airfield options. Assuming full passenger payloads, 90 degree F field temperatures and domestic markets, the length of this runway satisfies 100 percent of the landing requirements and over 85 percent of the departure requirements for aircraft in ADG I through VI. The data provided show that B737-300, B757 and A320 aircraft originating from O'Hare destined to the West Coast (range of 1,500 nautical miles) could do so without payload penalty while B737-200, MD82 and MD83 aircraft would be payload-restricted. The performance data suggest that as older aircraft are replaced by newer, higher performing aircraft, over 95 percent of the domestic market fleet mix served by O'Hare would be able to accept a 7,500 foot runway for departure (maximum passenger payload, and 90 degree F airfield temperature). To maximize the efficient use and flexibility of airfield options, and to minimize Air Traffic segregation of aircraft by providing the ability for the vast majority of aircraft to depart from any given runway, all new runways should be at least 7,500 feet in length. Based on manufacturer's information, new ADG VI runways with departure lengths greater than 10,300 feet should be provided where practicable.

2.2 Base Concept Description

In June 2001, the City of Chicago released a concept for future development of Chicago O'Hare International Airport. The concept envisions the redevelopment of O'Hare's airfield through construction of a new north Runway 9L-27R and the relocation of three existing runways (18-36, 14L-32R and 14R-32L) resulting in an airfield configuration consisting of six parallel runways in the east-west direction and two runways in the 4-22 direction. This concept was subsequently refined and evolved into the OMP. **Exhibit II-1** depicts this general runway layout concept consisting of six runways in the 9-27 orientation and two in the 4-22 orientation. A review of Exhibit II-1 shows the far outboard runways 7,500 feet in length, existing Runway 9L-27R extended to the west for an overall length of 11,500 feet and existing Runway 9R-27L extended to the west for an overall length of 13,000 feet. Additionally, closely spaced north and south parallel runways are provided at 10,000 feet and 10,800, respectively.

Exhibit II-2 shows the runway operating configurations used to assess the operating capabilities of the runway system. VFR configurations were defined in the Base Concept to consist of two flows (east and west) and generally provide for arrivals on the outboard runways and departures on the inboard runways. In periods of high departure demand, additional departure capacity is provided by the use of the outboard runways. IFR operations were assumed to consist of similar operating configurations based on current criteria. While the FAA has approved the use of quadruple independent IFR approaches at Dallas/Ft. Worth International Airport using the runway separations ultimately to be provided at that facility, the O'Hare runway concept uses different runway separations, most notably for the south runway. On this basis, use of this baseline runway concept to

conduct quadruple independent IFR approaches would require a prior FAA determination. **Exhibit II-3** and **Exhibit II-4** show possible taxi flows for the west flow and east flow operating configurations, respectively. Possible routings, directions of flow and queuing areas are also depicted.

2.3 Concept Alternatives

In early 2002, planning discussions were held with FAA, ATCT, TRACON, and airline representatives, and the City of Chicago DOA during various advisory sessions. During these sessions, several potential modifications and alternatives to the proposed airfield concept were discussed. Specifically, requests were made to consider the potential for providing dual parallel taxiways around the north side of the existing terminal area (consistent with concepts evaluated previously in the Delay Reduction Task Force Study) and to consider perimeter taxiways around the approach end of runways as a way to avoid runway crossings. Additionally, four new concept alternatives were suggested, some of which involved the use of perimeter taxiways. Alternate operational concepts, such as landings on the inboard pair of closely spaced runways (in lieu of departures) as a preferable option from a runway crossing and traffic management point of view, were also discussed. The following sections discuss these various alternatives.

2.3.1 Dual Terminal Area Taxiways

Alternatives were pursued regarding adding dual parallel taxiways north of the existing terminal area. One alternative maintains the existing ADG V taxiway and adds a new ADG VI taxiway. Another alternative provides two new ADG VI taxiways. **Exhibit II-5** illustrates the existing ADG V taxiway and adds a new ADG VI taxiway immediately to the north. A review of Exhibit II-5 shows the required spacing between the two taxiways is 300 feet. The net effect of adding this single new ADG VI taxiway is that the two north closely-spaced runways are moved 537 feet further to the north with a corresponding reduction in separation between Runway 9C-27C and Runway 9L-27R to 5,163 feet. To the degree the existing land and hold short distance of 6,050 feet for Runway 22R landings holding short of existing Runway 9L-27R is important to maintain, the graphic illustrates how Runway 4L-22R might be repositioned to maintain this capability. It should be noted that the repositioned Runway 4L-22R is shown as a true parallel to Runway 4R-22L. **Exhibit II-6** illustrates the changes resulting from providing dual ADG VI taxiways north of the existing terminal area. For the purposes of this assessment, the existing service road adjacent to the existing taxiway is considered as the fixed object to which required clearances must be maintained. The process of adding 193 feet of clearance off the service road and the required spacing between Group VI taxiways of 324 feet narrows the spacing between Runway 9C-27C and Runway 9L-27R to 5,106 feet. The graphic also illustrates repositioning of Runway 4L-22R to the degree the land and hold short distance is important to maintain.

2.3.2 Perimeter Taxiways

In advance of pursuing Perimeter Taxiway Alternatives, it was important to establish agreement on the type of operational capability/flexibility that is desired (i.e., taxi in the approach of a landing runway without impact and/or taxi around the departure end of a runway without impact to departures). **Exhibit II-7** presents proposed planning criterion for the consideration of perimeter taxiways that protects for both the aforementioned arrival and departure capability. The parameters set forth in this exhibit are subsequently used in the definition of perimeter taxiway alternatives discussed later. A review of Exhibit II-15 shows the centerline of the crossover taxiway element is 2,573 feet from the end of the runway. This distance was established to provide for a 40:1 departure surface over the tail height of a B-747 (64'-4"). A taxiway at this distance off the runway end

additionally satisfies ADG V taxiway clearance from the last light bar of the ALS (either an ALSF-II or a MALSF) that would need to be elevated at a slope of nearly 50:1 (two degrees is the maximum allowed) and an obstruction for taxi clearance purposes. Vision requirements for an ALS require the pilot to see the entire lighting system from a point ½ degree below the glide slope (i.e., 2 ½ degree slope angle) at a point 1,600 feet in advance of the first light bar. Based on the taxiway location shown in Exhibit II-15, the B-747 tail height at the point of crossover would not obstruct the lighting system. It also should be noted that locating the crossover taxiway at the location indicated would, for all practical purposes, force the Approach RPZ onto Airport property given the clearance requirements for an ADG V taxiway.

Exhibit II-15 also illustrates the required TERPS approach surface. Based on a review of the 65-foot high contour line, a B-747 could taxi around the approach runway end without penetration of the prescribed surfaces. However, the parallel taxiway separation of 600 feet would have to be increased as the taxiway is extended beyond the threshold area in order to avoid taxi penetrations of the TERPS surfaces. If the parallel taxiway is extended at a constant 600-foot separation, TERPS penetrations of approximately 15 feet (decreasing to zero) would exist over an approximate 700-foot section of taxiway. It should be noted that the proposed planning criteria for a Perimeter Taxiway would preclude its use for ADG VI aircraft based on both wing span and tail height considerations.

Exhibit II-8 illustrates application of the Perimeter Taxiway Criteria to the approach ends of Runways 9R and 9C. To reduce clutter, only the TERPS approach surface associated with Runway 9R is shown. The exhibit also shows the westernmost locations for runway ends 9C and 9R given the perimeter taxiway requirements. These locations are approximately 760 feet further east than shown on the Base Concept. Also worthy of note is the fact that extending the parallel taxiway located between the runways to the perimeter taxiway would result in TERPS penetrations discussed previously. **Exhibit II-9** illustrates application of the Perimeter Taxiway Criteria to the approach ends of Runways 27L and 27C, identified as Alternative A. Under Alternative A, the existing east end of Runway 27C is shortened by 316 feet, reducing its overall length to 9,364 feet to limit the east-end property impacts. Similarly, Runway 9R-27L is shortened by 1,867 feet, reducing its overall length to 9,471 feet. As shown on Exhibit II-17, the crossover taxiway element of the perimeter taxiway provides ADG-V clearance from Bessie Coleman Drive, but impacts the commercial vehicle holding area and the south portion of the former military base. If the Alternative A concept for perimeter taxiways were to be applied to the east end of Runways 9C-27C and 9R-27L in conjunction with that identified on Exhibit II-16 for the west end of these runways, the overall length of Runway 9C-27C would be reduced to 8,600 feet and Runway 9R-27L to 8,713 feet.

Exhibit II-10 illustrates a perimeter taxiway around the approach ends of Runways 27L and 27C, identified as Alternative B. The approach end of existing Runway 27R, Future Runway 27L (designated 27L in the exhibit), is shortened by 725 feet, reducing its overall length to 10,614 feet to limit the east-end property impacts. The approach end of Runway 27C is extended eastward 1,431 feet to align with that of Runway 27L. As shown on Exhibit II-18, to accommodate the crossover taxiway element of the perimeter taxiway requires crossing Bessie Coleman Drive and essentially all of the property out to, but not including, Mannheim Road. If the Alternative B option were to be adopted for the approach ends of Runways 27L and 27C in conjunction with that presented earlier for the west end, the length of Runway 9C-27C would be 10,347 feet and Runway 9R-27L would be 9,856 feet. It should further be noted that taxi of ADG V aircraft beyond the runway ends to utilize the "Perimeter Taxiway" would result in the aforementioned penetration of the TERPS approach surface by elements of the aircraft tail.

Application of the Perimeter Taxiway Criteria to the approach end of Runways 10L and 10C is illustrated on **Exhibit II-11**. As shown on Exhibit II-19, maintaining ADG V taxiway clearance to the property/fence line, due east of the railroad, and providing the approach clearance over the perimeter taxiway would result in the westernmost location of runway ends 10L and 10C to be relocated approximately 714 feet east of that depicted in the base concept. **Exhibit II-12** illustrates application of the Perimeter Taxiway Criteria to the approach ends of Runways 28C and 28R. A review of the TERPS approach surface and the corresponding 65-foot high contour line shows that to maintain the parallel taxiway to Runway 4R-22L as the crossing in the approach to Runway 28C requires the runway end to be located approximately 1,708 feet west of the location shown in the original concept. This reduces the overall length of Runway 10C-28C to 9,092 feet and, if taken in conjunction with the west end Perimeter Alternative, would result in an overall runway length of 8,379 feet. The perimeter taxiway alternative illustrated for Runway 28R maintains the independent use of Runway 4R-22L, but would force a substantial runway length reduction of 3,094 feet to Runway 10L-28R (9,906 feet available). If this east end perimeter taxiway concept were to be combined with the west end alternative, the length of Runway 10L-28R would be reduced to 9,192 feet.

With Perimeter Taxiways in place around the approach ends of the closely spaced parallel runways, consideration was given to whether there would be a need for a taxiway between each pair of runways. One scenario suggests that without the parallel taxiway, all landing aircraft could exit the runway away from the terminal area, use the perimeter taxiway, and proceed to the terminal. However, factors such as where the runway exit occurs and which terminal area the aircraft is destined for could create traffic conflicts or appreciably lengthen travel distances. **Exhibit II-13** illustrates an anticipated taxi flow pattern, with the center taxiway in place, under a west airfield operating configuration. While only the north airfield is depicted, the flows could be duplicated on the south airfield. A review shows aircraft landing on Runway 27C and destined to the west terminal area would exit the runway to the left and taxi around the end of Runway 27L. Conversely, Runway 27C landings destined to the existing east terminal area could exit to the right and proceed eastbound on the north parallel and subsequently around the approach ends of Runway 27C and Runway 27L.

2.3.3 Alternate Airfield Layouts

Option 1

Concept Layout Option 1 is one of four alternate airfield layout options identified and reviewed in the advisory sessions, and is graphically illustrated on **Exhibit II-14**. Concept 1 maintains the far north 7,500-foot runway of the base plan as well as the closely spaced parallel runway on the south airfield. The new south Runway 10R-28L has its centerline located 1,265 feet from Runway 10L-28R to allow for a perimeter taxiway around the approach end of Runway 10L-28R. The additional 65 feet of spacing between the runways, increased from the standard ADG VI parallel taxiway spacing of 600 feet, results from the need for a B-747 tail height to avoid penetration of the TERPS approach surface associated with the concept of providing a perimeter taxiway around the approach end of Runway 10L. Runway 10L-28R (formerly Runway 9R-27L) is extended on its west end for an overall new length of 12,000 feet. Existing Runway 14R-32L is shortened on its southeast end to avoid the intersection with Runway 10L-28R for an overall new length of 8,750 feet. Similarly, Runway 14L-32R is shortened on its southeast end to avoid the crossing of Runway 9R-27L, but a northeast extension is proposed to provide an operating length of 8,850 feet. Option 1 additionally incorporates a northeast extension to Runway 4R-22L for an overall length of 8,506 feet. This northeast extension is to allow aircraft to position and hold on the runway for a Runway 22L departure with a landing in process on Runway 28R.

Exhibit II-15 illustrates the extension of Runway 22L to permit aircraft to hold in position on the runway with arrivals occurring on Runway 28R. A review of Exhibit II-15 shows either a runway extension of 320 feet, or entrance taxiway of similar length, would be sufficient to allow a B-767-300 size aircraft to position and hold, ready for a Runway 22L takeoff, and still be located under the TERPS (MLS Approach Surface) criteria (though within the RPZ for existing runway 27R). As shown on the exhibit, the existing Runway 22L landing threshold location would be maintained, but the elevation of the approach lighting system would need to be altered but still able to cross over the roadways in the approach.

The following four exhibits illustrate runway use and taxi flow patterns associated with Layout Option 1. **Exhibit II-16** illustrates a possible runway use and taxi flow pattern for a VFR – East Flow operating configuration. Landings are on Runways 9L, 10L and 4R, whereas departures are on Runways 9R and 10R, with overflow (secondary) departures on Runway 4L. As noted, Runway 10R departing aircraft are shown "Looping Around" the approach end of Runway 10L via the use of the Perimeter Taxiway. Potential runway use and taxi flow patterns for a VFR – West Flow operating configuration are illustrated on **Exhibit II-17**. Landings are on Runways 28R, 27L and 22R (converging), whereas departures are on Runways 22L and 32L. Runway 32R is used as the overflow (secondary) departure runway. **Exhibit II-18** illustrates a potential runway use and taxi flow pattern for an IFR – East Flow operating configuration. Triple approaches are being made on Runways 9L, 9R and 10L, and the departing Runways are 4L and 10R. Runway 10R departures are fed via the Perimeter Taxiway in the approach to Runway 10L. Potential runway use and taxi flow patterns for an IFR – West Flow operating configuration are illustrated on **Exhibit II-19**. Triple approaches are being made on Runways 28R, 27L and 27R whereas the departing runways are 22L and 32L.

Option 2

Concept Layout Option 2 is illustrated on **Exhibit II-20**. Option 2 is similar to the base layout in that the far outboard runways are maintained in the same location and at 7,500 feet in length. However, Runway 9R-27L (current Runway 9L-27R) is maintained at its existing length to accommodate a Perimeter Taxiway around the west end. In a similar manner, the extension of existing Runway 9R-27L (renamed 10L-28R) to the west is limited to provide a Perimeter Taxiway around the west end. The length of Runway 10L-28R is shown as 12,000 feet. Additionally, the spacing between the closely spaced pair of new runways to the existing is 1,265 feet to accommodate 665 feet of parallel taxiway to runway distance so taxi aircraft proceeding around the west approach ends will not penetrate the TERPS approach surface. The length of the new closely spaced parallel runways is 11,237 feet for Runway 9C-27C and 10,800 feet for Runway 10C-28C. A taxiway is also provided around the west ends of these runways so aircraft can taxi behind a departing aircraft.

Exhibit II-21 illustrates the anticipated runway use for a VFR - East Flow operating configuration as well as the associated taxiway use pattern for Option 2. Triple approaches are in use to Runways 9R, 10L and 10R, with the potential for quadruple approaches to Runway 9L during high demand (overflow) conditions. The departure Runways are 9C and 10C, with the potential to use Runway 4L during high demand periods. As shown, the perimeter taxiways are used to both feed the outboard departure runways as well as to allow landing aircraft access to the terminal area. The VFR – West Flow operating configuration is illustrated on **Exhibit II-22**. Under west flow VFR, potential landings are to Runways 28R, 27L and 27R, with the potential to use quadruple approaches by adding Runway 28L during high demand periods. The departure runways are 27C, 28C and secondary (overflow) departure Runway 22L. **Exhibit II-23** illustrates the possible IFR – East Flow

operating configuration for Option 2. Under IFR east flow, landings are made to Runways 9R, 10L and 10R, with the potential to additionally use Runway 9L should FAA procedures be developed similar to those at DFW. The departure runways are 9C and 10C; with the potential to use Runway 10L under mixed operations conditions during peak departure demand periods. The perimeter taxiways around the runway ends to the west are used to feed the departure runways as well as to allow arriving aircraft to enter the terminal area without physically crossing a runway. The possible operating configuration under IFR – West Flow conditions is illustrated on **Exhibit II-24**. Under west flow IFR, landings are served on Runways 28R, 27L and 27R, with the potential to use Runway 28L if procedures permit. Departure Runways are 27C, 28C and Runway 22L. The Perimeter Taxiways around the west end of Runways 9R and 10L are used to feed departures to Runway 28C as well as to allow aircraft to taxi from Runways 27R and 28L to the terminal area without crossing a runway.

A variation of Option 2 was developed whereby Runway 4L-22R, 7500 feet in length, was moved to the far west airfield to preserve LAHSO distance while landing 22R to hold short of RW 9C-27C. This option, however, resulted in significant land use constraints in the proposed west terminal area due to the location of the Runway 4L RPZ, and required relocation of significantly more facilities in the Northwest Maintenance Area including the AAL and NWA hangars. Subsequently, this version of Option 2 was eliminated from consideration.

Option 3

Concept Layout Option 3 is illustrated on **Exhibit II-25**. Option 3 is similar to Option 2, but Runways 9C-27C and 9R-27L are relocated northward to accommodate dual parallel Design Group VI taxiways on the north side of the existing terminal area. Runway 4L-22R is also relocated westward to maintain existing land and hold short distance from Runway 9R-27L. The parallel taxiway to runway spacing on both sides of Runway 9R-27L is shown at 665 feet to accommodate a Perimeter Taxiway around the approach end of Runway 9R. Similarly, the parallel taxiway to runway spacing on the south side of Runway 10L-28R, as well as along the north side at the western end, is spaced at 665 feet to accommodate a Perimeter Taxiway around the approach end of Runway 10L.

A possible runway operating configuration and taxiway flow pattern for Option 3 under east flow VFR conditions is illustrated on **Exhibit II-26**. As shown, triple approaches are being made to Runways 9R, 10L and 10R, with the potential for secondary (overflow) arrivals directed to Runway 9L (i.e., a quadruple approach pattern). Departures would be made on Runways 9C and 10C with the potential to use Runway 4L during high departure demand periods. The perimeter taxiways around the approach ends of Runways 9R and 10L are used to feed departures to the center runways as well as to provide a taxi path to the terminal area for aircraft landing on the far outboard runways. **Exhibit II-27** illustrates a similar runway use and taxi flow pattern, except for a west flow VFR condition. Triple approaches are shown to Runways 28R, 27L and 27R with overflow (secondary) arrivals to Runway 28L. Departure runways are 27C and 28C with Runway 22L accommodating a high departure demand condition. The perimeter taxiways around the west ends of Runways 9C and 10C are used exclusively to accommodate landing aircraft from the far outboard runways to taxi to the terminal area. A possible east flow IFR operating configuration and taxi flow pattern is illustrated on **Exhibit II-28.** Under east flow IFR, landings are made to Runways 9R, 10L and 10R. A quadruple approach to Runway 9L is also illustrated as a possibility, but such use would require procedures yet to be developed specifically for O'Hare. The departure runways shown are Runways 9C and 10C with the potential to use Runway 10L during high departure demand periods, which would force mixed operations on Runway 10L. **Exhibit II-29** illustrates a possible IFR west flow

operating configuration and taxi flow pattern. Landings occur to Runways 27R, 27L and 28R with the potential for a fourth runway (i.e., 28L) should future procedures warrant. Departures are on Runways 27C, 28C and 22L (secondary/overflow).

Option 4
Concept layout Option 4 is illustrated on **Exhibit II-30**. Option 4 is nearly identical to Option 2, except Runway 4L-22R has been shifted westward. Additionally Runway 9R-27L has been shifted westward to maintain the same runway intersection geometry that currently exists and also to permit a Perimeter Taxiway around the new east end. The perimeter taxiway extends across existing Bessie Coleman Drive and into the area currently used by the rental cars. Runway 9C-27C is also shown at 12,000 feet, nearly 800 feet longer than on Option 2. **Exhibit II-31** and **Exhibit II-32** illustrate the east flow operating configuration and taxi flow pattern for VFR and IFR conditions, respectively. The arrival runways are Runways 9R, 10L and 10R, with the potential to use Runway 9L under peak demand periods although the use of Runway 9L under IFR conditions (i.e., the 4th arrival runway) would require FAA procedures not yet developed. Departures occur on Runways 9C and 10C, with Runway 4L used for overflow departure demand under VFR and Runway 10L used for overflow departure demand under IFR conditions. **Exhibit II-33** and **Exhibit II-34** illustrate the west flow operating configuration and taxi flow pattern for VFR and IFR conditions, respectively. The potential runway use and taxi flow pattern is identical for both conditions. Arrivals occur on Runways 27R, 27L and 28R, with Runway 28L used as the potential 4th arrival runway. Departures occur on Runways 27C, 28C and 22L. The perimeter taxiway west of Runway 9R-27L is used to feed departures to Runway 27C and arrivals from Runway 27R.

Option 5
The above airfield layout alternatives (Options 1 through 4) were considered in addition to the Base Concept that for comparison purposes was subsequently identified as Option 5.

2.4 Concept Refinements

On March 12, 2002, the FAA Chicago Airports District Office (ADO) indicated that taxi movements on perimeter taxiways that are located inside of the Runway Protection Zone (RPZ) of an active runway would have to be treated as controlled, dependent crossings. On this basis, Option 4 was removed from further consideration given the concept allowed for a perimeter taxiway around the approach end of Runway 27L, at the expense of Bessie Coleman Drive and the rental car parking area, with little prospects of modification to avoid the RPZ penetrations. Additionally, Option 3, which added dual parallel taxiways around the northern portion of the existing terminal area, was deferred pending completion of simulation analysis of Options 1, 2, and 5 to assess the potential need for this dual parallel taxiway.

2.4.1 Perimeter Taxiway Concept Refinements

Exhibit II-35 illustrates a revised Option 1 that attempts to maintain a taxiway outside the RPZ. As shown, a dual north/south perimeter taxiway has been added west of the approach end of Runway 10L. The outer perimeter taxiway is located outside the Runway 10L approach RPZ. The inner perimeter taxiway is located inside the RPZ and would need to have use restrictions during certain runway configurations. A dual east/west taxiway section was added 324 feet south of the Runway 10R parallel taxiway. This taxiway element connects the perimeter taxiway to the Runway 10R exit/entrance taxiway connector permitting the flow of aircraft to operate outside the Runway 10R RPZ. A holding bay (hold pad) was also added adjacent to the taxiway connector serving the west end of Runway 10R. This holding bay provides space for aircraft awaiting ATC clearance and

permits those airplanes already cleared to move to their runway takeoff position while ensuring queuing aircraft will remain outside the Runway 10R RPZ. Additionally, an end taxiway, originally proposed for Runway 22L for use in staging departures clear of Runway 28R arrivals, was dropped from the plan due to the inability to stage aircraft without them being within the Runway 28R RPZ. **Exhibit II-36** illustrates similar changes to Option 2 to incorporate taxiway additions in the approach to Runways 10L to avoid taxi in the Runway 10L RPZ, and to improve the queuing of aircraft departing Runway 10C.

2.4.2 Runway Length Refinements

Runway 10L-28R of Option 5 was originally shown as a 12,000-foot runway based on preliminary information from the airlines on runway length requirements. The airlines subsequently indicated a requirement for a minimum of 12,250 feet of runway length for "long-haul" Asian market departures. A modification to Option 5 was made that maintains the existing east end location of the runway and extends the west end to co-locate the thresholds of Runways 10L and 10C. The resultant 13,000-foot runway provides the runway length requested by the airlines and preserves the existing maximum runway length of 13,000 feet (existing Runway 14R-32L). Furthermore, the FAA ATCT indicated the desirability of conducting intersection departures on this runway under certain operating configurations. Sufficient runway length is provided to depart aircraft from an intersection such that arrivals on the outboard runways can taxi behind the departures unrestricted. In a similar manner, Runway 9C-27C of Option 5 was initially assumed to be an arrival runway and was planned for 10,000 feet. The FAA ATCT subsequently indicated the desire to conduct intersection departures on this runway under certain operating configurations. Given these factors, the runway was extended to the east for an overall length of 11,245 feet, which provides the ability to depart aircraft from a runway intersection such that arrivals or departures on the outboard runway could taxi behind the aircraft departure unrestricted.

2.4.3 ADG VI Refinements

The concepts developed/presented thus far were designed to meet FAA Design Group VI requirements for pavement width and distance between centerlines for all new runways and taxiways representative of the following criteria.

- 200' wide runways
- 100' wide taxiways
- 600' runway-to-taxiway spacing
- 324' taxiway-to-taxiway spacing

Subsequent analysis by the planning team determined that the design parameter to build and upgrade all east-west runways to ADG VI may be overly aggressive, in terms of capability and cost, with the further recognition that a reduction in parallel taxiway to runway separation to ADG V requirements would increase the available area for airport support functions (i.e., hangars, cargo facilities, etc.). The planning team determined that the south airfield is more suitable to be designed to ADG VI guidelines given that the existing terminal area essentially "opens" to the south. On this basis, ADG VI aircraft could enter the terminal area via the crossover taxiways and thereby avoid non-standard ADG VI spacing between the inner and outer taxiways surrounding the terminal area. In addition to making the south airfield ADG VI capable, the planning team determined that one north airfield runway should be ADG VI capable (preferably Runway 9C-27C of Options 2 and 5). Since many ADG VI aircraft are likely to be "long-haul" flights to Europe or Asia utilizing north airspace routes,

departing from the north airfield would avoid an airspace crossing resulting in a reduction in departure capacity during such procedures.

The planning team subsequently developed preliminary ADG VI taxi flows consistent with the taxi flow diagrams for Option 5 provided by the FAA Air Traffic controllers for the simulation modeling of various runway configurations. These taxi flows show that an A380 could depart and land on Runway 10C-28C of the south airfield and Runway 9C-27C of the north airfield. In many cases, the normal prescribed taxi flow would need to be altered because of access restrictions into the existing terminal area.

Exhibit II-37 depicts anticipated taxi routes for west flow operations during VFR conditions. As highlighted by a set of green lines, the taxiways between the main terminal area and Runway 28R are only designed for ADG V aircraft. ADG VI landing on Runway 27C destined for International Terminal 5/6 would be required to cross Runways 27L and 28R, then taxi eastward on the parallel taxiway on the south airfield (between Runway 28C and 28R), crossing the approach end of Runway 28R before reaching International Terminal 5/6. Other relevant issues include:

- Runways 27C and 28R are used for arrivals and Runways 27L and 28C for departing aircraft.
- ADG VI aircraft would land and depart on Runways 27C and 28C.
- LAHSO is in effect on the two arrival Runways 27C and 28R during VFR to facilitate traffic flow for arriving and departing aircraft beyond the LAHSO point.
- Aircraft arriving on Runway 27C destined to the terminal area would exit the runway and taxi eastward on the parallel taxiway between Runways 27L and 27C and, except for ADG VI aircraft, Runway 27L crossing would only be permitted behind the Runway 27L intersection departures. ADG VI arrivals on Runway 27C destined for the terminal area would cross Runway 27L at the west end.
- Departing aircraft on Runway 27L would use intersection departures to facilitate Runway 27C arrivals to cross behind Runway 27L departures. ADG VI aircraft departures on Runway 27C would require crossing Runway 27L at the west end of the runway and taxi eastward on the parallel taxiway between 27C and 27L.
- Arrivals on Runway 28R would use LAHSO procedures to permit runway crossings at the west end of the runway beyond the designated LAHSO point.
- Departing aircraft on Runway 28C would be required to cross Runway 28R beyond the designated LAHSO point and taxi eastward on the south parallel taxiway (between Runways 28C and 28R. This taxi route would be identical for ADG VI aircraft originating from the West Terminal. For ADG VI aircraft originating from Terminal 5/6, departures on Runway 28C would require these aircraft to cross Runway 27R at the east end and taxi on Taxiway S.
- Potential congestion exists between 27C and 27L for ADG VI aircraft requiring crossing the runways for both arrivals and departures.

Exhibit II-38 depicts anticipated taxi routes for west flow operations during IFR conditions during which Runways 27C and 28C are used for arrivals and Runways 27L and 28R are used for departures. During IFR operations, LAHSO is in not in effect and the center runways are used for arrivals. Operations in the north airfield are similar to the previous condition except LAHSO would not be in effect.

- Arriving aircraft on Runway 28C would use the south parallel taxiway (between Runways 28C and 28R) in the easterly direction to bypass Runway 28R before reaching the terminal area.
- ADG VI aircraft would use Runway 27C and/or Runway 28C for departures.
- Departing aircraft on Runway 28R would use intersection departures allowing aircraft arriving on Runway 28C to taxi behind the departing aircraft.
- ADG VI taxi in and taxi out flows would be similar to operations during VFR conditions. However, runway crossing would increase on Runway 28R as both arriving and departing ADG VI aircraft would need to cross the runway when using Runway 28C for arrivals or departures.

Exhibit II-39 shows anticipated taxi routes for east flow operations during VFR conditions. Runways 9C and 10L are used for arrivals and Runways 9R and 10C for departing aircraft. LAHSO is in effect on Runway 10L during VFR to facilitate the traffic flow for departing aircraft on Runway 10C.

- Aircraft arriving on Runway 9C would use the inner parallel taxiway (between Runways 9C and 9R) and cross Runway 9R at the west end to reach the terminal maneuvering area.
- Departing aircraft on Runway 9R would use intersection departures to allow arrivals on Runway 9C to taxi behind departures on Runway 9R.
- Departing aircraft on Runway 10C would cross Runway 10L beyond the designated LAHSO and use the south parallel taxiway (between Runways 10L and 10C) to depart from the runway end.
- As highlighted by a set of green lines, the taxiways between the main terminal area and Runway 28R are only designed for ADG V aircraft. ADG VI landing on 9C would require crossing both Runways 10L and 10C and use the parallel taxiway south of Runway 10C before reaching International Terminal 5.
- Potential congestion exists at the ends of Runway 10L-28R and Runway 10C-28C because of runway crossings required for group VI aircraft.

Exhibit II-40 illustrates anticipated taxi routes for the east traffic flow of operations during IFR conditions. Runways 9C and 10C are used for arrivals and Runways 9R and 10L for departing aircraft. Additionally, ADG VI aircraft will use Runways 9C and 10C for departures. With IFR operations, LAHSO is not in effect and the center runways are used for arrivals.

- Operations on the north airfield are similar to the previous condition except LAHSO is not in effect.
- Arriving aircraft on Runway 10C would use the south parallel taxiway (between Runways 10C and 10L) in the westerly direction to bypass Runway 10L-28R before reaching the terminal area.
- Departing aircraft on Runway 10L would use intersection departures allowing for arriving aircraft on Runway 10C to taxi behind the departing aircraft.

- ADG VI taxi in and taxi out flows would be similar to operations during VFR conditions. However, runway crossings would increase on Runway 10L as both arriving and departing aircraft on Runway 10C would need to cross the runway.

Exhibits II-41 through **Exhibit II-43** illustrate the changes to the airfield brought about by revising the length of Runways 10L-28R and 9C-27C to 13,000 feet and 11,245 feet, respectively for Option 5. They also show the changes resulting from modifying Runway 9L-27R of Options 1, 2 and 5 and Runways 10R-28L of Options 2 and 5 to ADG V standards of 150-foot wide runways, 75-foot wide taxiways and a runway to parallel taxiway centerline separation of 400 feet.

2.4.4 Runways 9L-27R and 10R-28L Refinements

As discussed in the prior section, runway to taxiway separations were revised for Runways 9L-27R and 10R-28L to meet ADG V requirements. The Runway 9L-27R to parallel taxiway separation is planned as 500 feet for the portion of the parallel taxiway located west of Taxiway P and 400 feet for the portion of the parallel taxiway east of Taxiway P. Runway 10R-28L to the parallel taxiway separation is planned for 400 feet. While the above reduction in runway to parallel taxiway separation provides more space for maintenance area redevelopment, water detention areas and cargo area redevelopment, it nonetheless raised a challenge regarding the desires to have the outboard runways capable of CAT II/III approaches. The runway to parallel taxiway separation standard for ADG V is 400 feet, however, TERPs Instruction Letter TIL00-005A, *Interim Category II/III Obstruction Clearance Criteria*, dated September 2000, specifies a minimum runway to parallel taxiway spacing of 500 feet for an ADG V aircraft (wing spans less than 214 feet and tail heights less than 66 feet) to occupy the parallel taxiway during CAT II/III operations. For the portions of the parallel taxiway with 400 feet of runway to taxiway separation, use of the parallel taxiway would be restricted to aircraft with wingspans less than 171 feet and tail heights less than 55 feet (i.e., B-767 size aircraft or smaller during CAT II/III operations). Given the relatively short length of these outboard runways (i.e., 7,500'), as well as the location of proposed runway exits, it is anticipated that landing aircraft would exit the runway at or near the roll out end and could taxi to the terminal area without the need to back-taxi on the parallel taxiway into the area adjacent to the CAT II/III touchdown area of the runway. Taxi flow patterns submitted by Local FAA Air Traffic have subsequently confirmed these IFR taxi flows and on this basis, the planning/design premise is CAT II/III landings on the outboard runways will be approved with the 400 feet of runway to parallel taxiway spacing proposed.

2.5 Selection and Refinement of Preferred Alternative

Three alternative future airfield configurations, Options 1, 2 and 5, were analyzed as part of the selection process. As noted earlier, consideration of Option 3, which added a dual parallel taxiway around the north portion of the terminal area, was deferred pending simulation results of an airfield without the subject dual taxiways. Option 4 was similarly removed from further consideration given that the concept allowed for a perimeter taxiway around the approach end of Runway 27L at the expense of Bessie Coleman Drive and the rental car parking area with little prospects of modification to avoid RPZ penetrations. The following presents an overview of each of the concepts, two of which were simulated, leading to the conclusion of Option 5 as the preferred alternative. It should further be noted that the runway use and taxi flows that were ultimately evaluated differ slightly from that presented earlier in this document. The runway use and taxi flows are presented fully in Sections 5.3 through 5.5 of the *Airside Simulation Analysis Report* for Options 1, 2 and 5, respectively.

Exhibit II-41 illustrates the Option 1 airfield layout. As shown, this option would construct one new runway on the North Airfield and one new runway on the South Airfield. All other existing runways would remain in their current configuration. While Runways 14R-32L and 14L-32R are shortened to eliminate runway intersections, existing Runway 9R-27L would be extended to better satisfy long-haul aircraft departure requirements. Option 1 also includes additional terminal gate facilities to support operations at the higher demand levels to allow for a full analysis of the airfield capacity without gate constraints.

Option 1 was eliminated from consideration because simulation results indicated that the alternative lacked departure capability in the IFR east scenario. In east flow, Runways 9L, 9R and 10L are used as arrival runways, whereas departures occur on Runways 9R and 10R. This disproportional allocation of runway resources resulted in a departure capacity that was estimated to be 40 percent below that of the arrival capacity, and a considerable reduction in operational capacity from that of the configuration under VFR conditions.

Exhibit II-42 provides a graphic illustrating the Option 2 airfield. The Option 2 airfield is nearly identical to that presented earlier, but additional terminal gate facilities to support operations at the higher demand levels were added to allow for a full analysis of the airfield capacity without gate constraints.

Two major operational deficiencies were encountered related to Option 2. The first relates to the 1,600-foot spacing between Runways 9C and 9R combined with the thresholds being staggered by approximately 3,600 feet. This geometric condition results in complex wake turbulence interaction that greatly reduces the potential operational throughput of these two runways. The second issue relates to the viability of using perimeter taxiways as a means of maintaining unrestricted ground movements. In the spring of 2002, the FAA Great Lakes Region Office Flight Standards Division, AGL-200, requested an interpretation from the Flight Technologies and Procedures Division, AFS-400 on this issue. AFS-400 clarified the FAA's operational criteria to be utilized when considering perimeter taxiways in a memorandum dated August 22, 2002. Based on the criteria described in this memorandum, the perimeter taxiway in Option 2 would be treated as controlled crossing, thus defeating one of the major benefits of its development.

Exhibit II-43 illustrates the Option 5 airfield. As with the above noted options, the airfield is essentially the same as developed earlier, with additional terminal gate facilities added to the west to provide for sufficient gate capacity to allow for a full analysis of the airfield capacity.

The throughput rates from the simulation of the Option 5 airfield are summarized on Table VI-1 of the *Airside Simulation Analysis Report*. Peak hour arrivals range from 142 to 144 for VFR east and west flows, reducing to 117 under IFR conditions. Similarly, peak hour departures range from 144 to 150 under VFR and from 125 to 127 under IFR. Additionally, the simulation process highlighted one issue related to the use of Runway 10R for departures under IFR east-flow conditions. Under IFR east-flow, some west and southbound departures were assigned Runway 10R. However, due to the location of the glide slope critical area, aircraft en-route to Runway 10R must first cross the departure course of Runway 10L. Opportunities for improving this condition were subsequently pursued. The following sections identify modifications and refinements made to Option 5.

2.5.1 Runway Safety Area Enhancement Runway 27L (existing Runway 27R)

The current extended Runway Safety Area (RSA) at the approach end of existing Runway 27R has a non-standard length of approximately 850 feet established by the location of Bessie Coleman Drive. To comply with the requirements for a full RSA, the threshold of Runway 27L was relocated 300 feet to the west to provide for a full 1,000-foot by 500-foot RSA with a relocated Runway 9R Localizer located at the limits of the safety area. The length of Runway 9R-27L was thereby reduced to 11,260 feet.

2.5.2 Northward Relocation of Runway 9C-27C

Among other elements, Option 3 presented and discarded earlier included the relocation of existing Runway 9L-27R to accommodate a dual parallel taxiway around the northern portion of the terminal area. This element was consistent with many earlier planning studies showing such capability, although review of taxi flows were always less than conclusive that such improvement would be cost-effective. In addition, the simulation analyses for Options 1 and 5 did not suggest the need for dual taxiway capability on the north side of the terminal area. The airlines, nonetheless, generally favored such future potential, and did not want a development plan to preclude it from being pursued at a future date. On this basis, Runway 9C-27C was relocated 407 feet northward from that previously shown to protect for dual parallel taxiways around the northern portion of the terminal area. The incremental impacts of this relocation are minimal since the same existing facilities are impacted, thus making this a prudent modification.

2.5.3 RSA Enhancement Approach End Runway 28R

A standard 1,000-foot by 500-foot extended Runway Safety Area (RSA) currently exists on the east end of existing Runway 9R-27L (future Runway 10L-28R) although Taxiway Q, an angled Runway 4R exit taxiway, as well as Runway 4R pavement protrudes into the RSA. While this RSA technically exists in plan view, from an airfield operations perspective the RSA is not always protected. A frequently used east-flow operating configuration uses Runways 9R and 4R for arrivals. Weather permitting, LASHO procedures are used for Runway 9R arrivals to protect for Runway 4R landing aircraft on the runway or on Taxiway Q. On this basis, the RSA for Runway 9R arriving aircraft is thereby protected. However, when LASHO procedures cannot be used, the operations are currently allowed to continue given that the runways do not intersect. Under these conditions, the use of Taxiway Q is considered a controlled crossing; however, the use of Runway 4R is not and thereby there is no protection of the RSA for the Runway 9L landing aircraft. Given the extension of Runway 10L-28R to the west for an overall new length of 13,000 feet, a permanent Landing Distance Available (LDA) for Runway 10L of 12,249 feet can be established (i.e., use of Declared Distances) to provide clearance from aircraft on Taxiway Q with arrivals on Future Runway 10L. **Exhibit II-44** illustrates how the RSA is established by reducing the landing distance by 751 feet as well as how aircraft can continue to use Taxiway Q.

2.5.4 Protection of Runway 10C Localizer (LOC) Signal

Simulations of the east-flow IFR operating configuration of the preferred concept identified the need for additional departure capability that could be provided by Runway 10R. Under such conditions, taxi paths to Runway 10R for departure would involve taxiing on Runway 4L-22R or parallel Taxiway S located east of Runway 10C-28R. The Runway 10C localizer, however, was originally planned to be located east of Runway 4L-22R. In this location, aircraft taxiing on the runway or parallel taxiway would interfere with the Runway 10C localizer signal. **Exhibit II-45** illustrates a revised location for the Runway 10C localizer to a point west of Taxiway S. As shown, the localizer is positioned to provide ADG VI clearance for aircraft on Taxiway S, but efforts to provide a full

1,000-foot extended RSA necessitated relocating the threshold for Runway 28C 200 feet westward for a revised published length of the runway of 10,600 feet. The Landing Distance Available (LDA) for Runway 10C also would need to be revised to 10,543 feet to protect for clearances to ADG VI aircraft taxiing on Taxiway S during arrivals on Runway 10C.

2.5.5 Accommodation of Service Roads

The preferred concept incorporates new service roads so their location adheres to current applicable taxiway clearance standards, and to ensure that a 15-foot vehicle height on the roads does not penetrate FAR Part 77[2] surfaces. A full airfield perimeter service road is provided from the new west terminal area clockwise around to the Post Office Facility to the south of the airfield. Additionally, to avoid runway crossings and crossings of potentially high-use taxiways, the current tunnel into the Southwest Cargo Area is extended to the south under new Runway 10C-28C and its parallel taxiway. Similarly, the existing service road between Taxiways J and T is tunneled under Taxiway T and current Runway 14R-32L (to become a taxiway) northeast of the new west terminal site to provide access to the terminal area as well as the Northwest Maintenance Area.

Within the taxiway area south of Terminal 5 is a service road as well as a dedicated "Snow Road" for the positioning of snow removal equipment in advance of movement onto the airfield. The area currently contains two taxiways that serve existing Runway 9R-27L in addition to the apron edge taxiway. Based on the anticipated increase in aircraft movement in the area brought about by adding Terminal 6 and/or the closely-spaced south runway (Runway 10C-28C), the plan incorporates an additional parallel taxiway in the area and in so doing combines the service road function with that of the Snow Road. **Exhibit II-46** highlights the taxiway reconfiguration in the area north of Runway 10L-28R (formerly 9R-27L). A review shows the combined Service/Snow Road is directly south of existing Taxiway D with two new parallel taxiway locations added to the south. While a considerable "jog" in one of the taxiways is evident under this configuration, it was deemed to be preferable to having this roadway function being located between two high use taxiways queuing aircraft for Runways 28R and 22L.

2.5.6 Location of NAVAIDs and Runway Instrumentation

All east/west runway ends are shown as having an ALSF-2 approach light system based on the planning premise that east-west runways should be CAT II/III capable. In addition, the location of the associated glide slopes and RVRs, as well as those of the adjacent equipment shelter buildings, were placed on the plan with the assistance of FAA staff. Similarly, the location of the new ASR-9, at the northeast corner of the United Airlines Reservations Facility property, and the locations of the VORTAC and numerous Remote Transmitter/Receiver (RTR) facilities were placed on the plan with the help of the FAA staff.

2.5.7 CAT II/III on Existing Runways 27R and 27L

Implementation of the preferred plan anticipates Runway 9L-27R and Runway 10C-28C would be CAT II/III equipped and the first runways to come on line. Subsequently, the existing CAT II capability on Runways 14L and 14R could then be temporarily degraded during the construction phasing program. Furthermore, in order to achieve the benefits of a third arrival stream during IFR conditions using the new Runway 9L-27R, the necessary instrumentation would be required on the existing 9-27 runways. Detailed studies were conducted to establish the feasibility of installing CAT II/III instrumentation on existing Runways 27R and 27L. To facilitate this review, the detailed aerial

[2] Federal, Aviation Regulation, Part 77, *Objects Affecting Navigable Airspace*

survey used to document existing facilities as part of the development program was used to conduct the required survey of obstructions. It should also be noted that the recently completed Delay Task Force study recommended CAT II/III upgrades for Runways 27R and 27L.

Exhibit II-55 illustrates the plan view of the applicable CAT II/III missed approach surfaces applied to Runway 27R consistent with the requirements of current TERPS CAT II/III criteria. Inherent in the portrayal of the surfaces is a ground level touchdown area (defined as Section 1A) 3,200 feet long commencing 200 feet in advance of the threshold at a width of 400 feet on either side of the runway centerline. Beyond the touchdown area (in direction of travel) is a rising 40:1 surface, defined as Section 1B, expanding to a lateral width of 2,900 feet over a distance of 6,000 feet. As noted on the exhibit, this expanding Section 1B has been extended to an overall length of 27,052 feet to correspond to the existing CAT I missed approach procedure of climbing to 1,400 feet before making a right-hand turn. Off the lateral limits of Sections 1A and 1B, are 7:1 transitional surfaces (defined as Section 1C) rising to a height of 150 feet or to the elevation of the start of turn point in the direction of turn.

Exhibit II-48 is an enlargement of the missed approach surfaces in the area north of Terminal 1, including the entrance road into the terminal. Included on the exhibit are the elevations of various features, per the survey, as well as surface elevations for the 7:1 Section 1C surface. Objects representing a penetration of the surfaces illustrated are identified by pointer with a red number. A total of 22 objects were found to penetrate the missed approach surface, mostly light poles and signage along the entry road, but included are four parked aircraft tails along the north face of Terminal 1. **Table II-6** further identifies the obstructions by their height, degree of penetration, as well as their coordinates.

Of the three aircraft tails penetrating the 40:1 surface, the B-747 tail, identified as Object 22, is the controlling object with the tail of the aircraft penetrating the 40:1 surface by 16.6 feet. Standard CAT II minimums of 100 feet Height Above Threshold (HAT) and RVR of 1,200 feet should be achievable with this penetration, but a note on the approach chart would be required specifying a non-standard climb gradient (e.g., "Obstructions in the missed approach area require a rate of climb of at least 445 FPM/100K, 668FPM/150K, 890 FPM/200K, no wind conditions – until reaching a height of 716 feet MSL"). Given the location and the degree of penetration of the remaining 19 obstructions, a second note on the approach chart may also be required (e.g., "Light poles and sign to 739 feet located between 580 and 980 feet south of the runway centerline").

The CAT III minimums will be determined by a collision risk analysis conducted by FAA Flight Standards Services. The data provided on Table II-6 should contain the information required by the FAA to submit a request for a Collision Risk Analysis. The Airport does not currently operate CAT III minimums below 600 feet RVR. Special airfield lighting requirements (i.e., Runway lead-on and lead-off centerline lighting, controllable runway stop bars, controllable taxiway centerline lighting to parking positions, etc.) as defined by the FAA Surface Movement and Guidance and Control System (SMGCS) are not currently installed. It should be noted that a cost-benefit analysis conducted by the Airport SMGCS Working Group had previously concluded that the extra cost to install special lighting systems to operate below 600 feet RVR was not warranted given the percentage of CAT IIIc weather experienced at O'Hare.

Exhibit II-49 illustrates a similar review of the CAT II/III missed approach surfaces, but as applied to existing Runway 27L. As shown, Section 1 has been extended out to an overall length of 19,188 feet to correspond with the existing CAT I missed approach procedure of climbing to 1,200 feet

before commencing a left turn. No obstructions were found to penetrate the CAT II/III missed approach surfaces as applied to Runway 27L.

Table II-6

Runway 27R Obstruction List

	Obstruction	Max Height (ft)	Obstruction Height (ft)	Penetration (ft)	Distance from 27R C/L (ft)	Distance from 27R end (ft)	LATITUDE	LONGTITUDE	Rate of Climb in ft/min at: 100 kts	150 kts	200 kts	7 to 1Less (than 40 ft. Penetration)
1	Light Pole	676.9	679.8	2.9	590.00	2450.00	415856.214	875353.038				*
2	Light Pole	676.8	680.4	3.6	588.60	2531.60	415856.228	875354.118				*
3	Light Pole	677.0	680.0	3.0	588.70	2606.20	415856.227	875355.106				*
4	Overhead Sign	674.6	706.0	31.4	583.10	2618.80	415856.282	875355.273				*
5	Light Pole	677.6	680.6	3.0	589.20	2700.30	415856.222	875356.352				*
6	Light Pole	677.8	679.9	2.1	588.00	2790.50	415856.234	875357.546				*
7	Light Pole	677.8	679.9	2.1	589.20	2865.50	415856.222	875358.539				*
8	Light Pole	678.4	680.4	2.0	589.30	2959.00	415856.221	875359.777				*
9	Light Pole	678.3	681.7	3.4	589.60	3034.90	415856.218	875400.782				*
10	Light Pole	680.9	682.0	1.1	591.60	3131.60	415856.198	875402.063				*
11	Light Pole	680.8	683.0	2.2	589.30	3217.30	415856.22	875403.197				*
12	Light Pole	684.1	684.8	0.7	607.40	3366.60	415856.041	875405.174				*
13	Overhead Sign	684.1	688.4	4.3	608.70	3412.60	415856.028	875405.783				*
14	Light Pole	682.2	682.7	0.5	603.40	3462.30	415856.081	875406.441				*
15	Light Pole	683.0	687.5	4.5	600.30	3704.30	415856.111	875409.645				*
16	Light Pole	731.5	737.2	5.7	938.10	3657.20	415852.774	875409.021				*
17	Light Pole	734.5	738.3	3.8	958.50	3937.30	415852.572	875412.73				*
18	Light Pole	737.2	738.3	1.1	978.90	3578.50	415852.371	875407.979				*
19	Parked Aircraft[1/]	683.7	689.3	5.6	604.60	4121.90	415856.068	875415.175				*
20	Parked Aircraft[1/]	684.7	689.3	4.6	605.90	4255.90	415856.055	875416.949	378	567	756	
21	Parked Aircraft[1/]	687.6	689.1	1.5	607.70	4385.20	415856.037	875418.661	341	511	682	
22	Parked Aircraft[2/]	699.2	715.8	16.6	645.60	4859.80	415855.661	875424.945	445	668	890	

Notes: All elevations are in Mean Sea Level (MSL) unless otherwise noted.
1/ B737-400 typical
2/ B747-400 typical
* No effect on Cat II HAT or RVR. Will require note on approach chart to read: Light poles and sign to 739 ft. MSL located between 580 and 980 ft. south of the runway. The 40:1 penetrations will require an additional note to read: Obstructions in the missed approach area will require a rate of climb of at least 445 ft/min/100 kts, 668 ft/min/150 kts and 890 ft/min/200 kts - no wind conditions - until reaching a height of 716 ft. MSL.

Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc., February 2003

Chicago O'Hare currently has an approved SMGCS Plan. This plan would need to be revised to include CAT III operations on Runways 27L and 27R. It is also understood that the runway must be fully compliant with AC-120-57 before CAT III operations can be implemented.

2.5.8 Grades and Elevations - Runway 10C-28C

The Airport Design Standards as set forth in AC 150/5300-13 were used in the development of the draft Airport Layout Plan. Similarly, the requirements of FAR Part 77 in terms of approach surfaces and lateral clearances off the runway centerlines also were incorporated to the degree practical and feasible. The following outlines those cases where other applicable criteria were utilized and the rationale behind their use.

The main cargo complex, located on the south airfield, is directly impacted by the construction of runways, particularly Runway 10C-28C, requiring relocation of several cargo buildings and realignment of current access roads. The feasibility of preserving the second tier of cargo buildings (Northwest [NWA] building No. 613 and Federal Express [FedEx] building No. 612) at their present site was deemed critical given the limited area within the revised cargo area to accommodate the relocation as well as the duration of the leases held on the site, the costs and time to relocate the facilities.

In an effort to retain the subject cargo buildings, two alternatives were explored. One involved elevating the runway adjacent to the cargo buildings to comply with FAR Part 77 transitional 7:1 surface requirements, whereas the other assessed the presence of the subject cargo buildings relative to an essentially level (i.e., at existing grade) runway and the TERPS missed approach surfaces as specified for a CAT II/III runway. The difference in construction cost between an elevated runway alternative and an essentially flat runway has been estimated to be $99 million dollars. Furthermore, a runway built to protect for FAR Part 77 surface would require the center portion of the runway to be 23 feet higher than the runway ends. Although within FAA compliance of maximum runway and taxiway percent grade criteria, operational concerns of the runway profile are mitigated with the "flat runway" concept. The proposed ALP is based on the anticipation that the FAA will conduct an aeronautical study of the cargo buildings relative to the level runway and concur with maintaining a level Runway 10C-28C. Following is a description of the subject buildings and site, as well as the related analyses for the elevated and level runway alternatives.

2.5.8.1 Facility Description

Parallel Runway 10C-28C, located 1,200 feet south of Runway 10L-28R (existing Runway 9R-27L), will be 10,600 feet long and 200 feet wide to accommodate up to and including ADG VI aircraft. Runway 10C-28C will be used primarily for departures during VMC, and primarily for arrivals during IMC or in VMC when Runway 10L LAHSO is not available according to an operational plan developed by O'Hare's ATCT and the Airport. The runway will be equipped with a Category II/III Instrument Landing System (ILS) on both ends to handle aircraft during poor weather conditions.

A site plan of the cargo area is shown on **Exhibit II-50**. A review of the plan shows the main air cargo complex at O'Hare consists of several individual cargo buildings, aircraft parking aprons, an ARFF building, as well as other support infrastructure. The construction of Runway 10C-28C requires relocating both the United Airlines Cargo (building No. 610) and FedEx Metroplex (building No. 611) currently located on the first tier of the cargo area. The subject FedEx and NWA Cargo buildings are shown at their existing location on the second tier adjacent to future Runway 10C-28C. A review shows both buildings have a maximum elevation of 701.3 feet MSL (about 41.0

feet AGL) and a lowered roof portion at an elevation of 693.3 feet MSL. Both buildings are approximately 670 feet from the Runway 10C-28C centerline. An existing public access road is located north of the cargo buildings with a direct connection to relocated Irving Park Road. Additionally, under the ALP concept, an airside service road would be developed running parallel, and north of the public access road, to mainly serve cargo and other airside operations. An existing bypass tunnel under current Runway 9R-27L (Future 10L-28R) would be extended to provide direct vehicular access to other sections of the airfield and passenger terminal.

2.5.8.2 Application of FAR Part 77

FAR Part 77 defines what represents an "obstruction to air navigation" thus requiring further analysis by the FAA in an airspace study. Through this airspace study, FAA determines whether an obstruction represents a "hazard to air navigation" and is objectionable to the FAA. Under this initial scenario, the implication of complying with FAR Part 77 surfaces are investigated relative to the Runway 10C-28C centerline elevation and potential obstructions.

Under this scenario, three elevation points along the north edge of the building roof lines were identified as controlling and utilized to establish a corresponding elevation for the adjacent runway centerline. **Exhibit II-51** illustrates the location and elevation of those three points along the building roof line and the corresponding elevation of the adjacent runway centerline. As shown on the exhibit, the 693.3 feet MSL elevation on the roof line of FedEx Cargo Building established a corresponding elevation of 672.15 feet MSL at the adjacent point on the runway centerline. Similarly, roof line elevation points on the NWA Cargo Building of 701.3 feet MSL and 693.3 feet MSL established corresponding adjacent points on the runway centerline of 672.77 feet MSL and 669.0 feet MSL. Additionally, to reduce the amount of fill required and still comply with Design Standard requirements for differences in grade between a runway and its parallel taxiway, the adjacent point on the parallel taxiway has been established as 9 feet lower than that of the runway to comply with the maximum 1.5 percent grade design criteria limit and allow taxiway connections between the runway and parallel taxiway.

Exhibit II-52 provides a profile view along Section Line A-A identified on Exhibit II-51. As shown, the runway needs to be elevated to 669.0 feet MSL or by 23.0 feet to clear the 7:1 transitional surface. Additionally, the elevation on the parallel taxiway is illustrated as 660.0 feet MSL to comply with the maximum 1.5 percent difference in grade criteria. The existing access road and planned service roads would remain clear of FAR Part 77 surfaces by a minimum of 15 feet required clearance. In this case, the new service road needs to be lowered by several feet from existing ground elevation to meet the required clearance. The current service road tunnel also would be realigned and sufficiently extended such that it would remain outside of the RSA and FAR Part 77 object clearance area. A review of Exhibit II-52 additionally shows several light poles within the airside and landside premises of cargo buildings that penetrate the transitional surface. The impact of these light poles is discussed later in this section under the TERPS (level runway) scenario.

Exhibit II-53 illustrates the full lateral profile of Runway 10C-28C. The runway elevation, substantially higher in the middle, would have a constant slope of approximately 1.3 percent to reach 672.7 feet MSL for clearing the NWA cargo building. This lateral slope would still meet the FAA criteria of not exceeding positive slope of 1.5 percent for the main runway section. However, the increase in grade would, in all probability, negatively affect departure aircraft performance. The runway end elevations are established at 665.8 feet MSL and 650.0 feet MSL for the Runway 10C

and Runway 28C ends, respectively. Also existing Taxiway K would need to be raised by as much as nine feet to connect to the new runway.

2.5.8.3 Application of TERPS Category II/III Missed Approach Criteria

A full length lateral profile of Runway 10C-28C that essentially maintains a relatively flat runway surface elevation is illustrated on **Exhibit II-54**. The runway end elevations are established at 665.8 feet MSL and 650.0 feet MSL for Runway 10C and Runway 28C, respectively, taking into consideration existing airfield grades and crossing elevations of Runway 14R-32L and associated taxiways. As shown on the exhibit, with the exception of portions of existing Lake O'Hare, an essentially level runway can be provided without substantial amounts of fill.

Terminal Instrument Procedures (TERPS) standards are used in designing instrument flight procedures and by FAA to determine whether an obstruction is a hazard to air navigation. TERPS includes various approach and missed approach surfaces for the protection of aircraft movement in flight. **Exhibit II-55** illustrates the trapezoidal section (Section 1B) of the CAT II/III missed approach surface for Runway 10C that begins 3,000 feet from the runway end rising at a slope of 40:1 over a distance of 6,000 feet. The rising 40:1 surface starts at a proposed runway elevation for the point of 661.0 feet MSL. A review of the elevation values established for the rising 40:1 surface shows that no element of the FedEx and Northwest Cargo Buildings would penetrate the surface.

Similarly, the missed approach surface for Runway 28C is depicted on **Exhibit II-56**. As shown on Exhibit II-56, the 40:1 surface rises at a starting runway elevation of 650.0 feet MSL to a height of 850.0 feet MSL at the Runway 10C end. As with the Runway 10C missed approach procedure, no element of the FedEx and NWA cargo buildings would penetrate the rising Section 1B 40:1 surface.

Exhibit II-57 depicts a cross section through the Northwest Cargo Building as identified by Section Line A-A on Exhibit II-56. As shown, the height of missed approach surfaces would be higher than the cargo building at that point of the missed approach surface.

An assessment of the applicable Obstacle Free Zone (OFZ) was also conducted for Runway 10C-28C. The OFZ standard, according to FAA AC 150/5300-13, precludes object penetrations except for frangible NAVAIDS that need to be located in the OFZ because of their function. **Exhibit II-58** illustrates with a flat runway, both NWA and FedEx Cargo Buildings, traffic on the public and service roads, as well as the light poles, would not penetrate the OFZ surface. The OFZ as illustrated on Exhibit II-58 corresponds to that of a CAT II/III runway and is based on the wingspan of an A380 aircraft (i.e., 259'-2") and a threshold elevation of 665.8 feet MSL.

As discussed in the prior evaluations, light poles are present in and around the Northwest and FedEx Cargo Buildings. These light poles fall into essentially two categories, lighting standards that illuminate the auto parking areas along the north face of the buildings and higher lighting standards necessary to illuminate the aircraft apron areas south of the building. The lights in the auto parking lot are located at various points in the parking lots, whereas those on the airside are immediately along the south building faces. The lights illuminating the airside are approximately 30 feet higher.

Exhibit II-59 and **Exhibit II-60** present enlargements of the Runway 10C and Runway 28C 40:1 missed approach area over the subject building sites, respectively, with the location and heights of the lighting standards indicated. A review of the two graphics indicates several light poles, situated within the FedEx and NWA building sites, would penetrate the 40:1 missed approach surface and on

this basis would either impact missed approach climb rates or require removal. **Table II-7** provides a summary of the location and height of these light poles with the obstructions number referenced to the two exhibits. As highlighted on the table, Light Pole #4 on the airside of the Northwest Cargo Building penetrates the 40:1 surface by 8.2 feet and would be the controlling obstruction for the calculation of a higher climb rate for the Runway 10C missed approach. For Runway 10C, the standard climb rate of 330 fpm @100 kts would increase to 378 fpm @100 kts. Expressed as a function of other speeds, the climb rate would be 567 fpm @150 kts, and 755 fpm @200 kts. For Runway 28C, the controlling obstruction is #7, a Light Pole in the auto parking lot of the NWA Cargo Building. This obstruction penetrates the 40:1 surface by 8.8 feet and would establish a non-standard climb rate of 405 fpm @100 kts, 608 fpm @150 kts, and 810 fpm @200 kts. It should additionally be noted that there are several other lighting standards, not summarized on Table II-7, that penetrate the 40:1 missed approach surface, but do penetrate the 7:1 (Section 1C) of the missed approach procedure.

Table II-7

Runway 10C/28C Obstruction List

		Max Height (ft)	Obstruction				Rate of Climb		
No.	Object	(40:1 surface)	Height (ft)	Penetration (ft)	Building	RWY	100kts	150 kts	200 kts
1	Light Pole	732.9	734.7	1.8	NWA	10C	342	513	684
2	Light Pole	731.0	733.8	2.8	NWA	10C	350	525	700
3	Light Pole	727.9	734.5	6.6	NWA	10C	367	550	734
4	**Light Pole**	**726.0**	**734.2**	**8.2**	**NWA**	**10C**	**378**	**567**	**755**
5	Light Pole	718.1	724.3	6.2	FDX	28C	364	546	728
6	Light Pole	720.5	722.9	2.4	FDX	28C	345	517	690
7	**Light Pole**	**690.7**	**699.5**	**8.8**	**NWA**	**28C**	**405**	**608**	**810**
8	Light Pole	693.2	699.4	6.2	NWA	28C	381	572	762
9	Light Pole	692.1	696.3	4.2	NWA	28C	367	550	733

These objects penetrate the 40:1 surface

Source: Ricondo & Associates. Inc. Climb rates provided by Tom Hilquist.
Prepared by: Ricondo & Associates, Inc.

While the above table summarizes the light poles that penetrate the 40:1 surface and the resulting non-standard climb gradients brought about by two of them, the OMP anticipates removal of these penetrations.

2.5.9 Approach End Elevation – Runway 10R

The addition of Runway 10R-28L to the Airport Layout Plan requires the relocation of the Union Pacific Railroad line as well as Irving Park Road into the approach area of Runway 10R.

Early discussions with the airlines regarding the plan and the new south runway centered around the need to elevate the west end of Runway 10R-28L to accommodate a 50:1 FAR Part 77 approach surface to adequately clear the railroad. Early planning studies carried a west end runway elevation of 684.5 feet MSL, or nearly 26 feet higher than that proposed for the east end. The airlines expressed concern over what they perceived to be an excessive grade for the runway considering its relative short length (7,500') and plans for CAT II/III capability for each runway end. It should be noted, with the west end 26.5 feet higher than the east end, the effective up-hill grade to the west

would be 0.35 percent if the runway grade was to remain constant to minimize the overall impacts. A runway with this grade satisfies current FAA criteria for acceptable runway grades for the end quarters of the runways as well as the middle portion.

Subsequent detailed planning for the rerouting of Irving Park Road and the Union Pacific tracks produced an alignment for these elements resulting in a slightly lower runway end elevation of 679.8 feet MSL for a 50:1 FAR Part 77 approach surface to clear the roadway and railroad tracks. Additional study also has identified that the approach end of Runway 10R could be located at existing grade (i.e., 662.7 feet MSL) and not impact the TERPS MLS approach surface criteria. Application of the relatively narrow 34:1 element of the TERPS approach surface compared with the wider 50:1 surface associated with FAR Part 77 accounts for this difference.

The difference in construction cost between an elevated west runway end (679.8 feet MSL) and a level runway at existing grades has been estimated to be $54 million dollars. The lowering of the west end to enable an essentially flat runway profile would also satisfy airline concerns over grade. The plan, as presented, anticipates approval from the FAA to allow the use of the controlling TERPS approach surface criteria and thereby allow for an essentially level runway with the attendant cost savings and operational benefits.

The following exhibits illustrate the raised runway end scenario (FAR Part 77) as well as the level runway scenario (i.e., TERPS approach surface criteria). An additional exhibit provides a comparison in grade profiles of a level versus elevated west runway end.

Exhibit II-61 illustrates the FAR Part 77 50:1 approach surface as applied to the approach end of Runway 10R. Exhibit II-61 additionally illustrates the alignment for a realigned Irving Park Road and the Union Pacific rail line. As illustrated on the exhibit, for a 50:1 FAR Part 77 surface to clear Irving Park Road with 15 feet of roadway clearance, the west end of the runway would need to be elevated to 679.8 feet MSL. Additionally, with the approach surface so established, the approach surface elevation abeam the Union Pacific rail line would just clear the track elevation plus 23 feet of height by 0.4 feet. The exhibit shows adequate room exists for the required extended RSA. Roadway and rail line relocations are additionally suitable for the spacing of the lighting standards associated with an elevated ALSF-2 lighting system.

Application of the TERPS MLS criteria for the approach end of Runway 10R is illustrated on **Exhibit II-62**. A review of Exhibit II-62 shows application of the relatively narrow 34:1 surface element versus the wider 50:1 surface associated with FAR Part 77 offers considerable benefit in the clearance of obstructions. As illustrated, with the west end of Runway 10R maintained at an existing ground level of 662.7 feet MSL, the approach surface elevation from a point abeam the Union Pacific Rail line (692.4 feet MSL) provides 3.4 feet of clearance over the rail line elevation plus 23 feet of train height (689.0 feet MSL). Irving Park Road, however, would need to be lowered 4 feet below existing grade within the area to accommodate the 34:1 surface elevation and the required 15 feet of vehicle height. Given the expected cost differential between raising the runway end 4 feet and depressing the roadway an equal amount, the choice was to depress the roadway.

Exhibit II-63 provides a comparison of the grade profile of an essentially level runway with a Runway 10R end elevated to 679.8 feet MSL. To minimize the amount of fill required for the raised runway condition, the grades for the parallel taxiway at the physical west end of the runway are 1.5 percent below that of the runway.

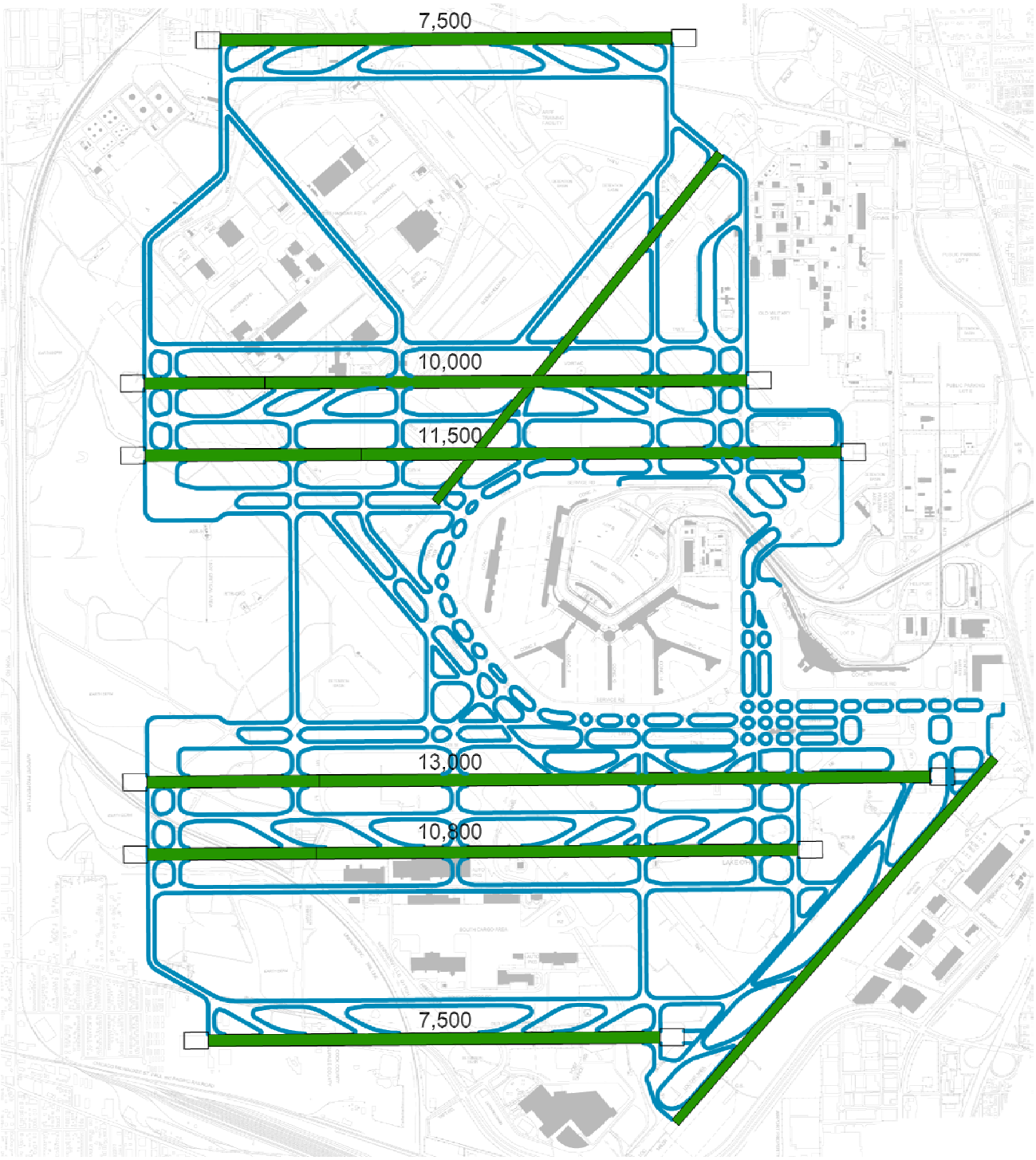
2.6 Airport Traffic Control Tower (ATCT)

The Airport Layout Plan incorporates two new Airport Traffic Control Towers as part of the revised airfield. The north airfield tower is located within the Northwest Maintenance Area and is envisioned to supplement controller line-of-sight, especially regarding controller vision to Runway 9L-27R and its parallel taxiway. Similarly, a new south ATCT is proposed within the Southwest Cargo Area to supplement controller vision to Runway 10R-28L and its parallel taxiway. The need for two new tower locations was brought about by line-of-sight analyses conducted in reference to the existing ATCT. **Exhibit II-64** illustrates the shadowing impact reference the north airfield. As shown on the exhibit, the existing United Airlines Service Center as well as the American Airlines Hangar substantially block controller vision of the west quarter of Runway 9L-27R and its parallel taxiway.

Active discussions are continuing with the FAA regarding the location and height of these new control towers.

EXHIBITS

SECTION II



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

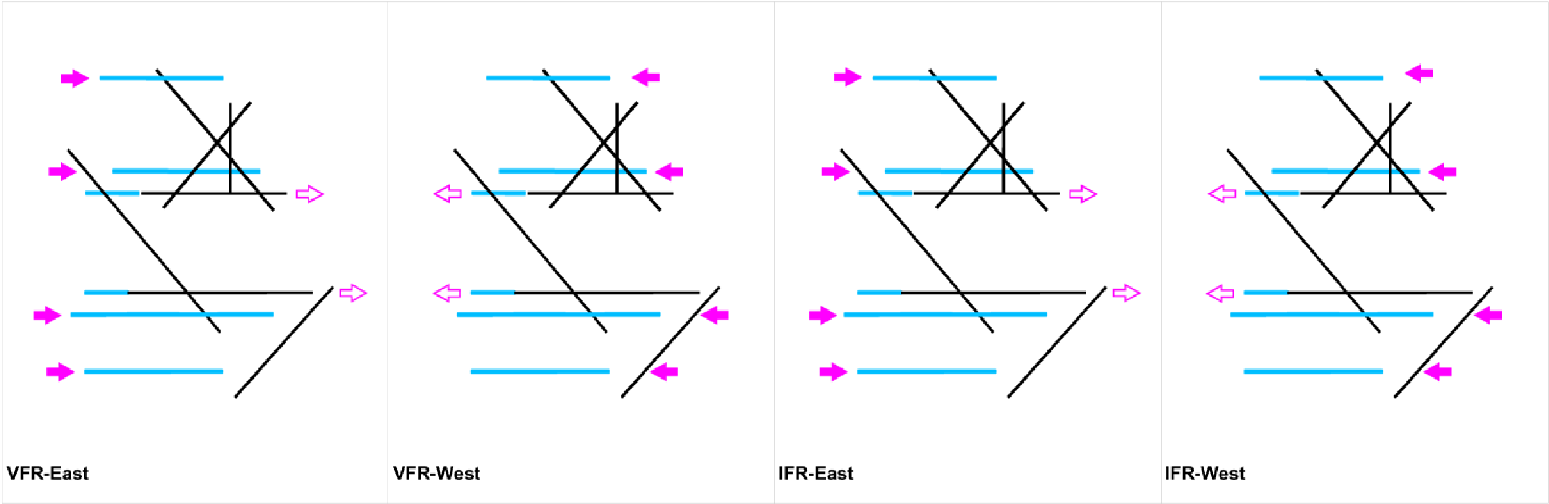
Exhibit II-1

0 N.T.S.

north

Base Concept Layout

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-01.dwg_Layout: 8.5x11_Feb 26, 2003, 4:45pm



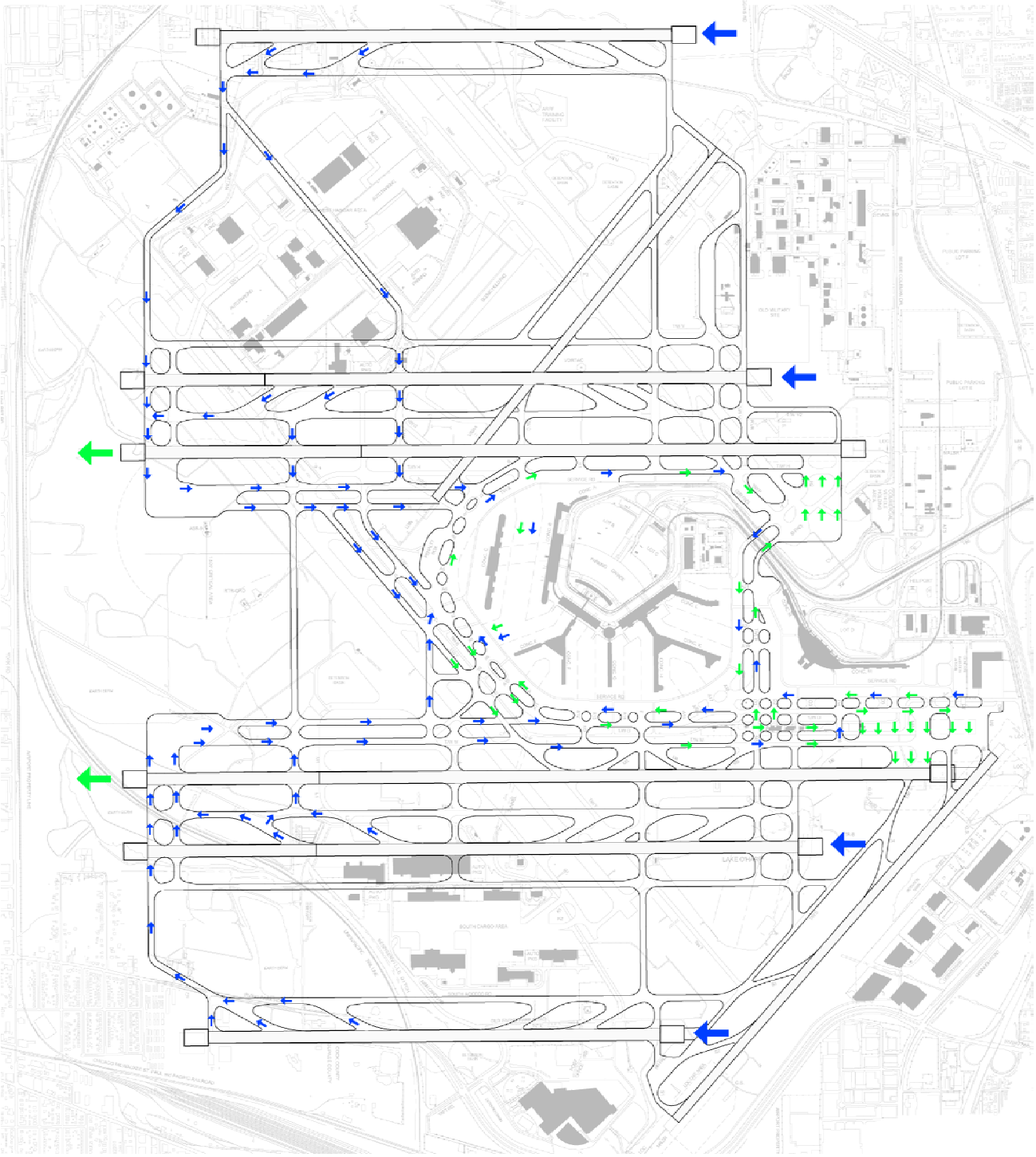
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-2

0 Not To Scale north

Runway Operating Configurations

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-02.dwg_Layout: 8.5x11_Feb 26, 2003, 4:43pm



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

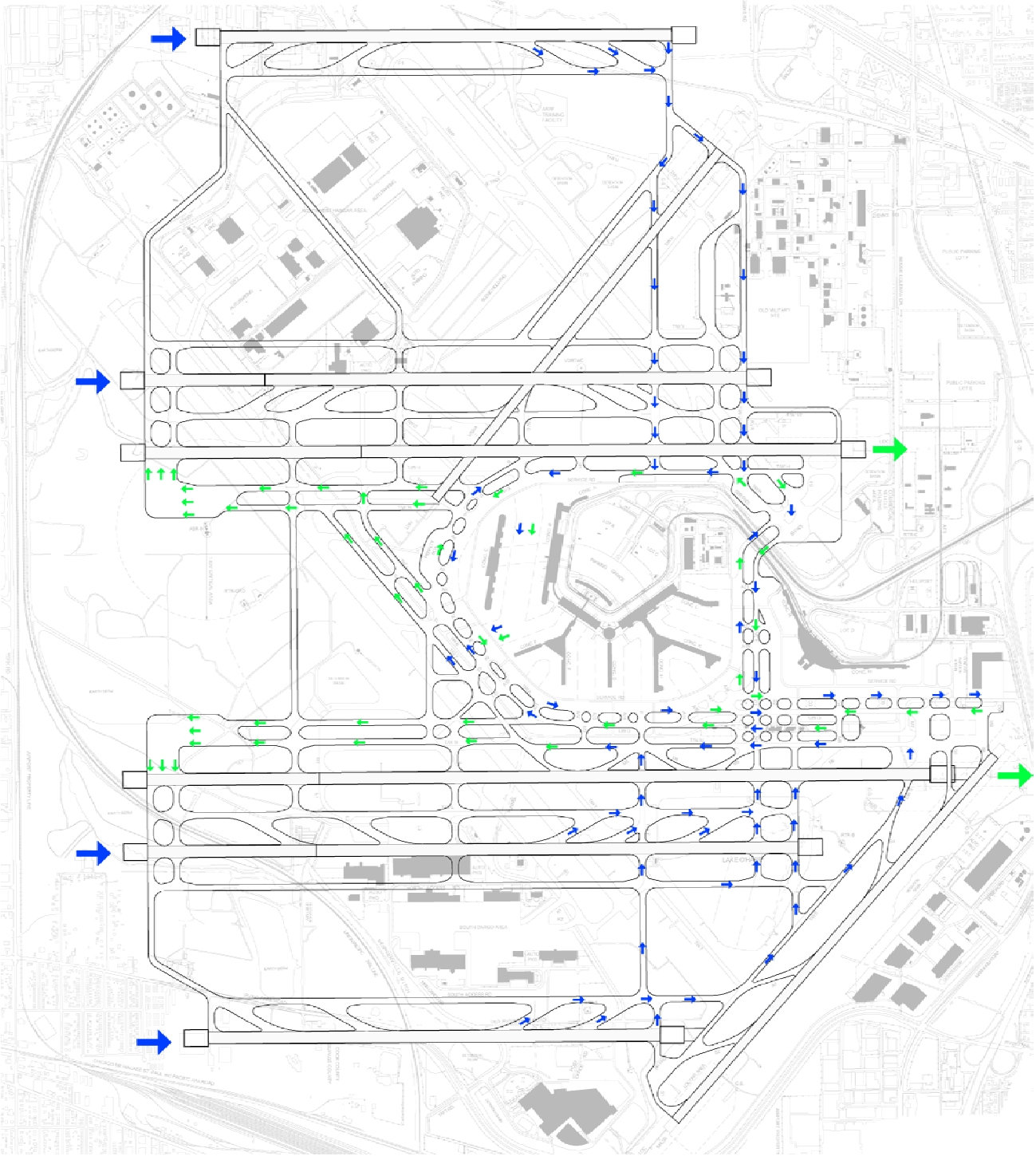
Exhibit II-3

0 N.T.S.

north

Possible Taxiway Flows
West Flow

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-03.dwg_Layout: 8.5x11_Feb 26, 2003, 4:51pm



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

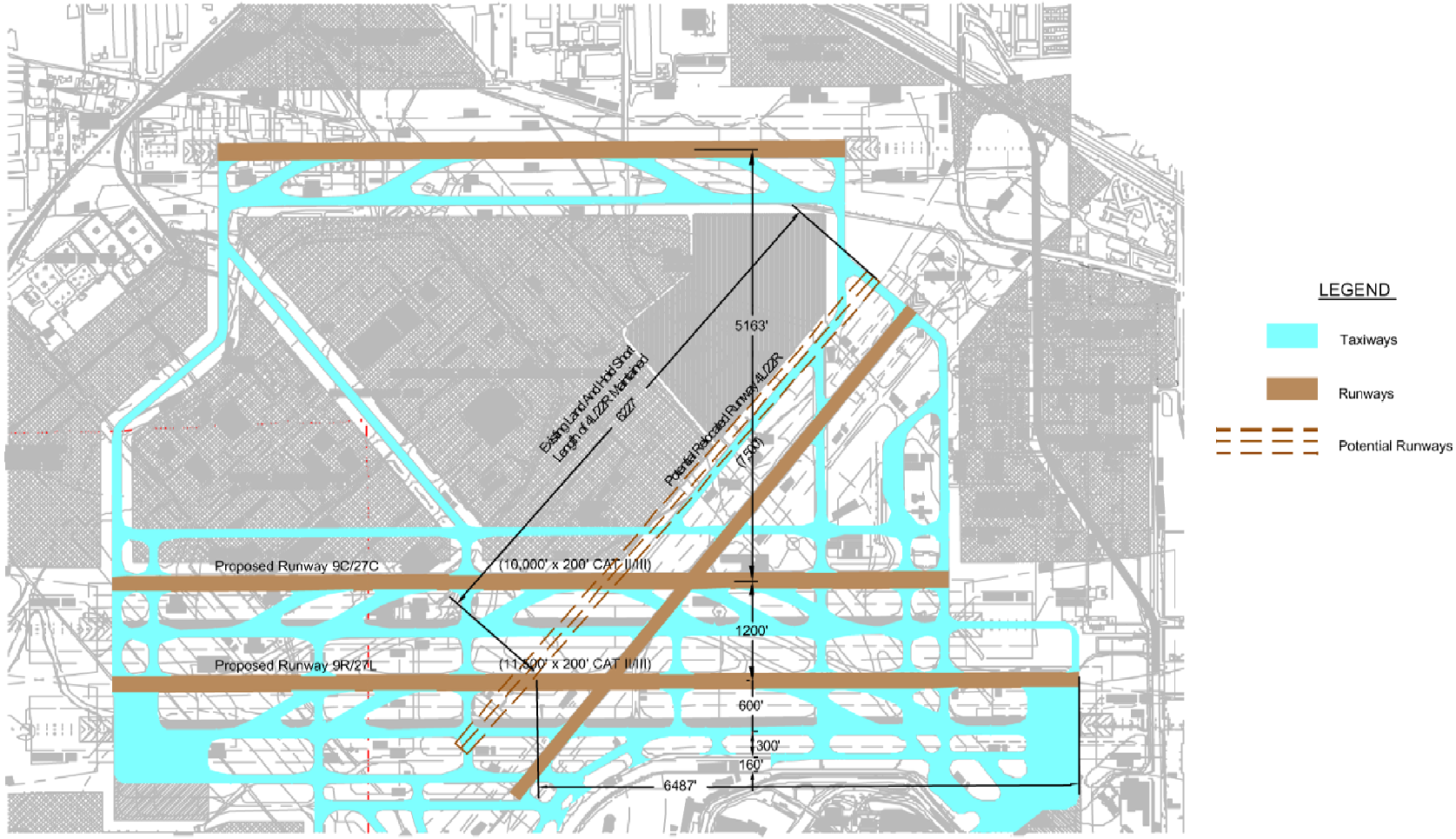
Exhibit II-4

0 N.T.S.

north

Possible Taxiway Flows
East Flow

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-04.dwg_Layout: 8.5x11_Feb 26, 2003, 4:49pm



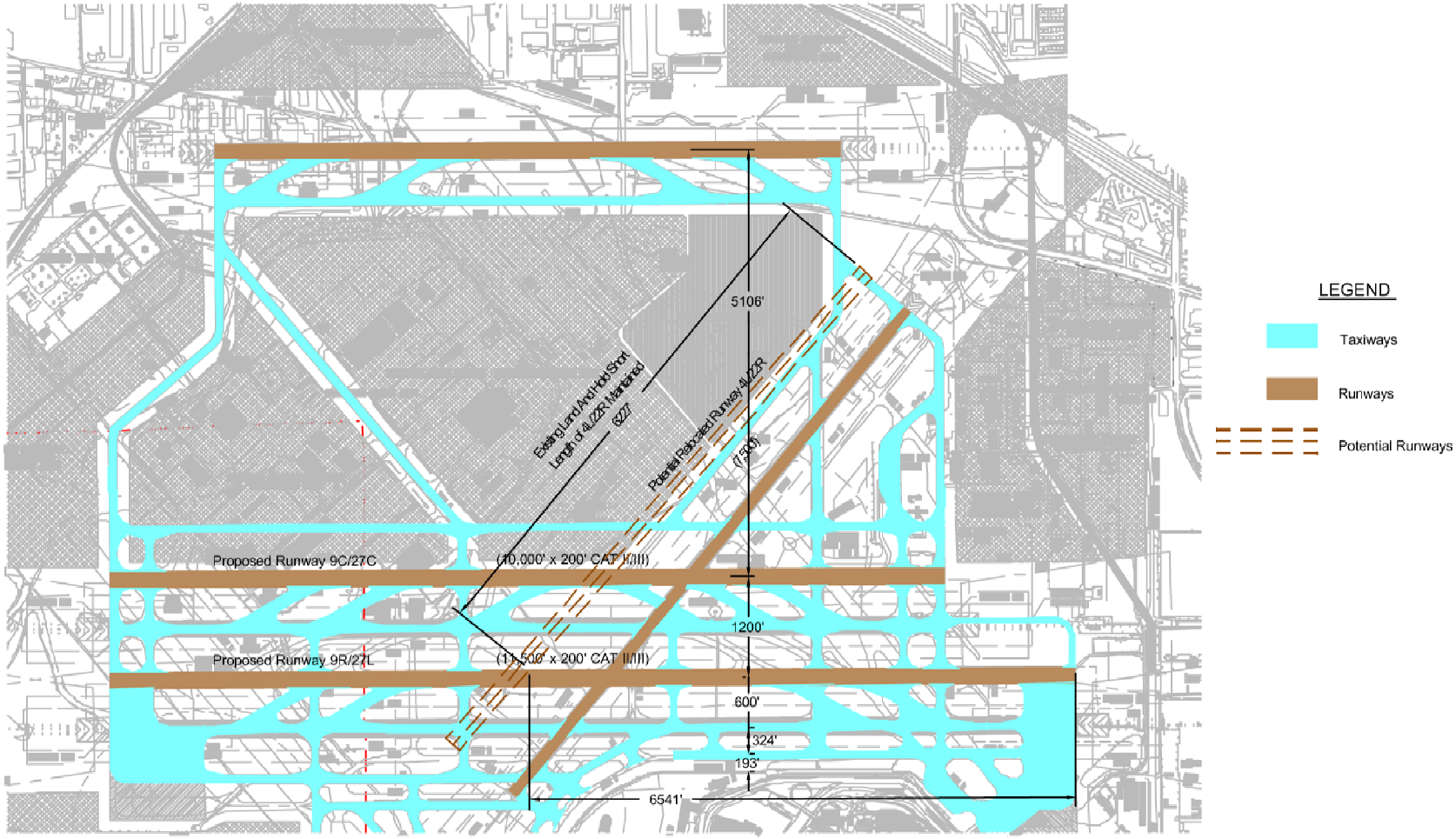
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-5

0 2000
north

Dual Terminal Area Taxiways Group V and Group VI

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-05.dwg_Layout: 8.5x11_Feb 26, 2003, 4:56pm



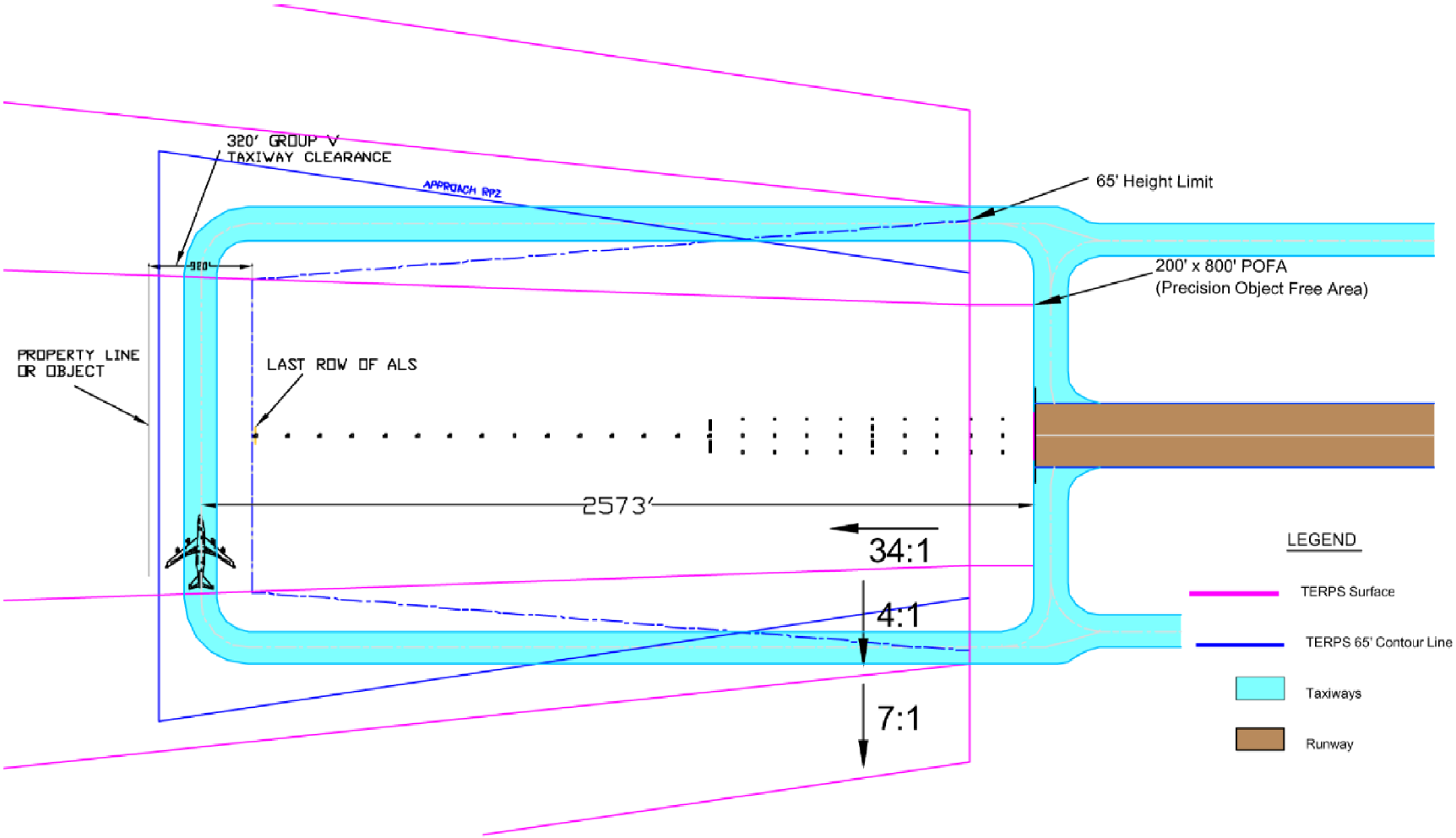
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-6

0 2000 north

Dual Terminal Area Taxiways Both Group VI

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-06.dwg_Layout: 8.5x11_Feb 26, 2003, 4:53pm



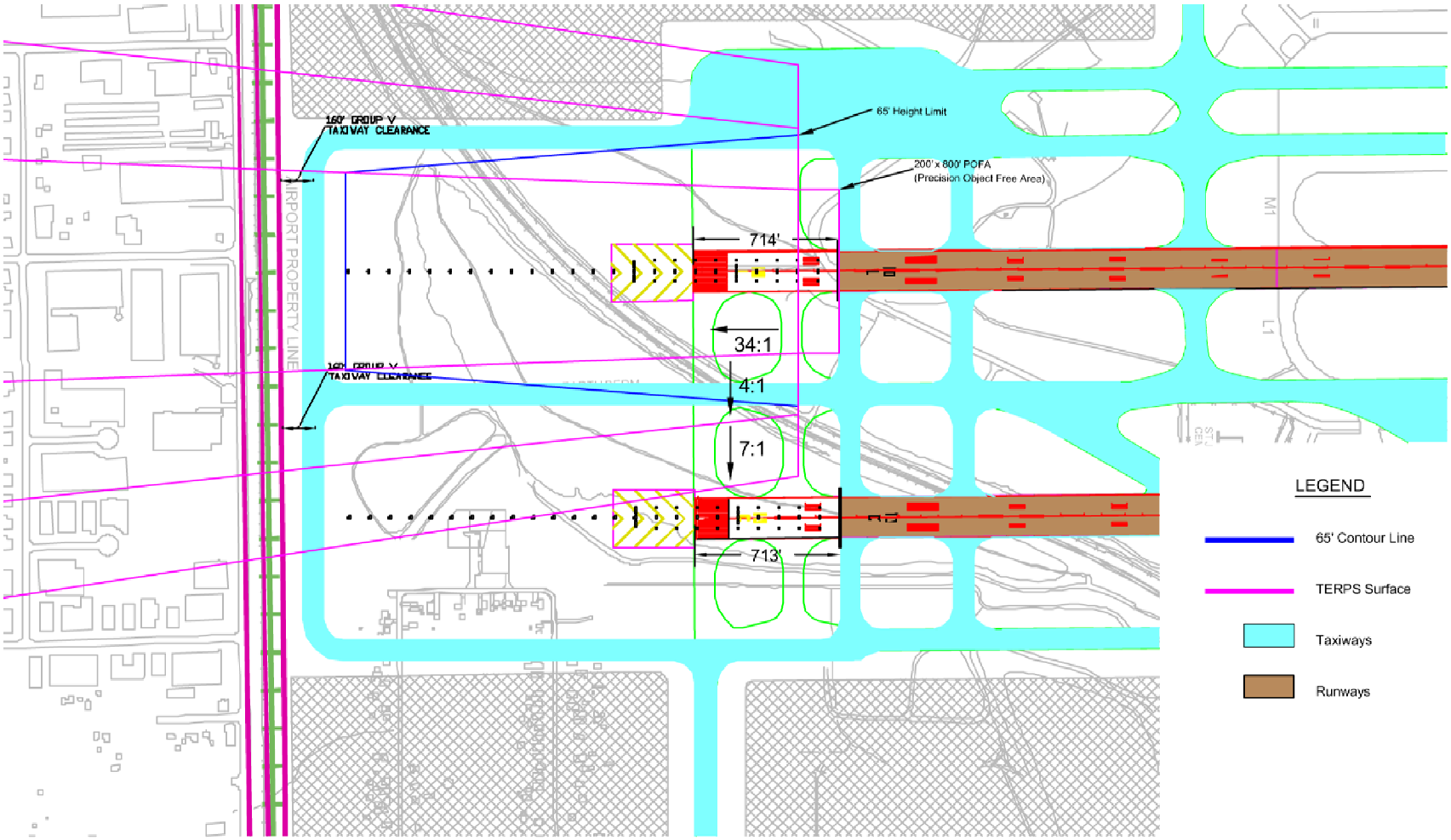
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-7

0 500 north

Perimeter Taxiway
Proposed Planning Criteria

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-07.dwg_Layout: 8.5x11_Feb 26, 2003, 4:59pm



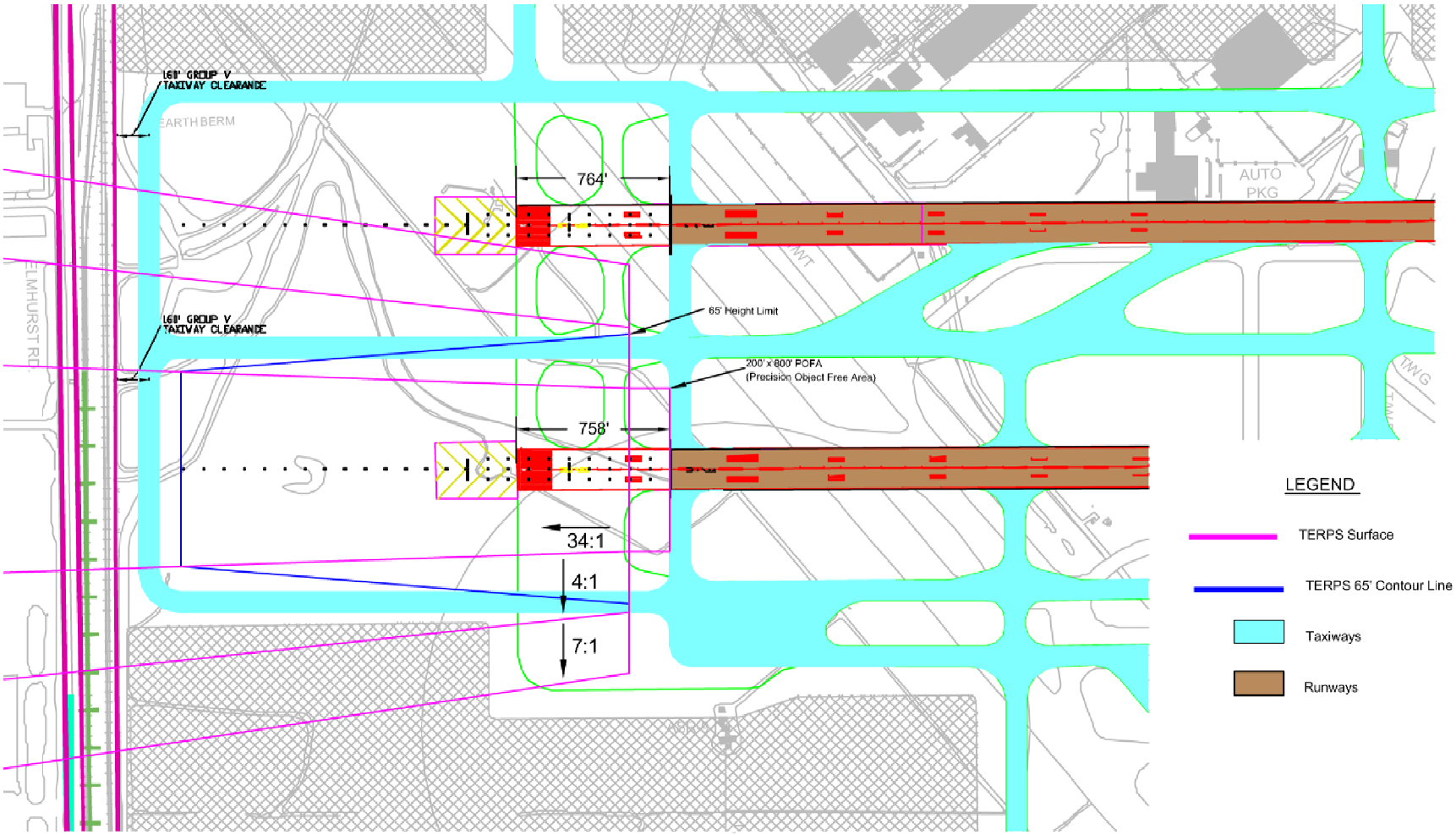
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-11

0 800
north

Perimeter Taxiway Assessment
Approach End Runways 10L & 10C

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-11.dwg_Layout: 8.5x11_Feb 26, 2003, 7:13pm



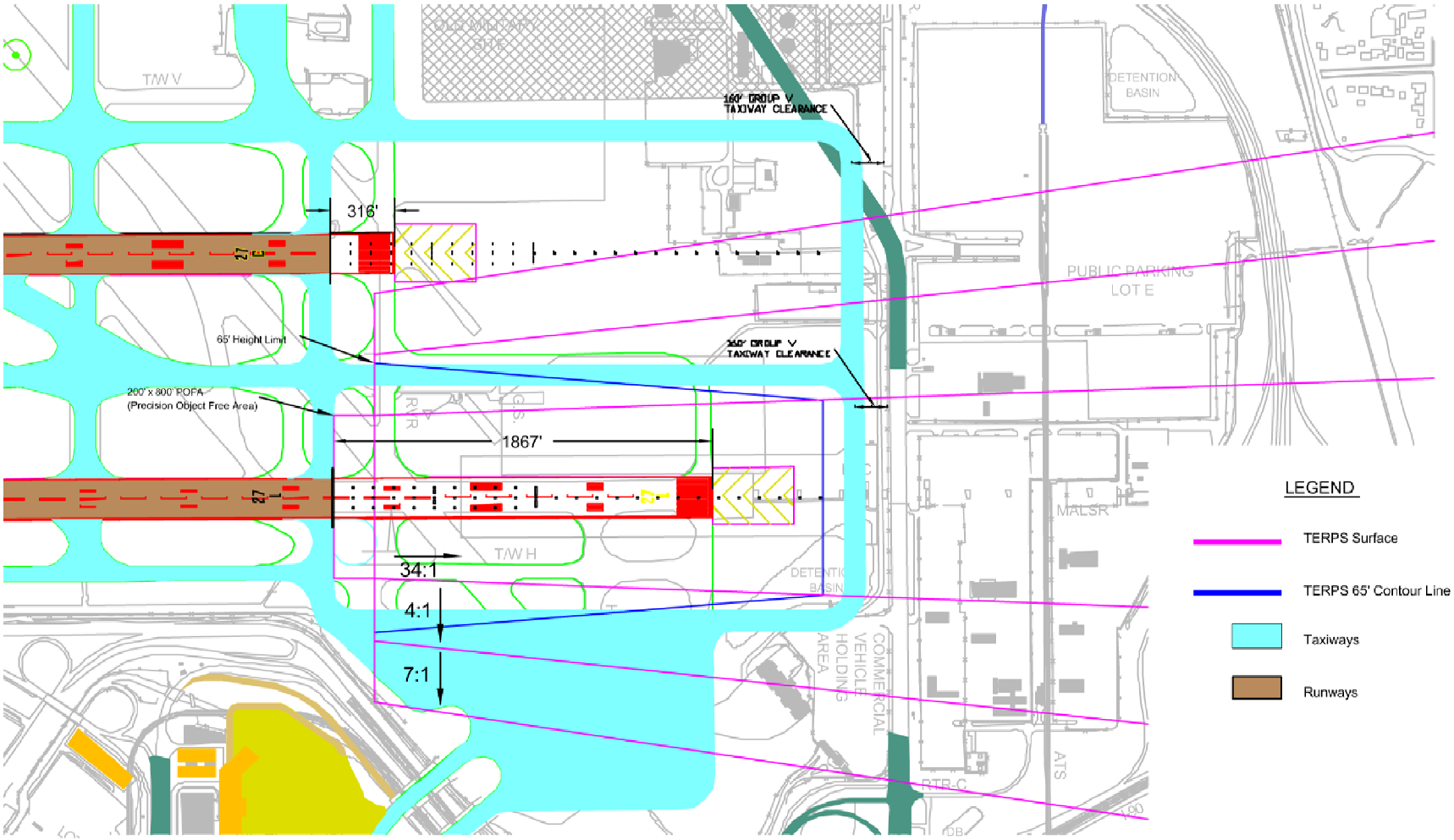
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-8

0 800
north

Perimeter Taxiway Assessment
Approach End Runways 9R & 9C

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-08.dwg_Layout: 8.5x11_Feb 27, 2003, 9:49am



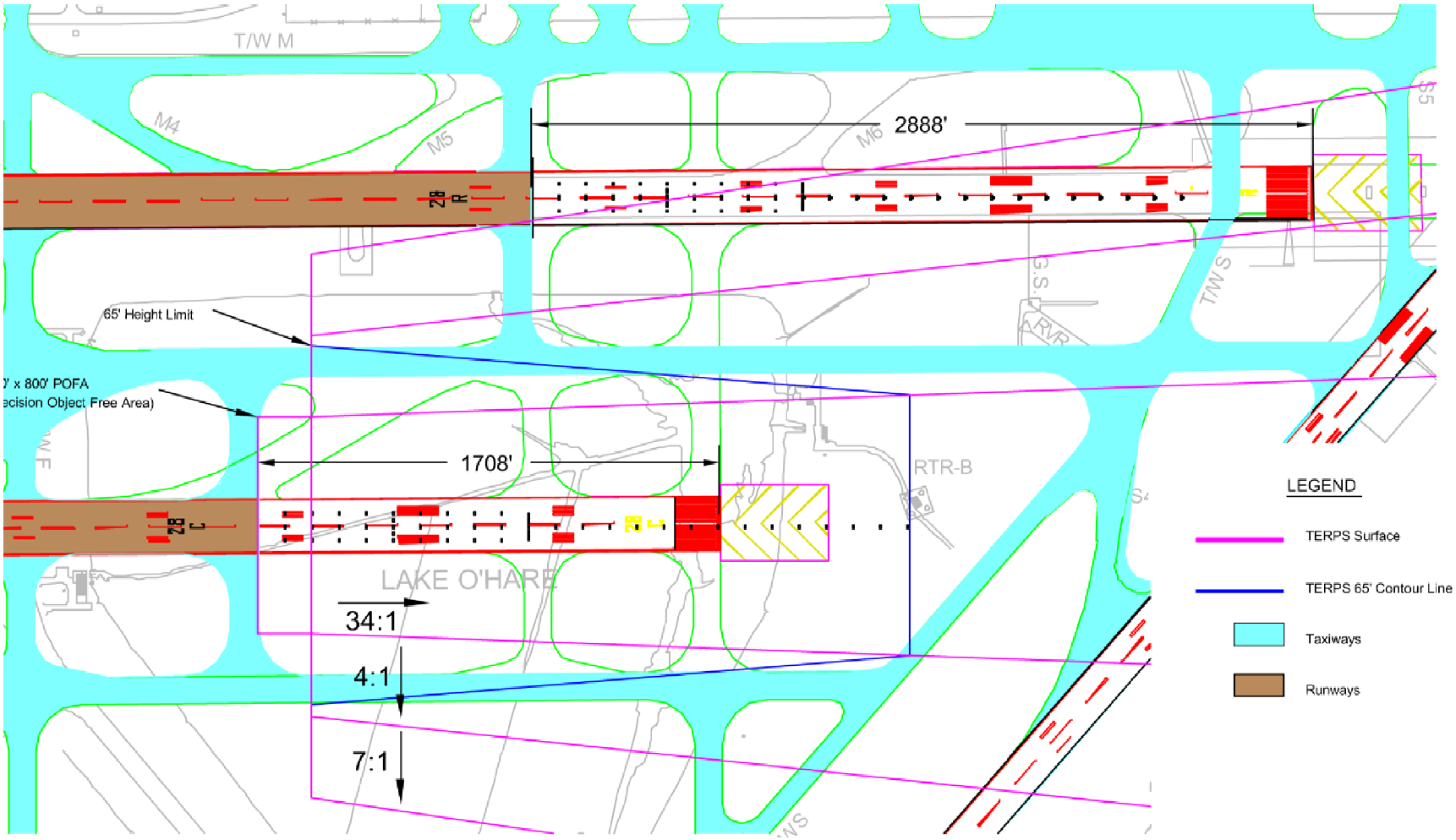
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-9

0 800 north

Perimeter Taxiway Assessment
Approach End Runways 27L & 27C (Alt - A)

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-09.dwg_Layout: 8.5x11_Feb 26, 2003, 5:13pm



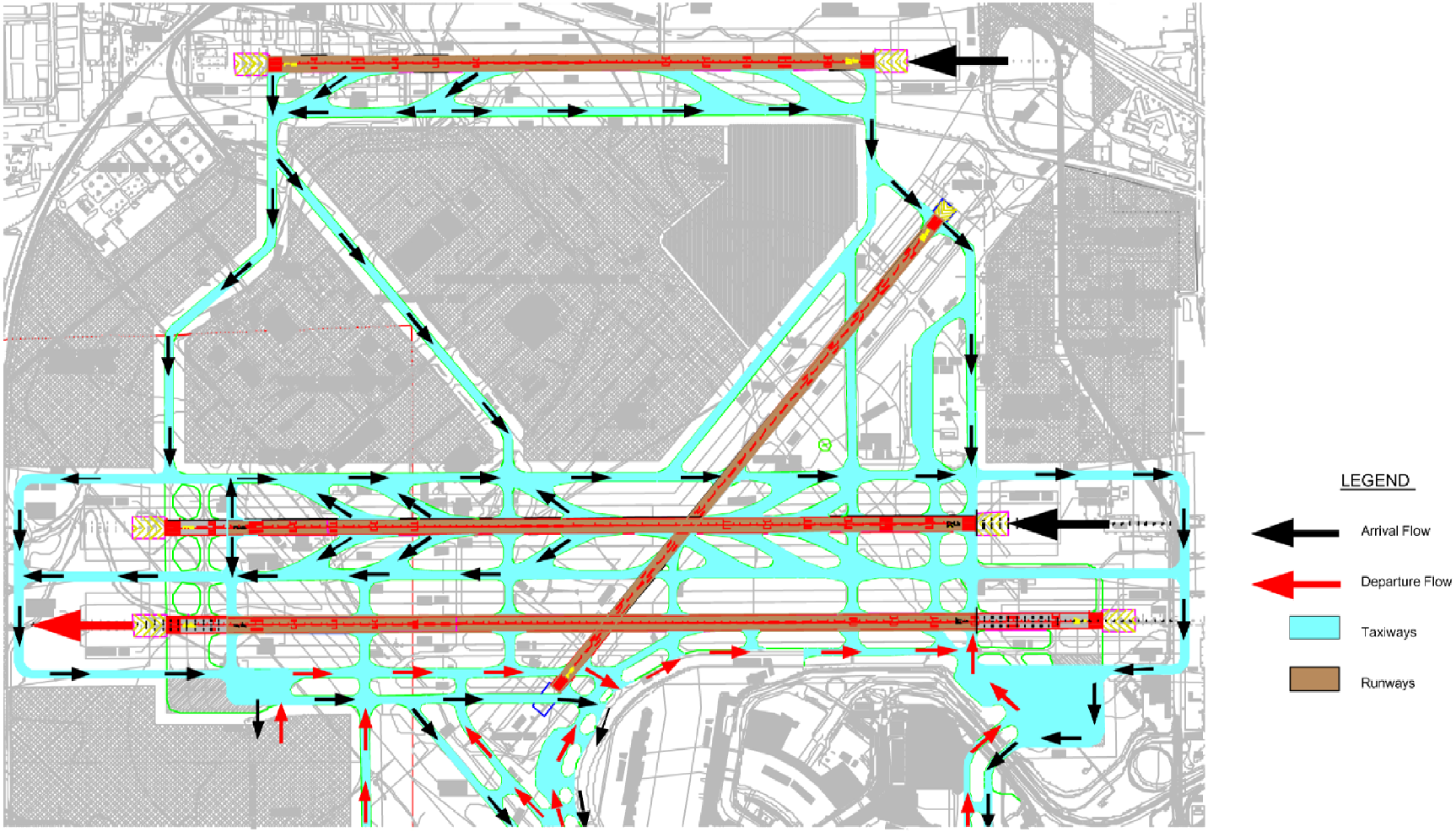
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-12

0 600 north

Perimeter Taxiway Assessment
Approach End Runways 28R & 28C

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-12.dwg_Layout: 8.5x11_Feb 27, 2003, 9:44am



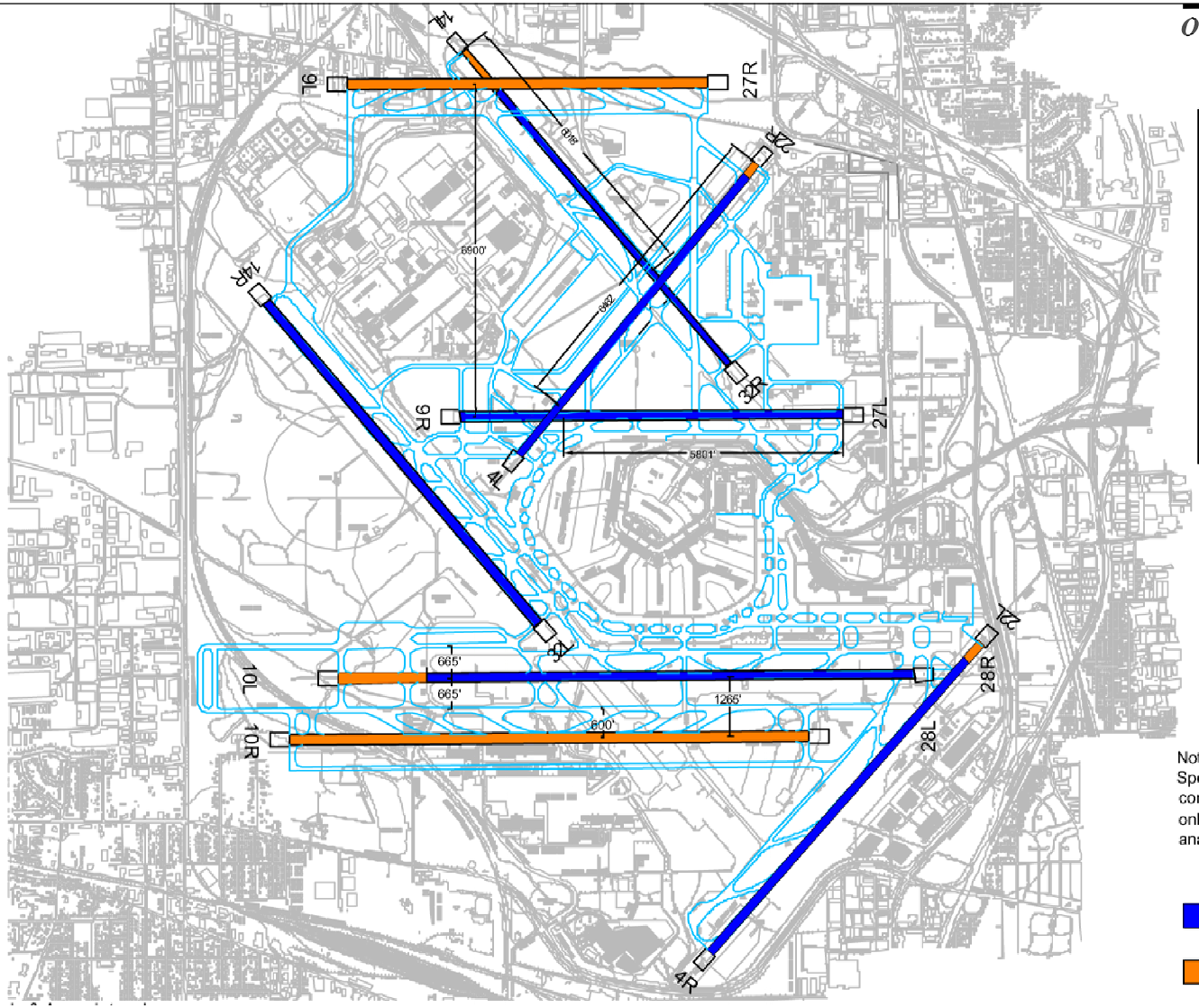
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-13

0 2000 north

Perimeter Taxiway Assessment
North Airfield Taxi Flows (West Flow)

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-13.dwg_Layout: 8.5x11_Feb 26, 2003, 7:11pm



RWY Name	Approx. Lengths
4L-22R	7800'
4R-22L	8506'
9L-27R	7500'
9R-27L	7967'
10L-28R	12000'
10R-28L	10800'
14R-32L	8750'
14L-32R	8550'

Note:
Specific elements included in this layout concept are shown for illustration purposes only. Further obstruction and operational analyses are necessary.

LEGEND

Existing Runways

New or Relocated Runways

Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

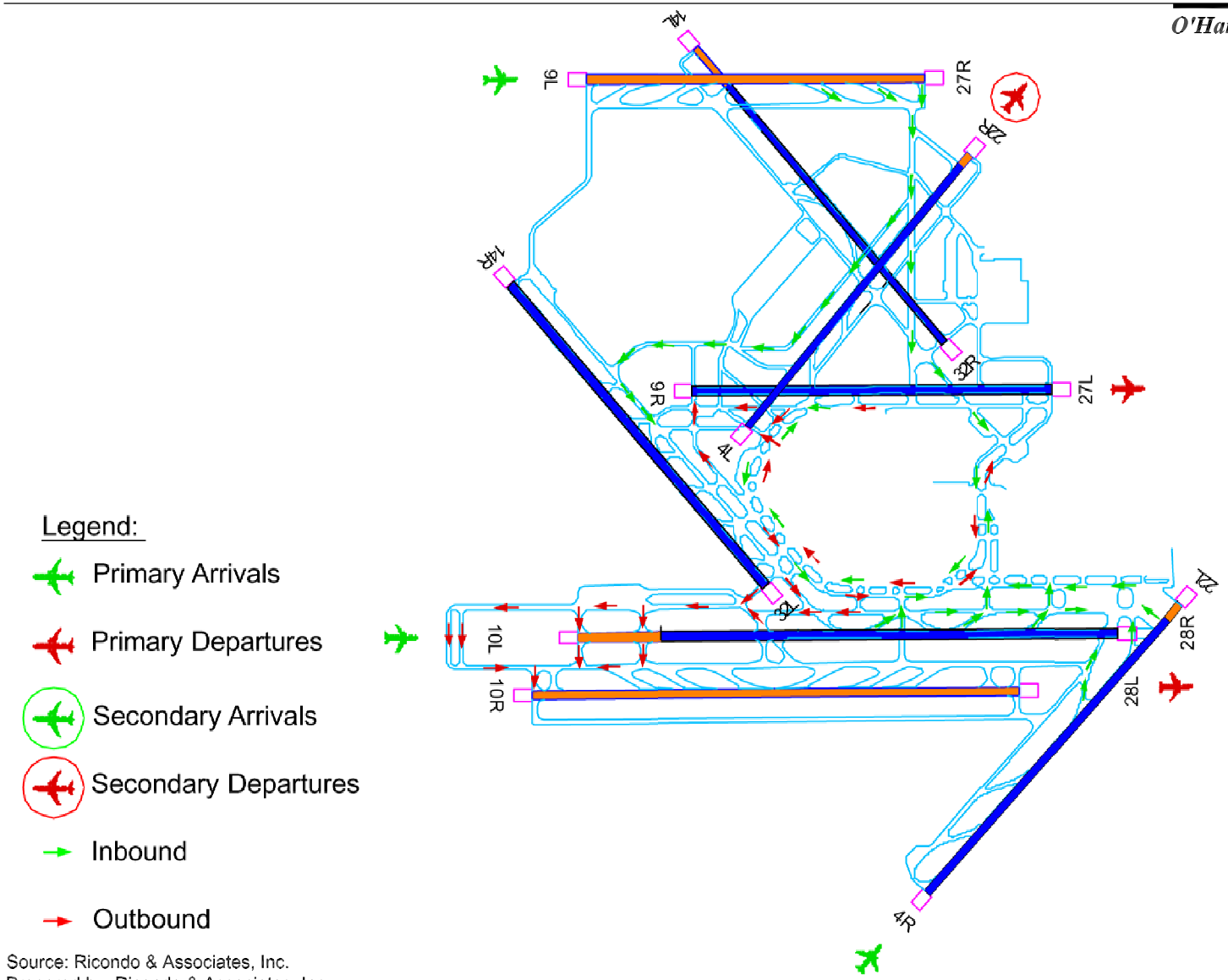
Exhibit II-14

0 3600

north

Layout Option 1

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-14.dwg_Layout: 8.5x11_Feb 27, 2003, 9:37am



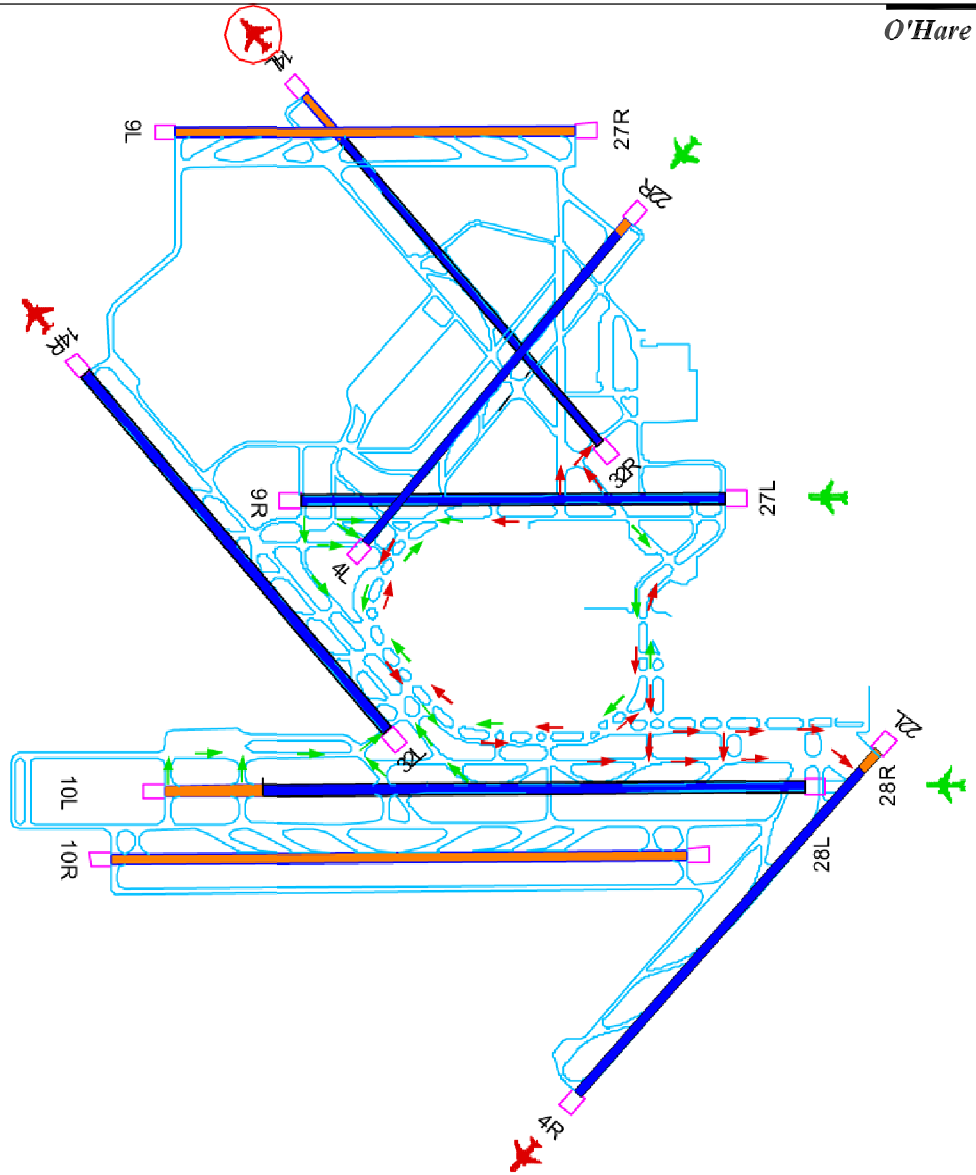
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-16

0 3600 north

Possible Operating Configuration
Layout Option 1 - VFR - East Flow

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-16.dwg_Layout: 8.5x11_Feb 27, 2003, 9:33am



Legend:

- Primary Arrivals
- Primary Departures
- Secondary Arrivals
- Secondary Departures
- Inbound
- Outbound

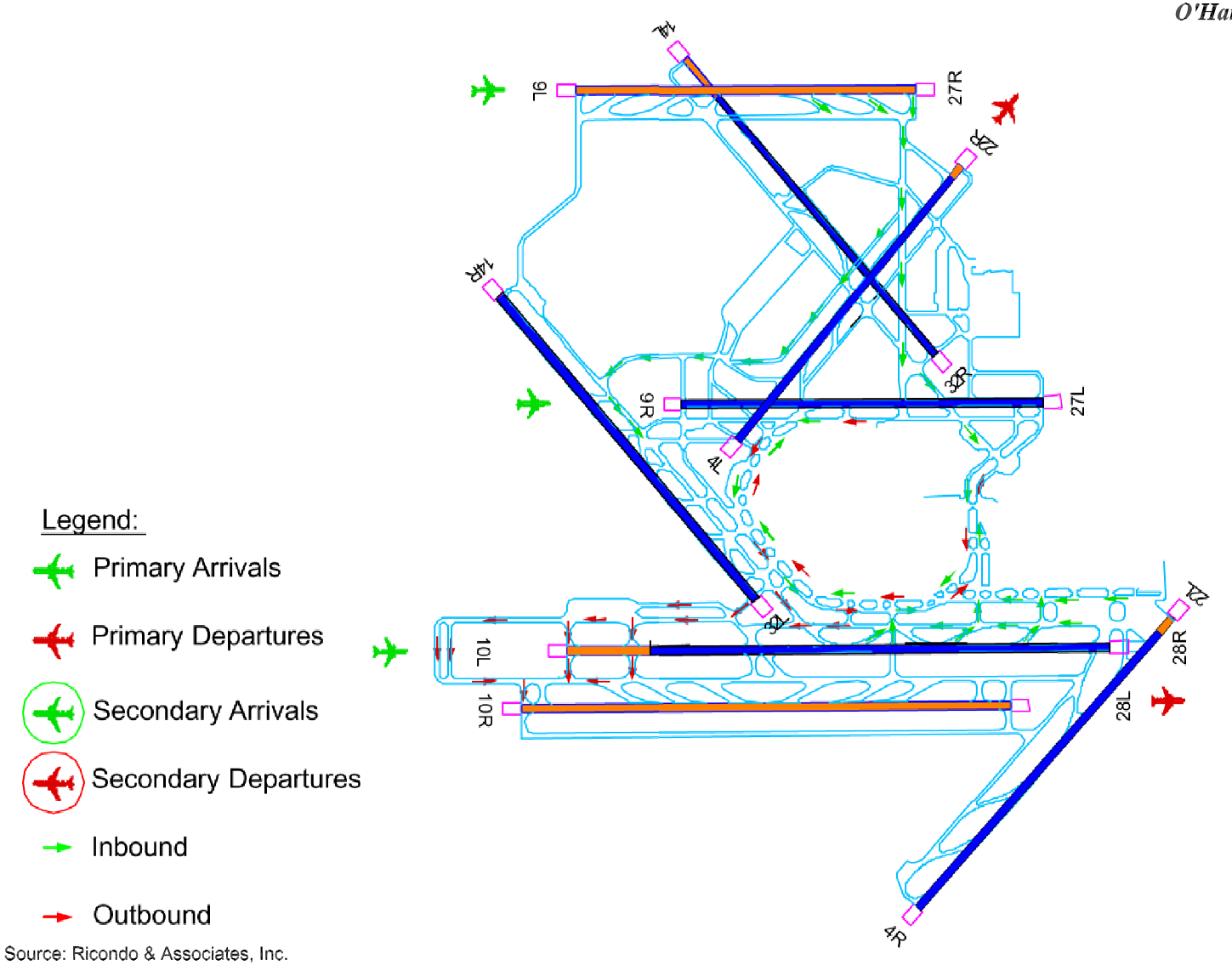
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-17

0 3600 north

Possible Operating Configuration
Layout Option 1 - VFR - West Flow

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-17.dwg_Layout: 8.5x11_Feb 26, 2003, 7:07pm



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-18

0 3600 north

Possible Operating Configuration
Layout Option 1 - IFR - East Flow

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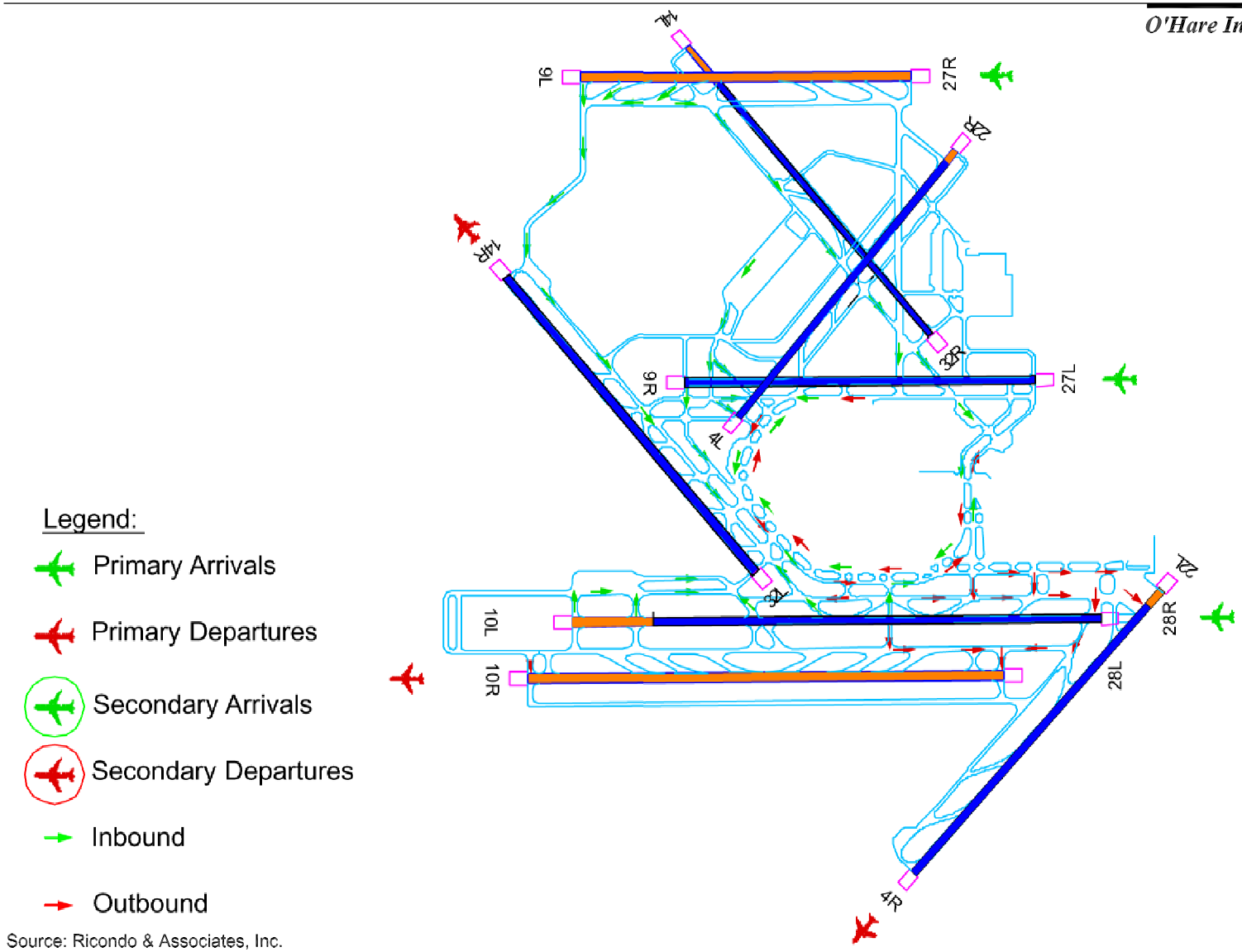

Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-19

0 3600 north

Possible Operating Configuration
Layout Option 1 - IFR - West Flow

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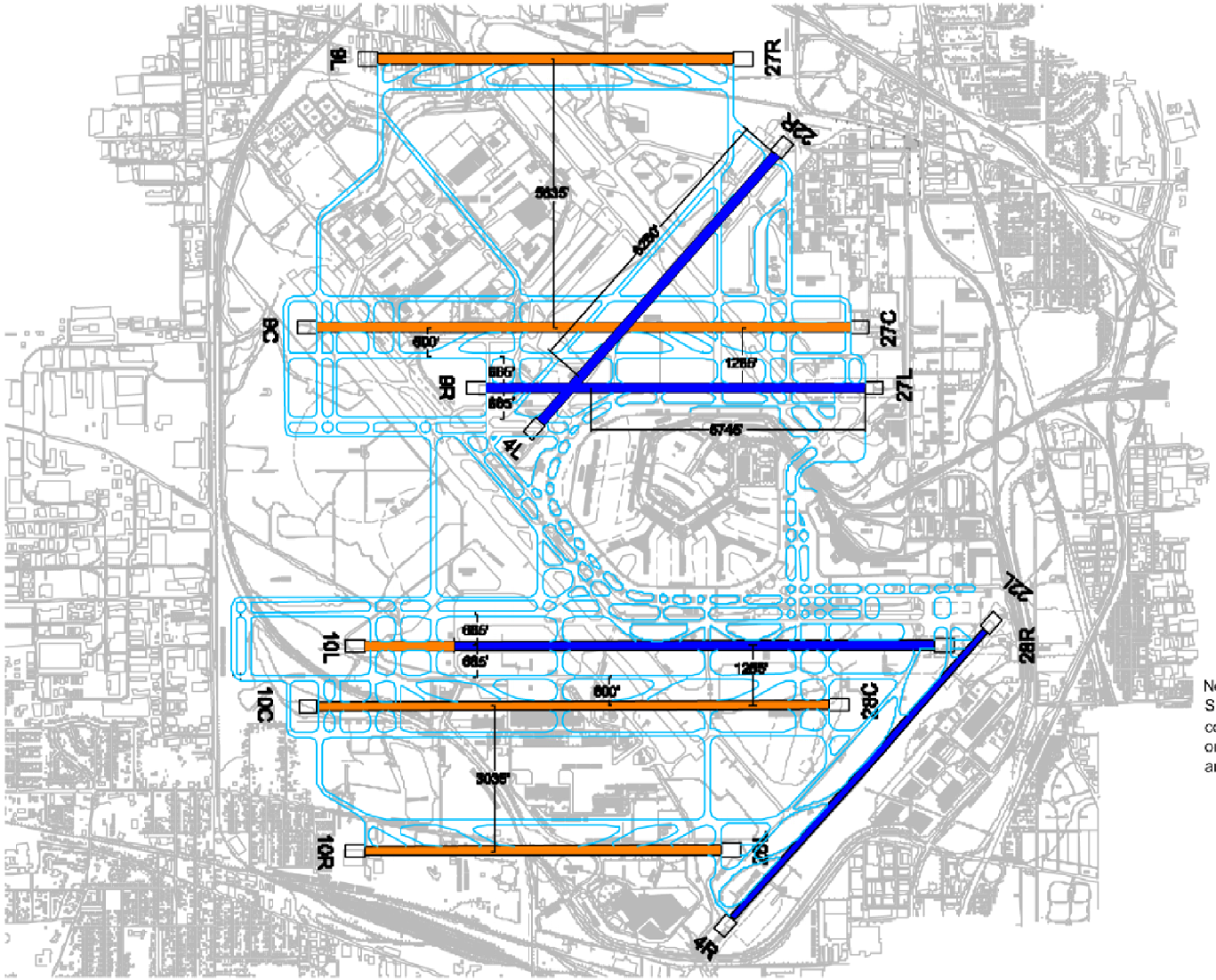


RWY Name	Approx. Lengths
4L-22R	7500'
4R-22L	8071'
9L-27R	7500'
9C-27C	11237'
9R-27L	7967'
10L-28R	12000'
10C-28C	10800'
10R-28L	7500'

Note:
Specific elements included in this layout concept are shown for illustration purposes only. Further obstruction and operational analyses are necessary.

LEGEND

Existing Runways

New or Relocated Runways

Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

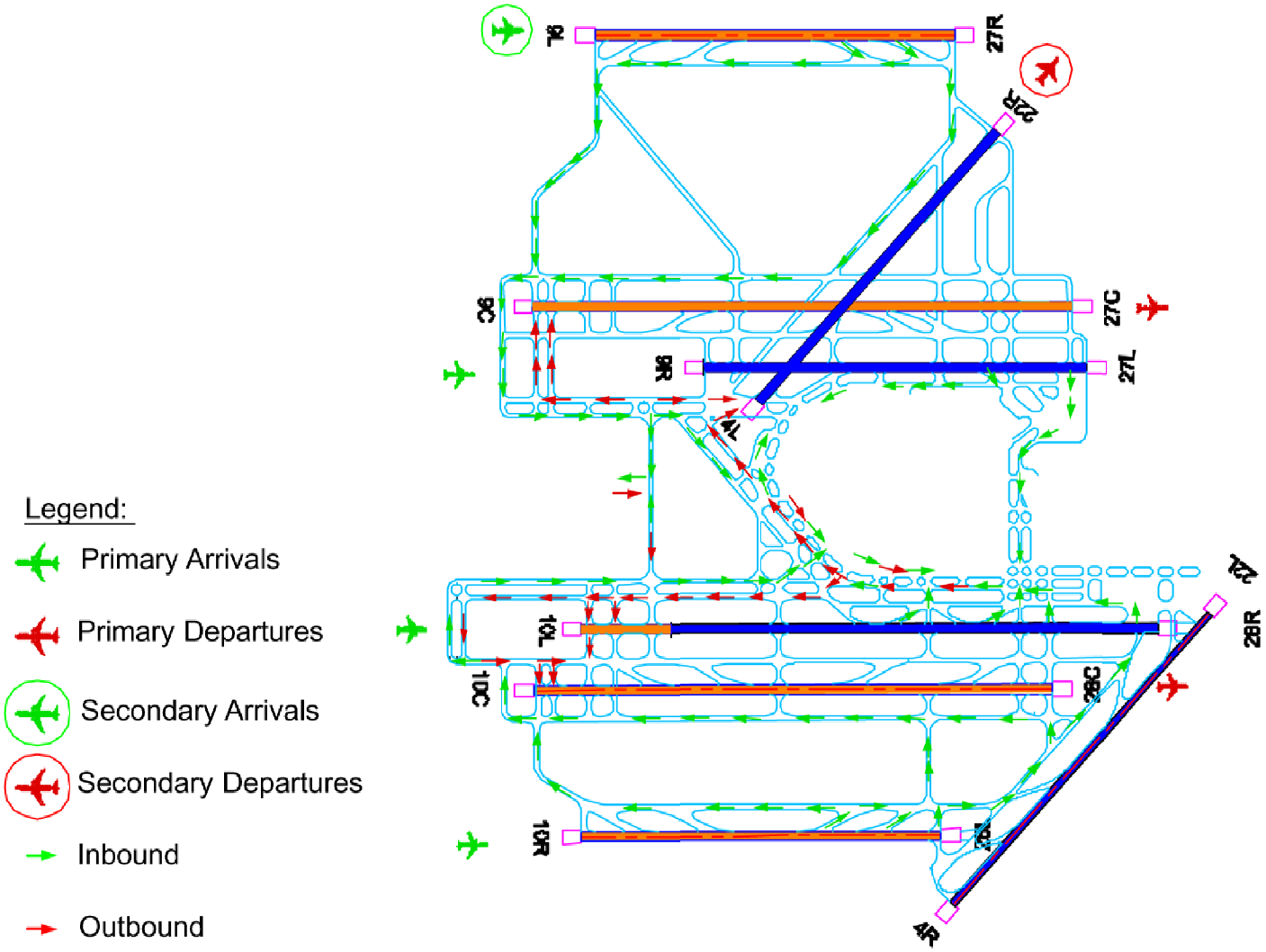
Exhibit II-20

0 3600

north

Layout Option 2

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-20.dwg_Layout: 8.5x11_Feb 27, 2003, 9:28am



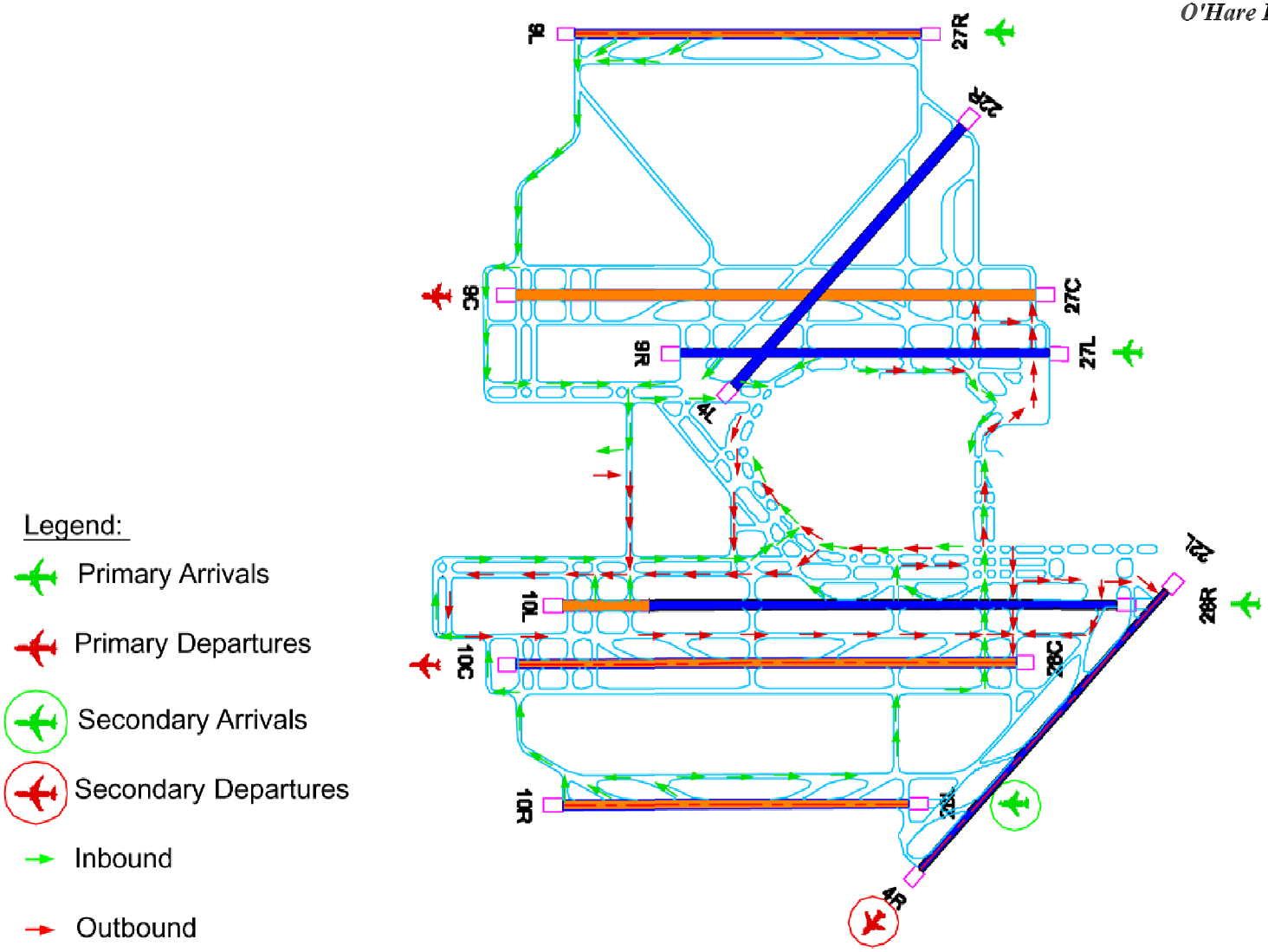
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-21

0 3600 north

Possible Operating Configuration
Layout Option 2 - VFR - East Flow

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-21.dwg_Layout: 8.5x11_Feb 26, 2003, 7:01pm

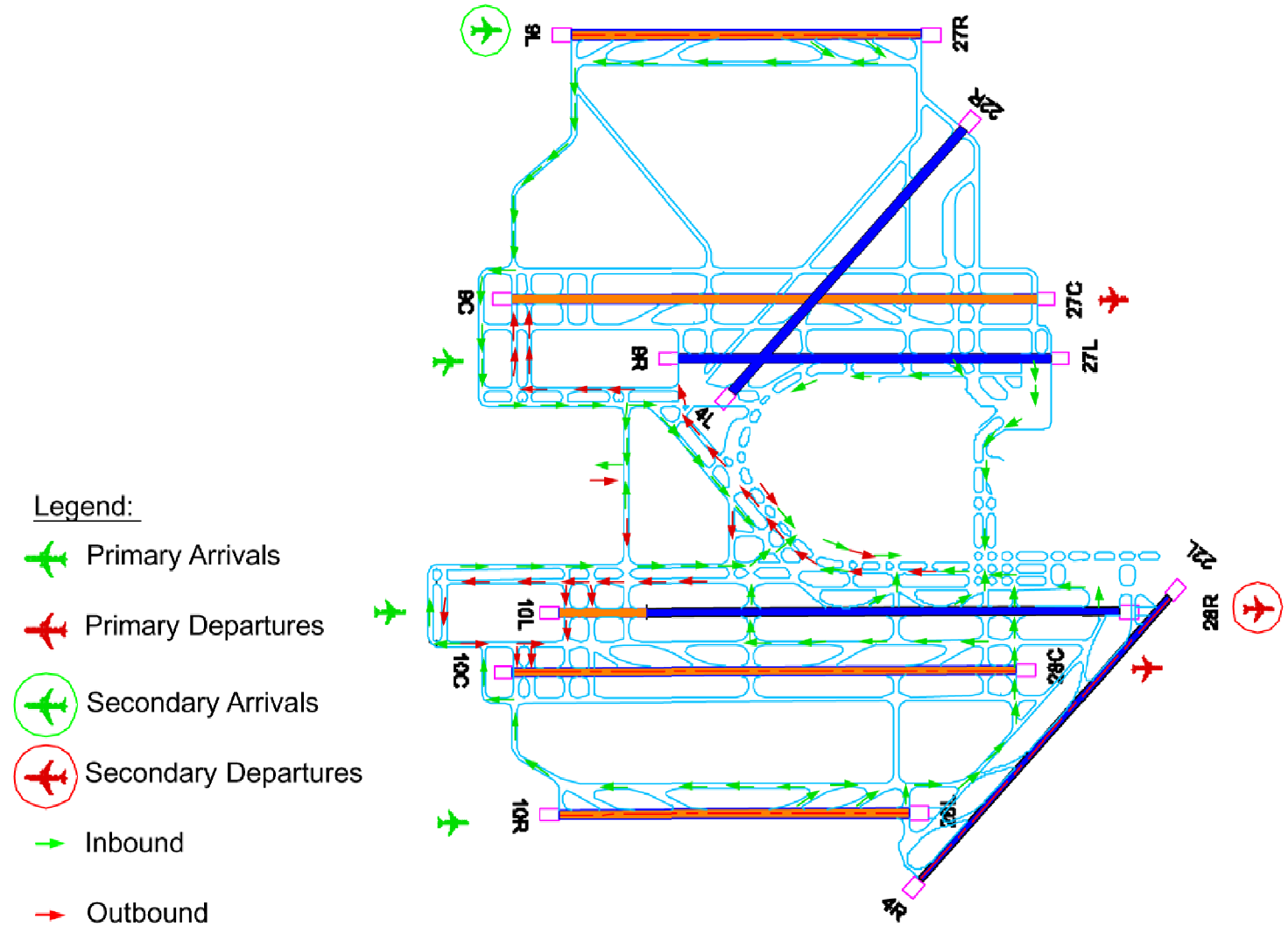


Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-22

Possible Operating Configuration Layout Option 2 - VFR - West Flow

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-22.dwg_Layout: 8.5x11_Feb 27, 2003, 9:19am



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-23

0 3600 north

Possible Operating Configuration Layout Option 2 - IFR - East Flow

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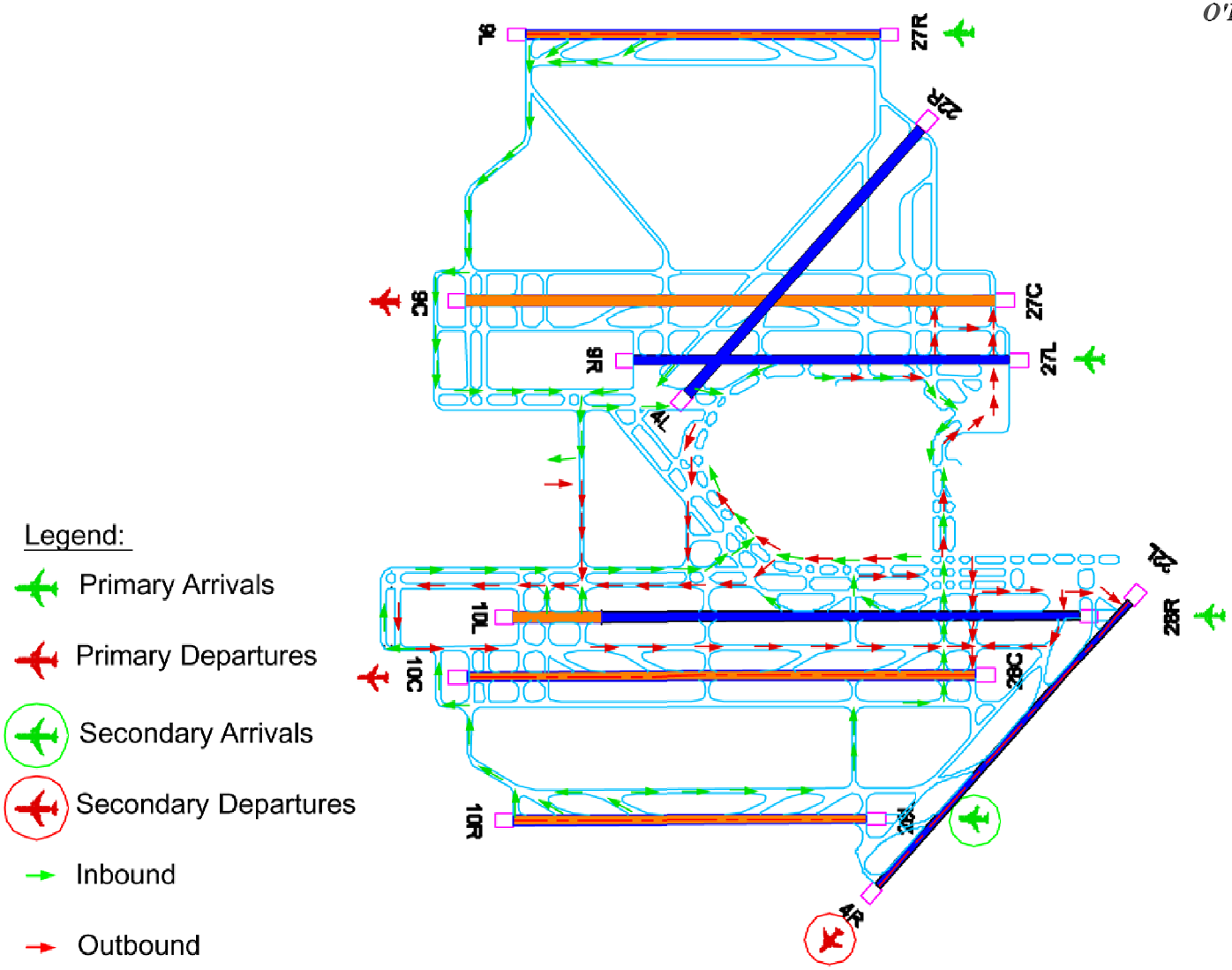


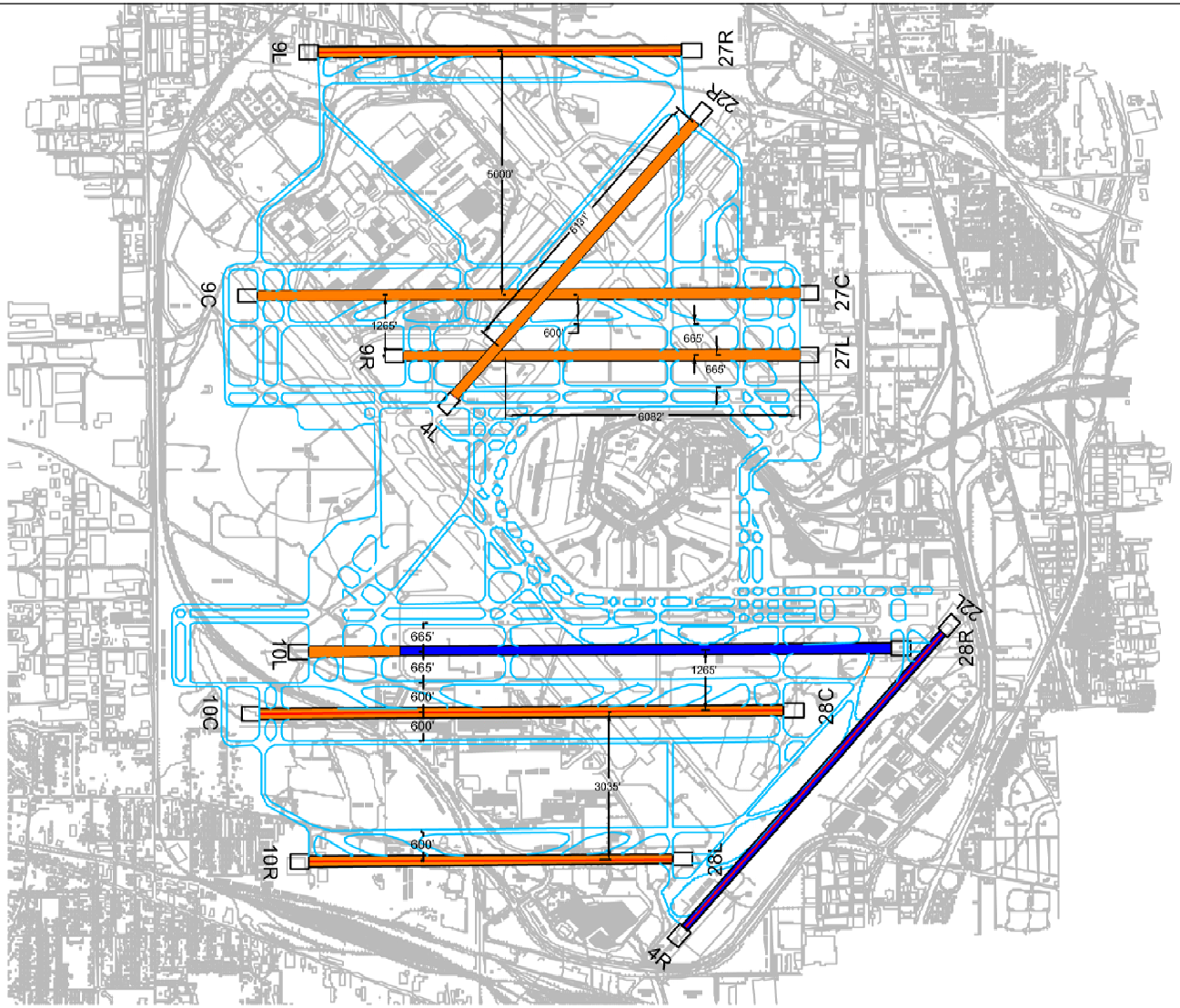
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-24

0 3600 north

Possible Operating Configuration Layout Option 2 - IFR - West Flow

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-24.dwg_Layout: 8.5x11_Feb 27, 2003, 9:15am



RWY Name	Approx. Lengths
4L-22R	7500'
4R-22L	8071'
9L-27R	7500'
9C-27C	11160'
9R-27L	8146'
10L-28R	12000'
10C-28C	10800'
10R-28L	7500'

Note:
Specific elements included in this layout concept are shown for illustration purposes only. Further obstruction and operational analyses are necessary.

LEGEND

Existing Runways

New or Relocated Runways

Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

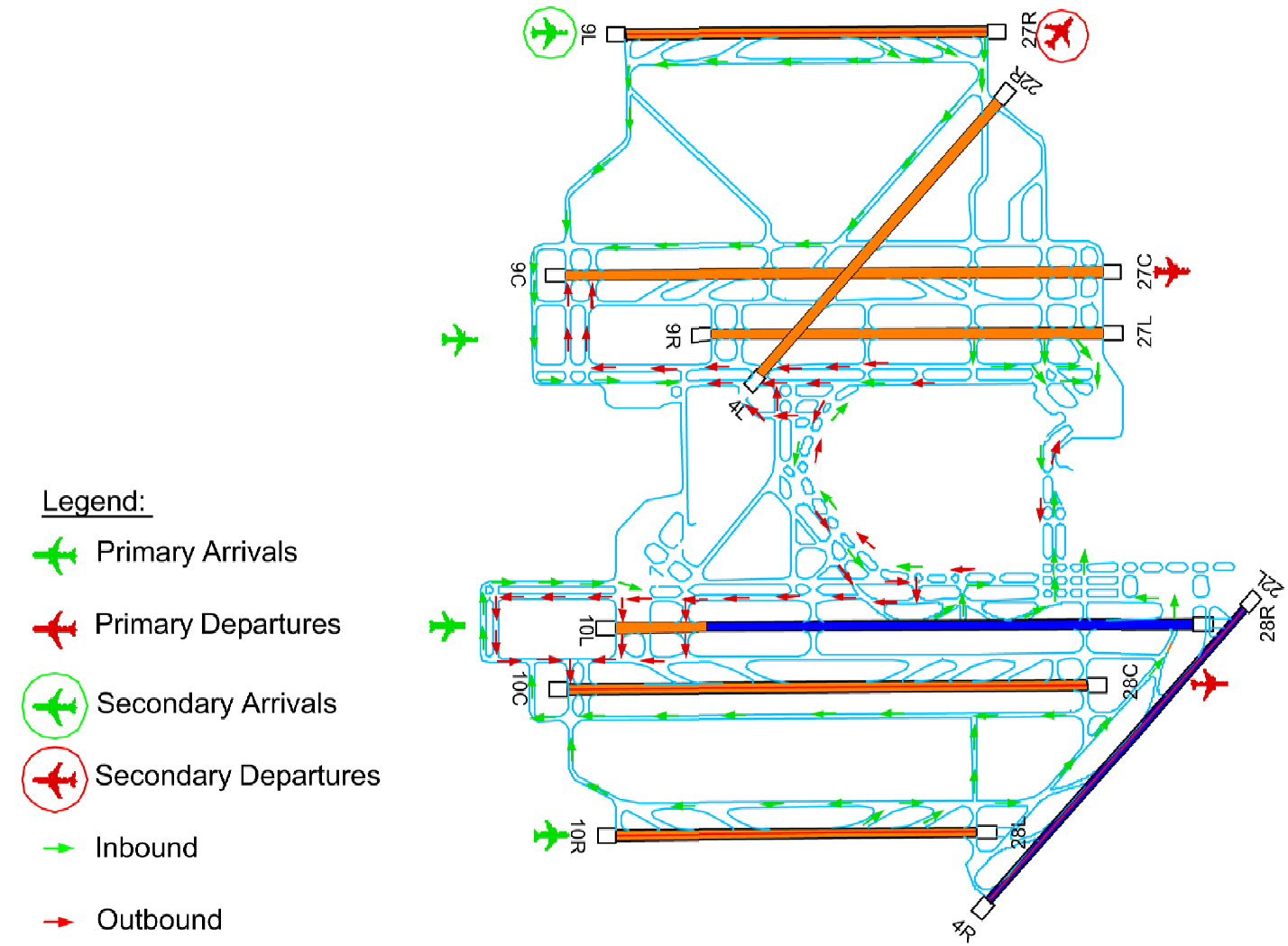
Exhibit II-25

0 3600

north

Layout Option 3

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-25.dwg_Layout: 8.5x11_Feb 26, 2003, 6:41pm



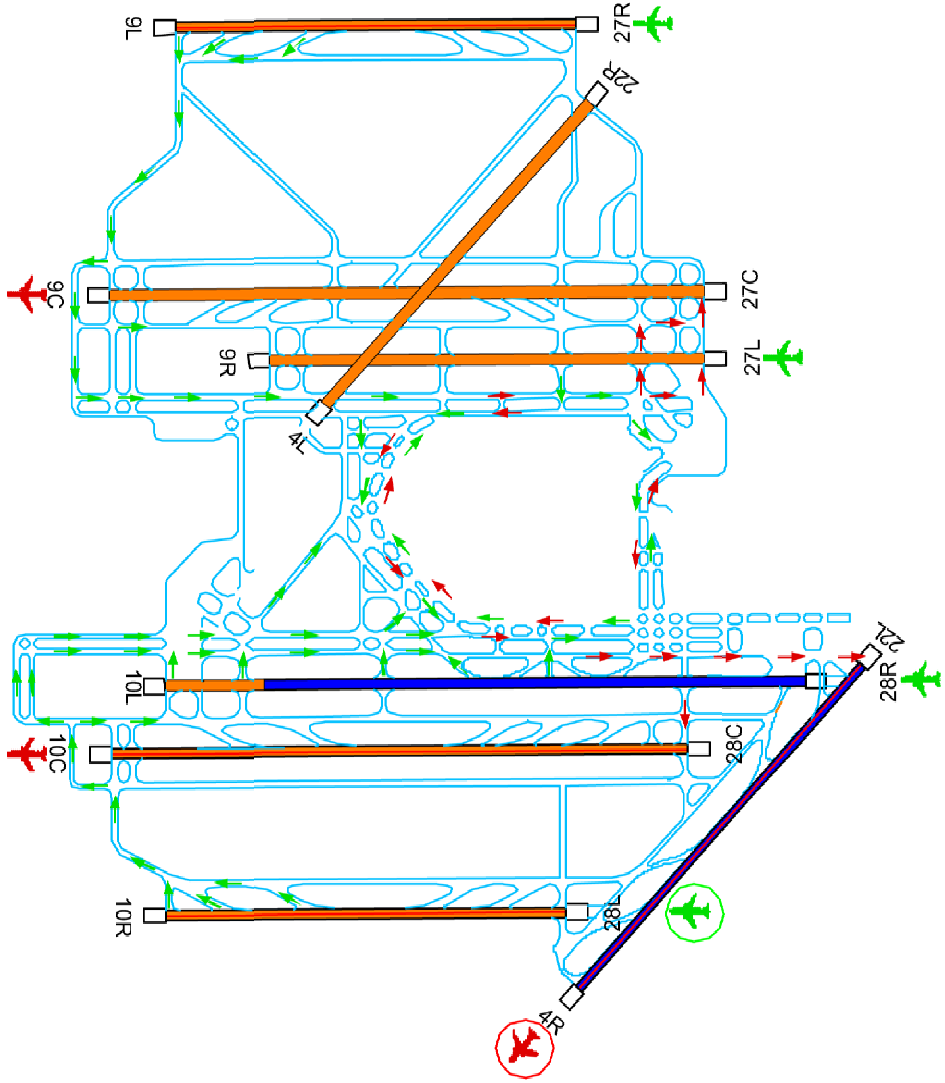
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-26

0 3600 north

Possible Operating Configuration
Layout Option 3 - VFR - East Flow

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-26.dwg_Layout: 8.5x11_Feb 26, 2003, 8:14pm



Legend:

- Primary Arrivals
- Primary Departures
- Secondary Arrivals
- Secondary Departures
- Inbound
- Outbound

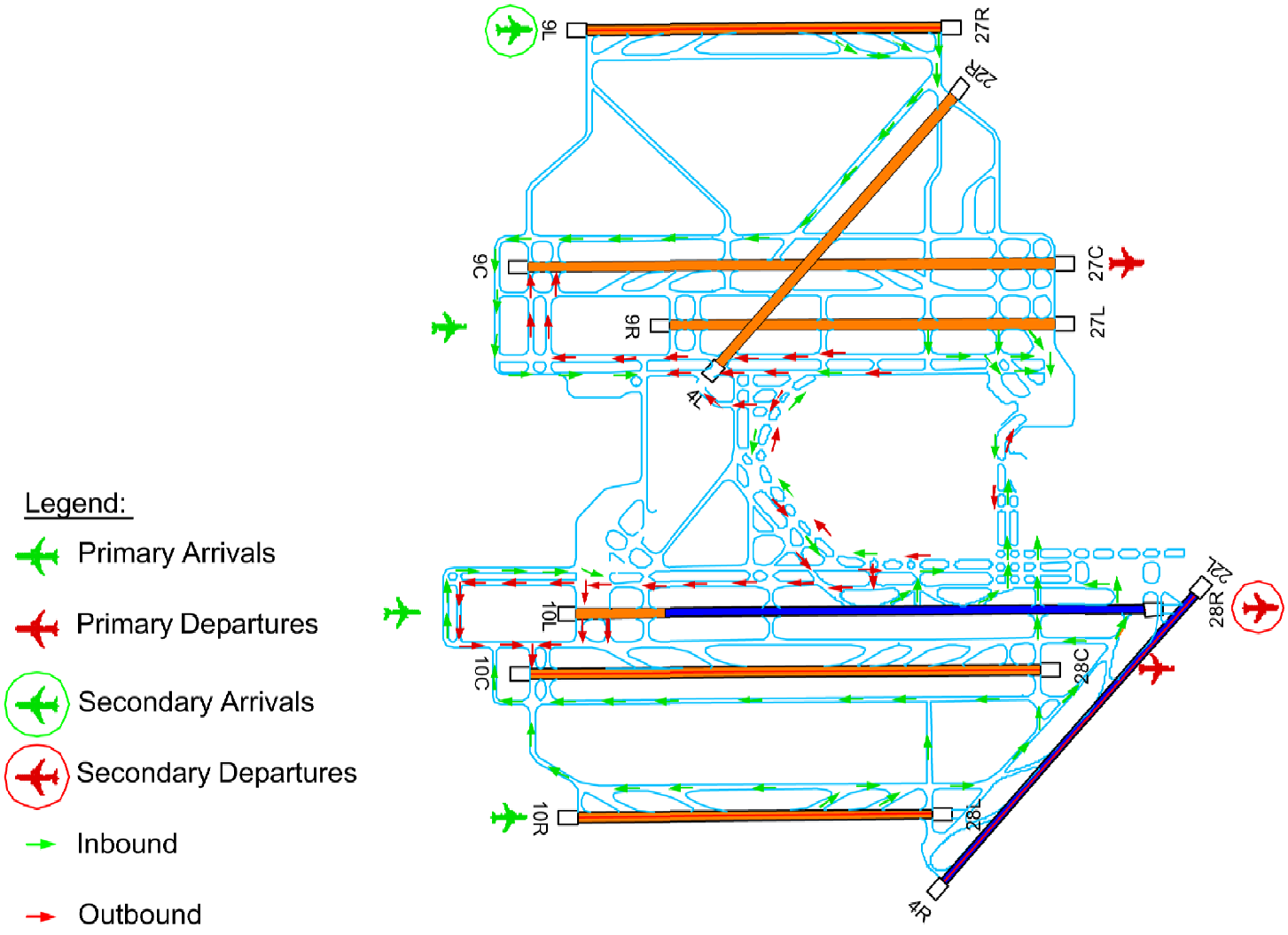
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-27

0 3600 north

Possible Operating Configuration
Layout Option 3 - VFR - East Flow

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-27.dwg_Layout: 8.5x11_Feb 26, 2003, 6:35pm



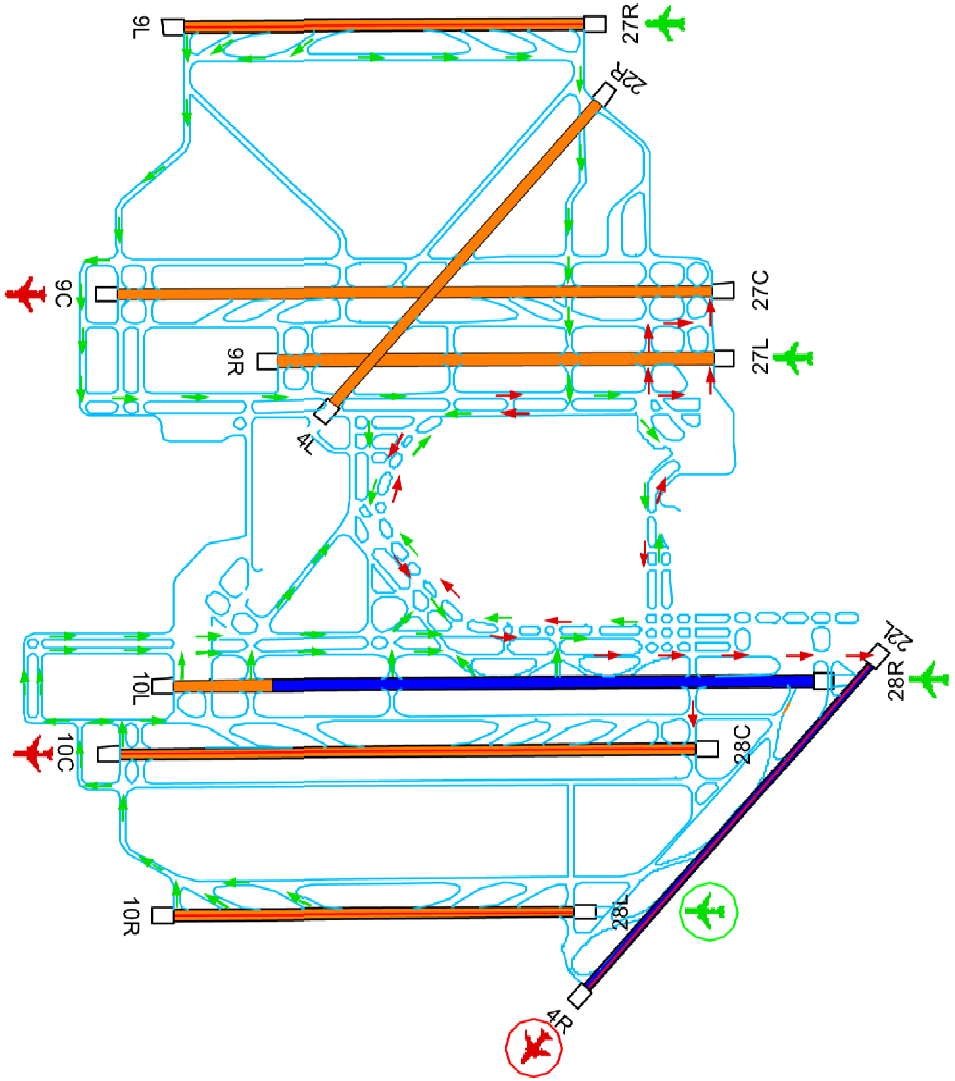
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-28

0 3600 north

Possible Operating Configuration
Layout Option 3 - IFR - East Flow

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-28.dwg_Layout: 8.5x11_Feb 26, 2003, 7:49pm



Legend:

- Primary Arrivals
- Primary Departures
- Secondary Arrivals
- Secondary Departures
- Inbound
- Outbound

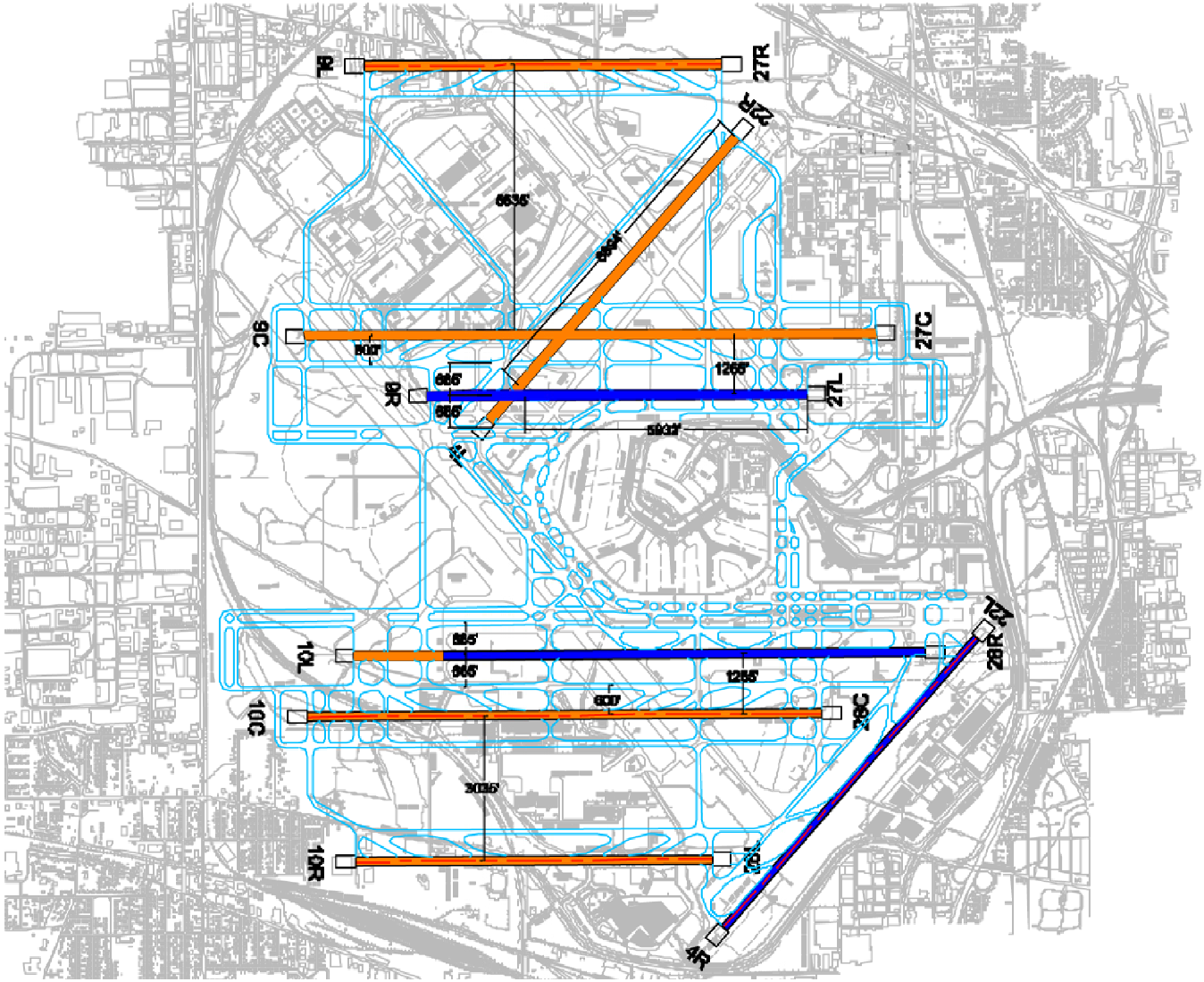
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-29

0 3600 north

Possible Operating Configuration
Layout Option 3 - IFR - West Flow

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-29.dwg_Layout: 8.5x11_Feb 26, 2003, 6:24pm



RWY Name	Approx. Lengths
4L-22R	7875'
4R-22L	8071'
9L-27R	7500'
9C-27C	12000'
9R-27L	7967'
10L-28R	12000'
10C-28C	10800'
10R-28L	7500'

Note:
Specific elements included in this layout concept are shown for illustration purposes only. Further obstruction and operational analyses are necessary.

LEGEND

Existing Runways

New or Relocated Runways

Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

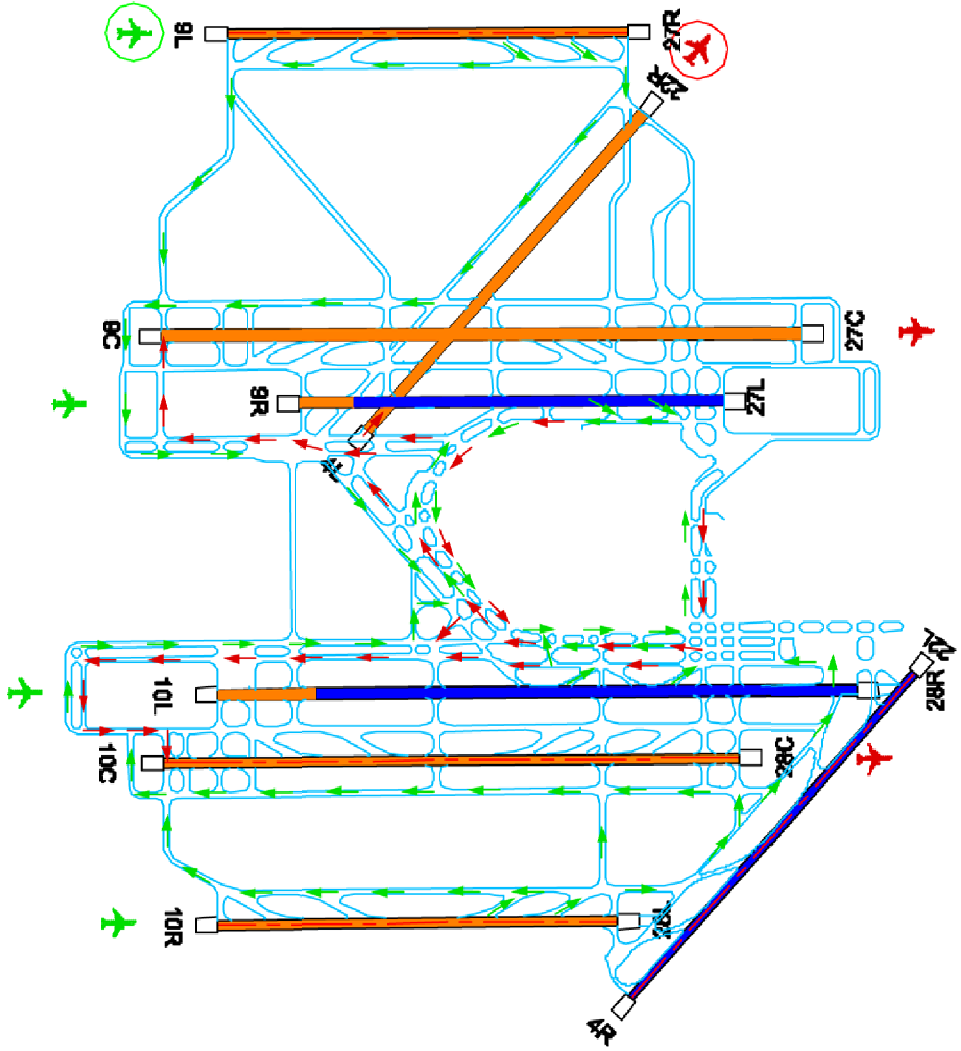
Exhibit II-30

0 3600

north

Layout Option 4

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-30.dwg_Layout: 8.5x11_Feb 26, 2003, 7:46pm



Legend:

- Primary Arrivals
- Primary Departures
- Secondary Arrivals
- Secondary Departures
- Inbound
- Outbound

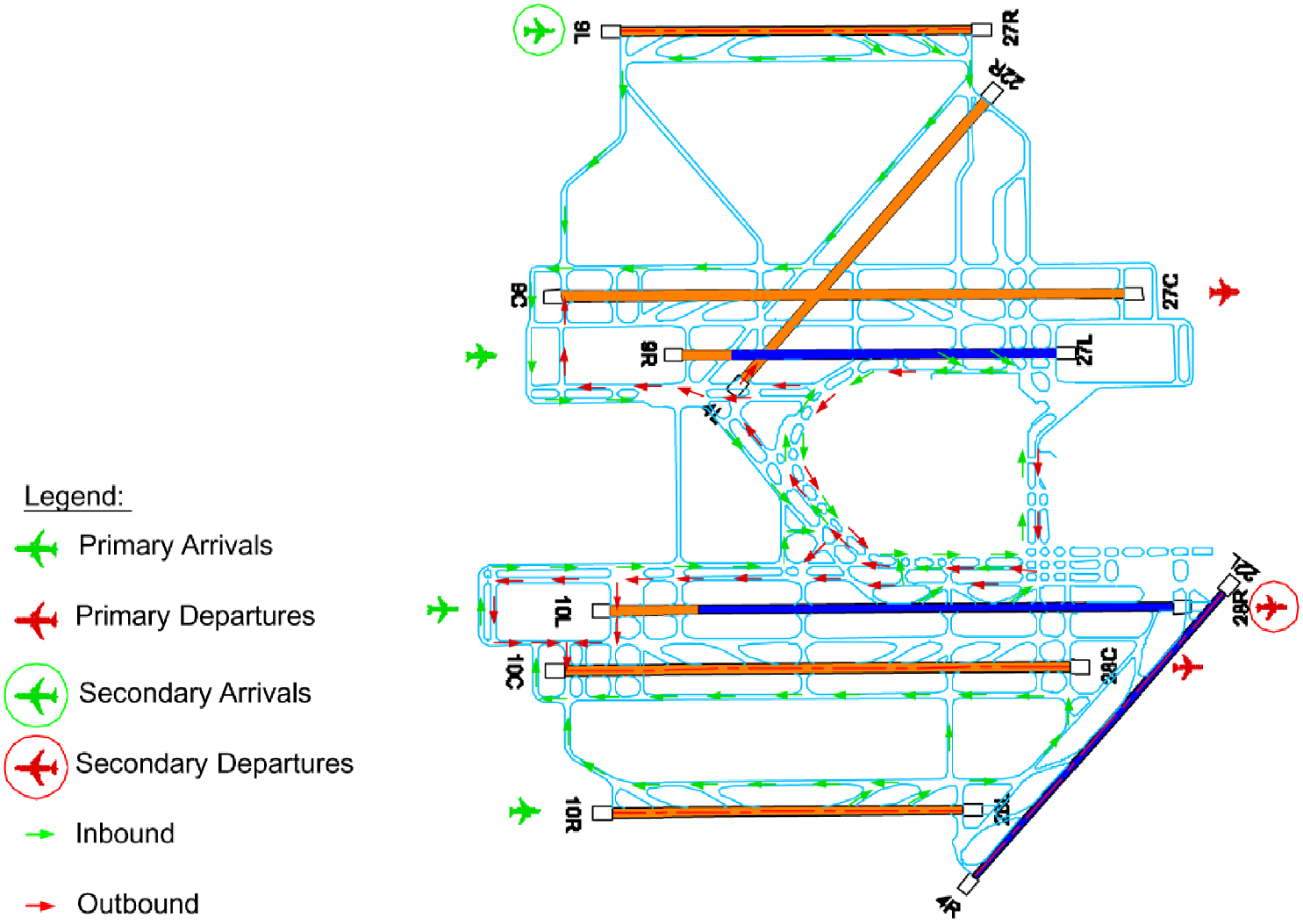
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-31

0 3600 north

Possible Operating Configuration Layout Option 4 - VFR - East Flow

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-31.dwg_Layout: 8.5x11_Feb 26, 2003, 6:19pm



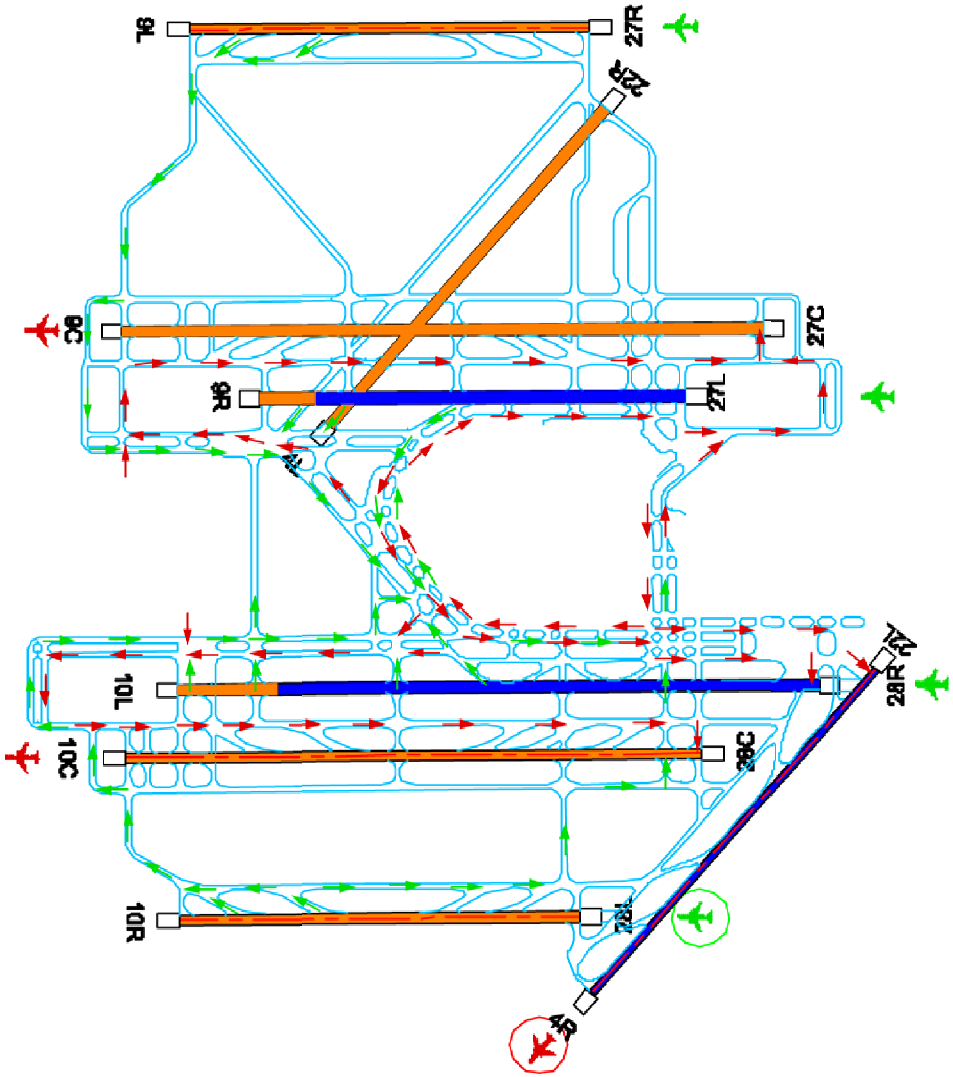
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-32

0 3600 north

Possible Operating Configuration
Layout Option 4 - IFR - East Flow

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-32.dwg_Layout: 8.5x11_Feb 26, 2003, 7:44pm



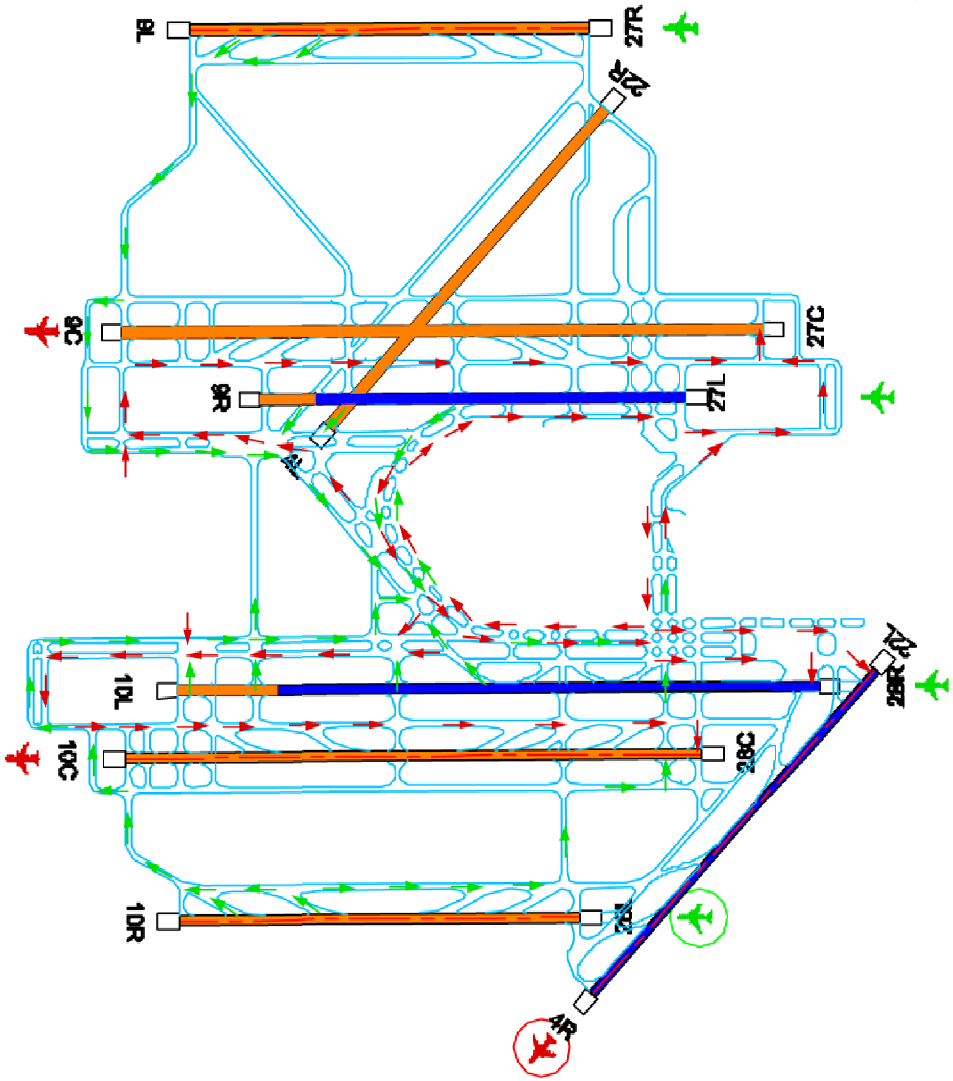
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-33

0 3600 north

Possible Operating Configuration
Layout Option 4 - VFR - West Flow

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-33.dwg_Layout: 8.5x11_Feb 26, 2003, 5:25pm



Legend:

- Primary Arrivals
- Primary Departures
- Secondary Arrivals
- Secondary Departures
- Inbound
- Outbound

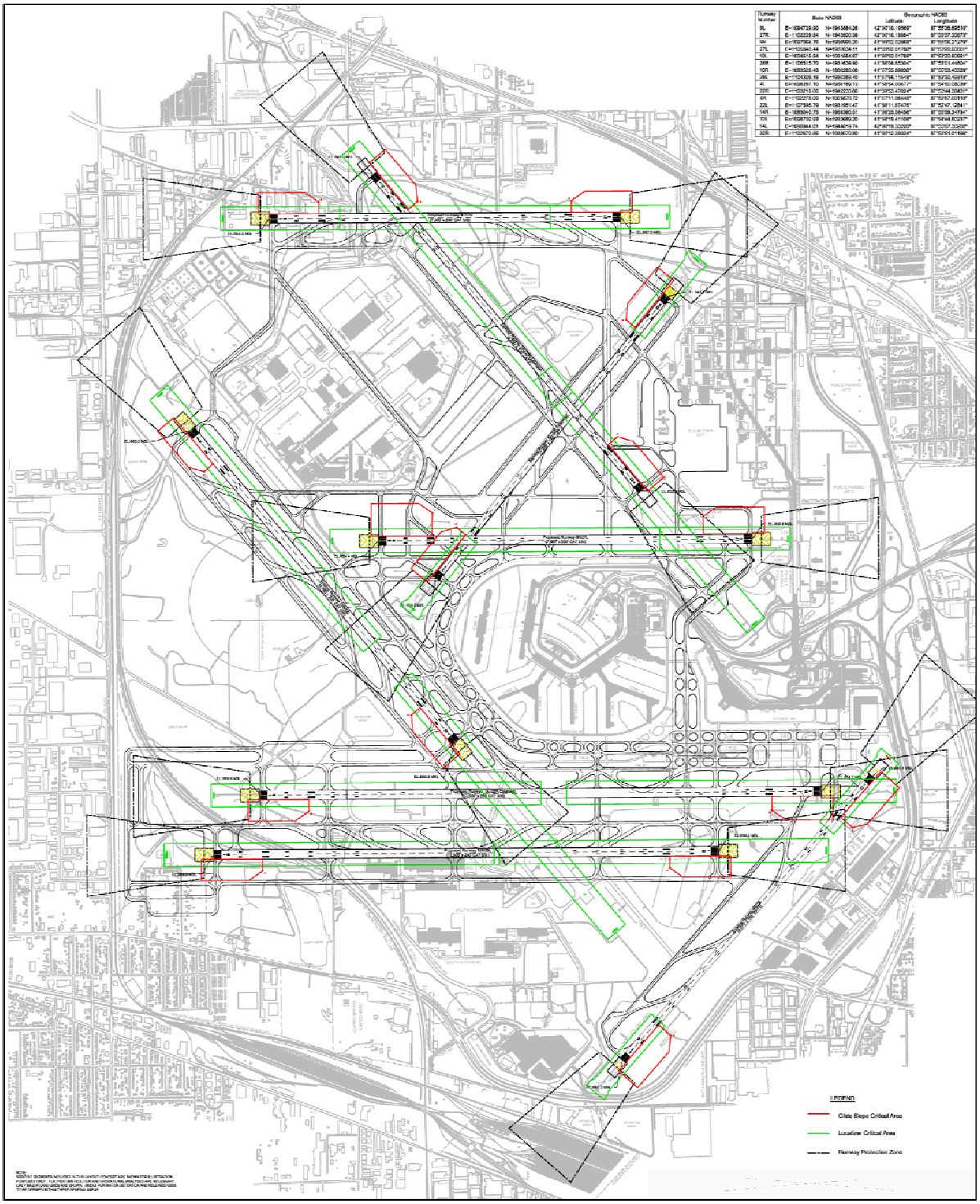
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-34

0 3600 north

Possible Operating Configuration
Layout Option 4 - IFR - West Flow

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-34.dwg_Layout: 8.5x11_Feb 26, 2003, 7:43pm



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

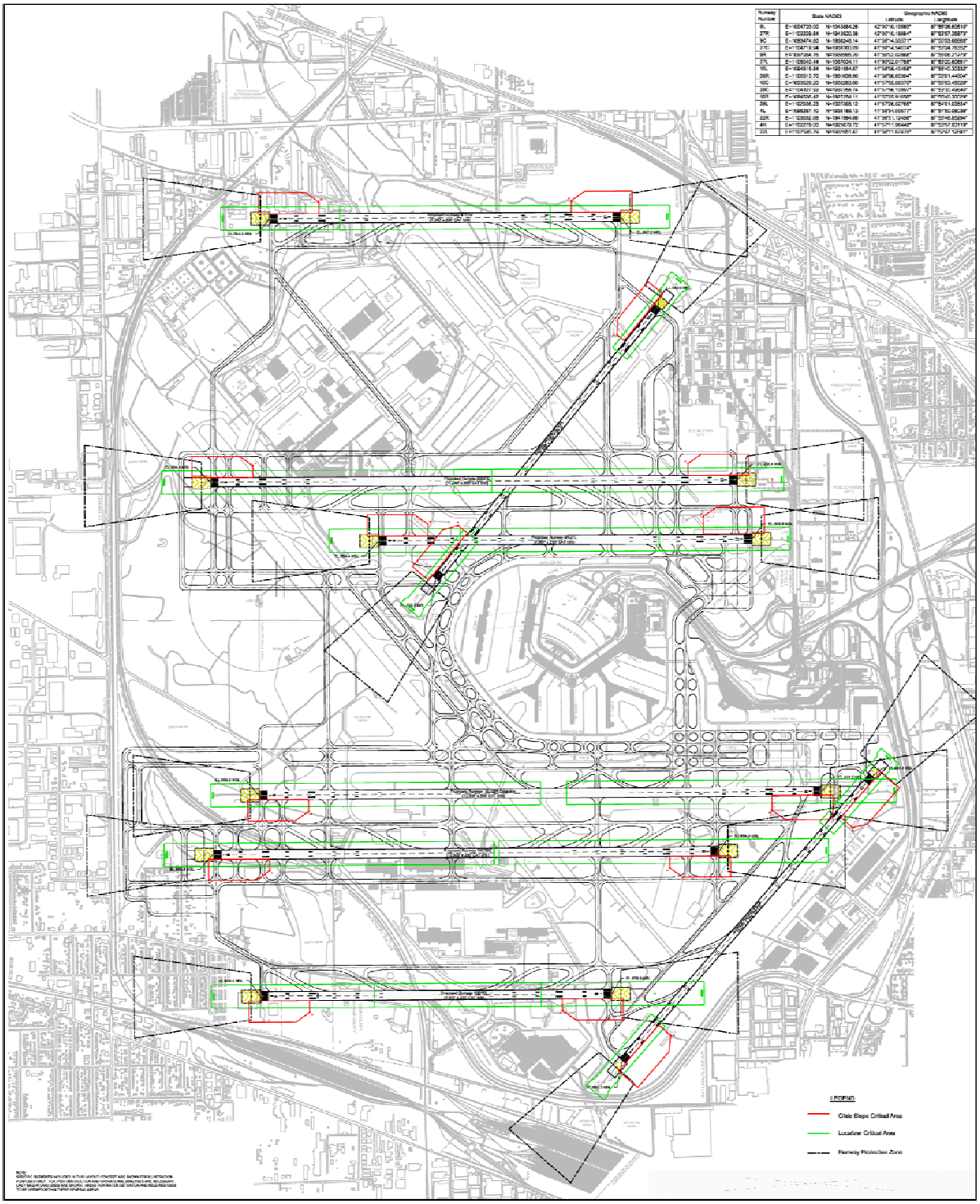
Exhibit II-35

0 N.T.S.

north

Option 1

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-35.dwg_Layout: 8.5x11_Feb 26, 2003, 5:22pm



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

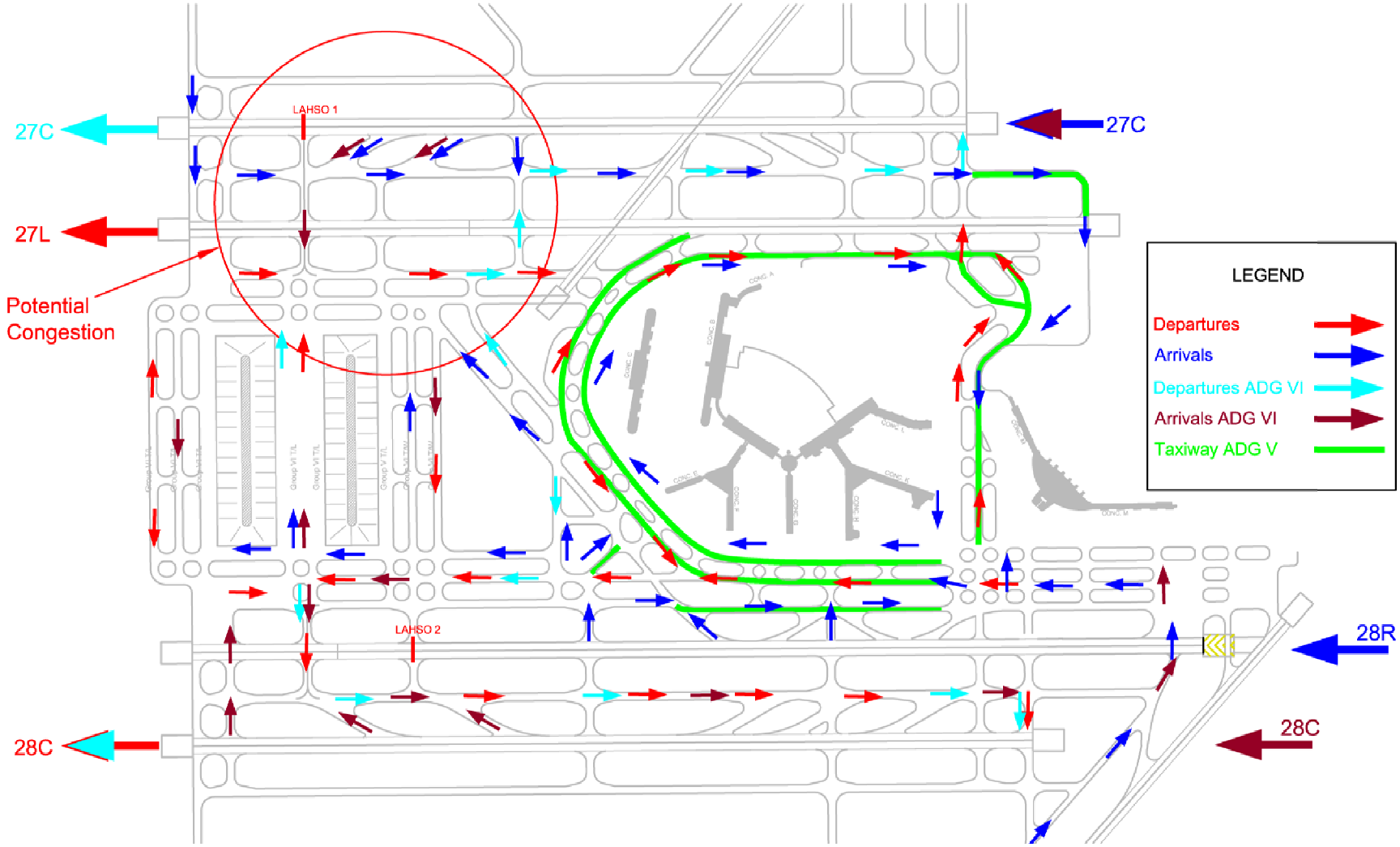
Exhibit II-36

0 N.T.S.

north

Option 2

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-36.dwg_Layout: 8.5x11_Feb 26, 2003, 7:38pm



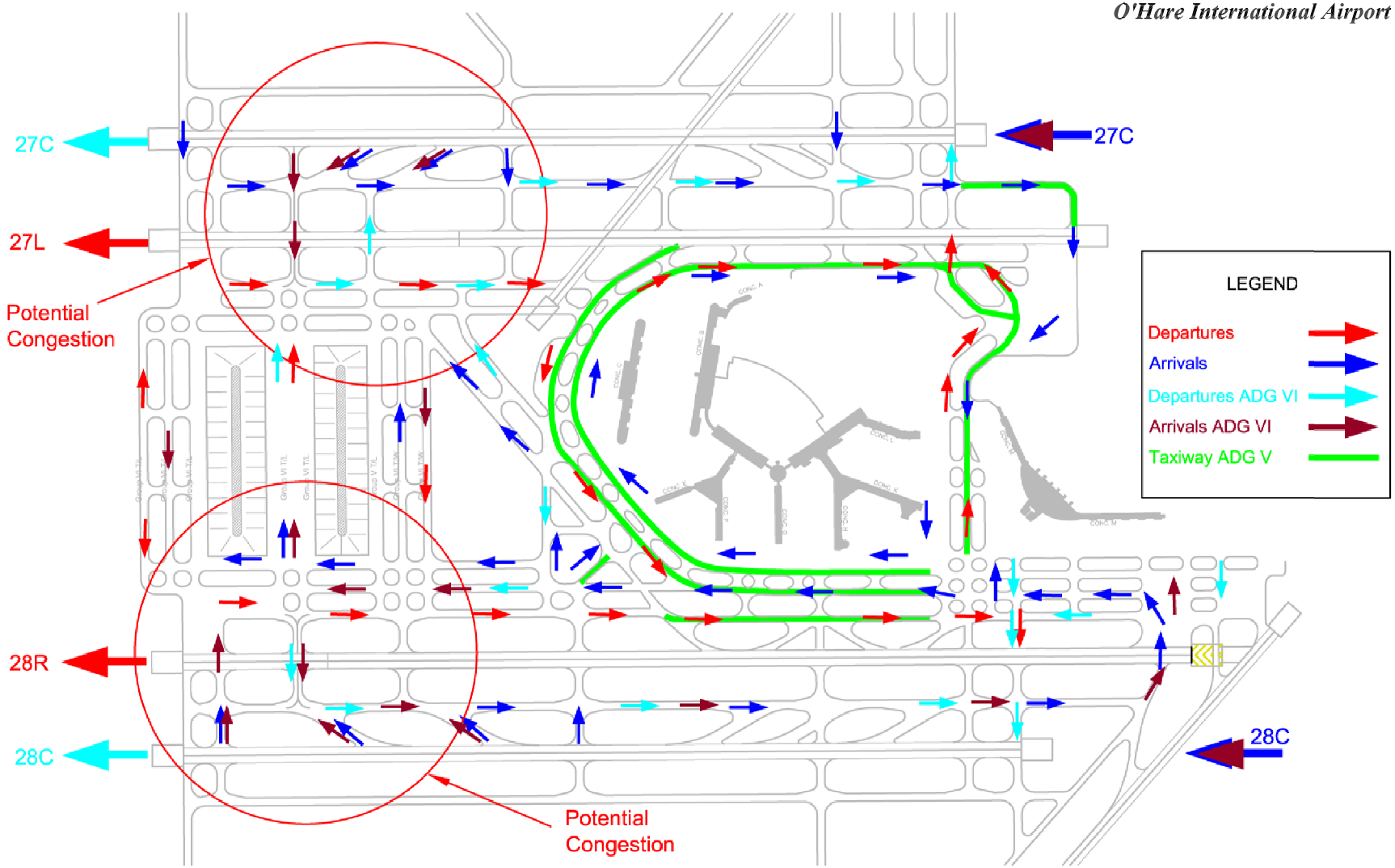
Source: O'Hare Air Traffic Control Tower and Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-37

0 2000 north

VFR West Flow

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-37.dwg_Layout: 8.5x11_Feb 26, 2003, 5:19pm



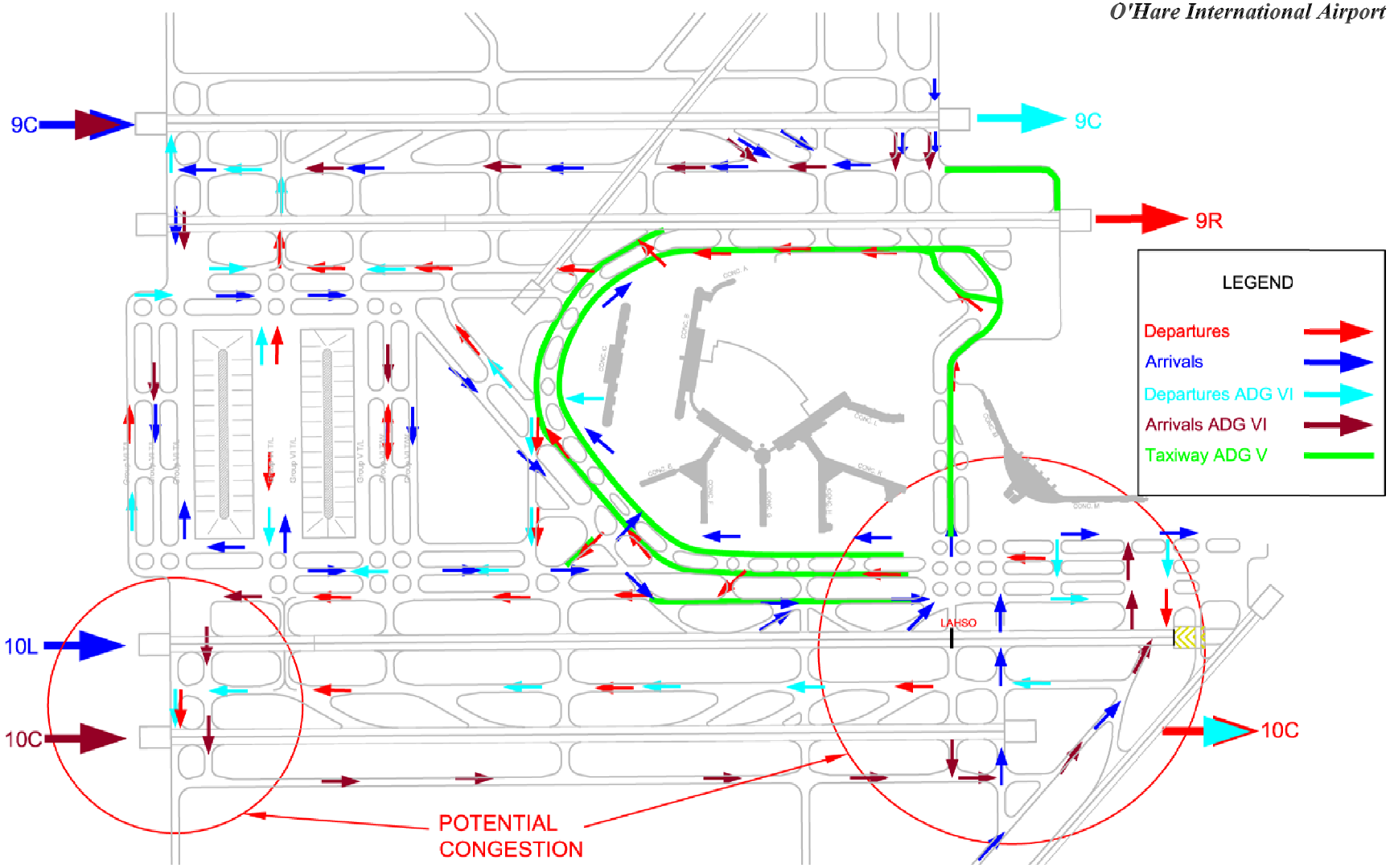
Source: O'Hare Air Traffic Control Tower and Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-38

0 2000 north

IFR West Flow

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-38.dwg_Layout: 8.5x11_Feb 26, 2003, 7:36pm



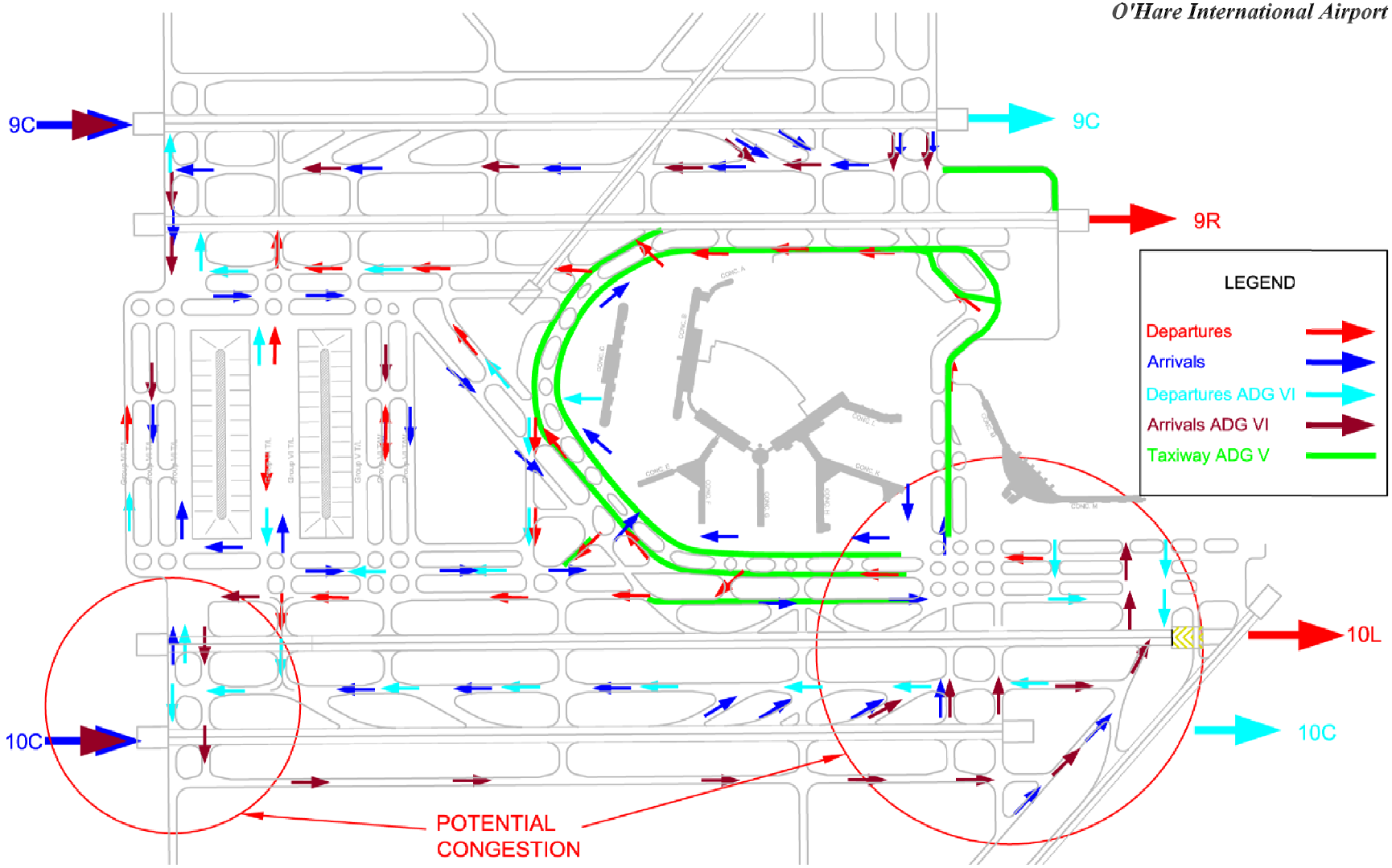
Source: O'Hare Air Traffic Control Tower and Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-39

0 2000 north

VFR East Flow

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-39.dwg_Layout: 8.5x11_Feb 26, 2003, 5:17pm



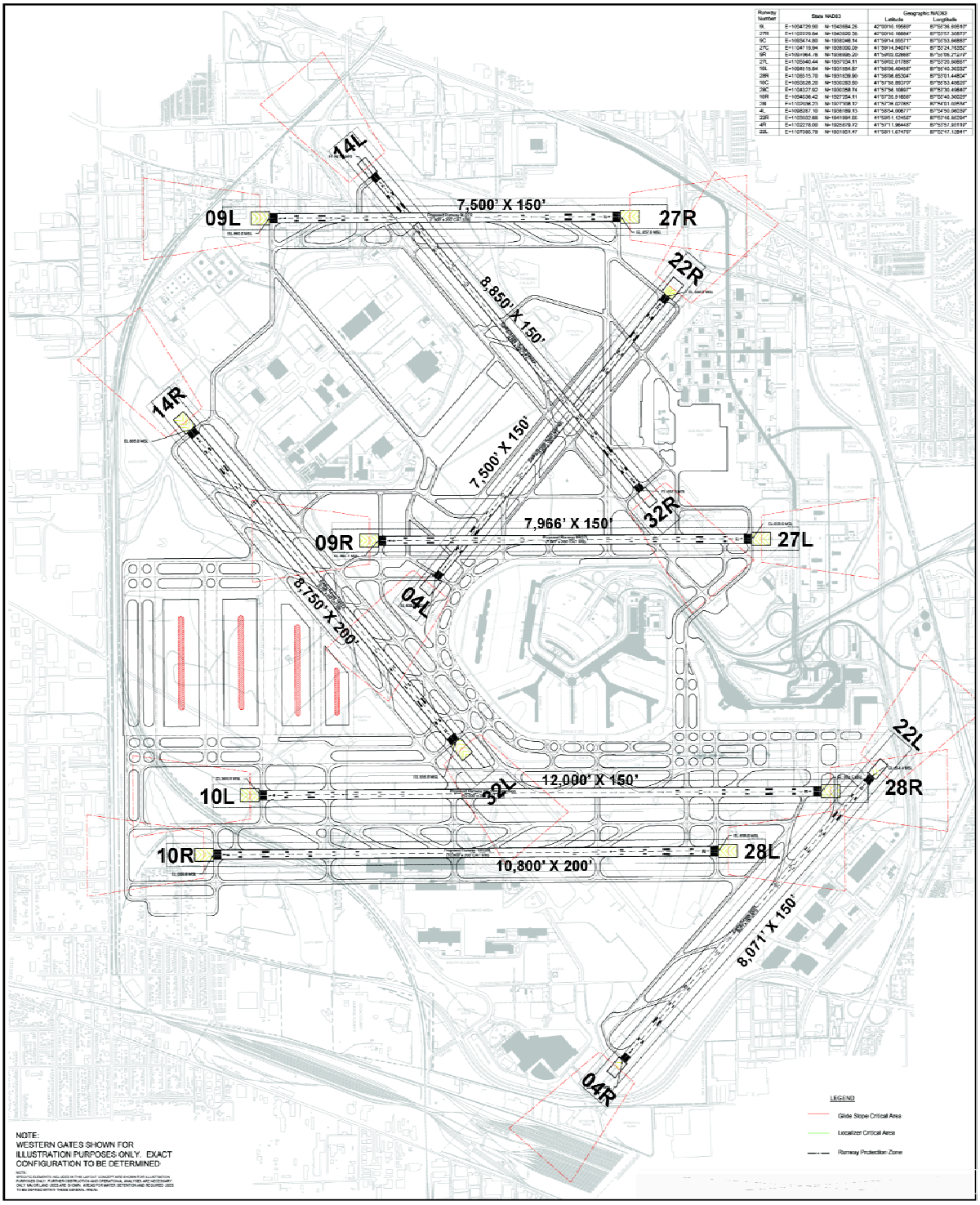
Source: O'Hare Air Traffic Control Tower and Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-40

0 2000 north

IFR East Flow

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-40.dwg_Layout: 8.5x11_Feb 26, 2003, 7:33pm



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

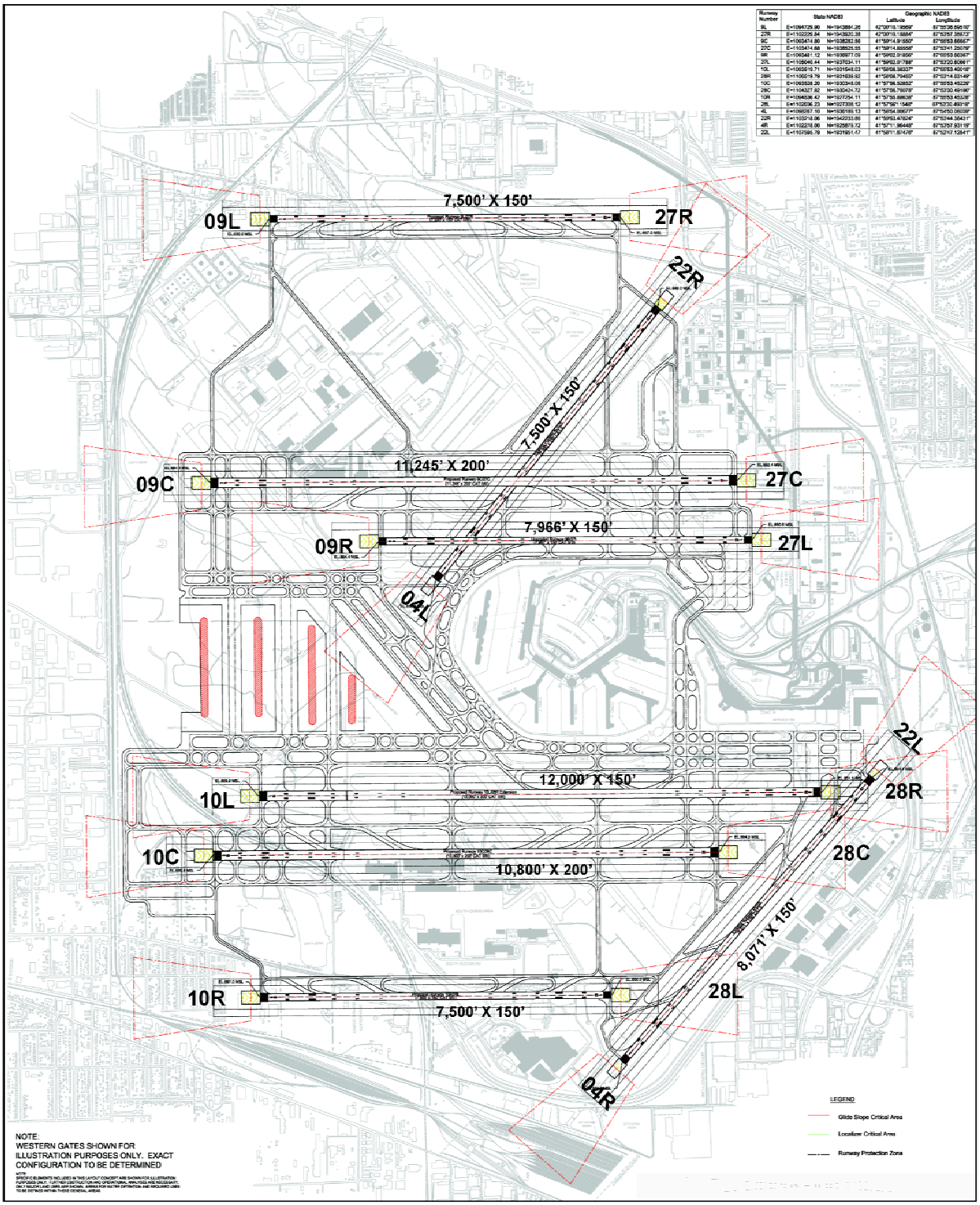
Exhibit II-41

0 N.T.S.

north

Future Airport Drawing Option 1 (As Simulated)

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-41.dwg_Layout: 8.5x11_Feb 27, 2003, 10:08am



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

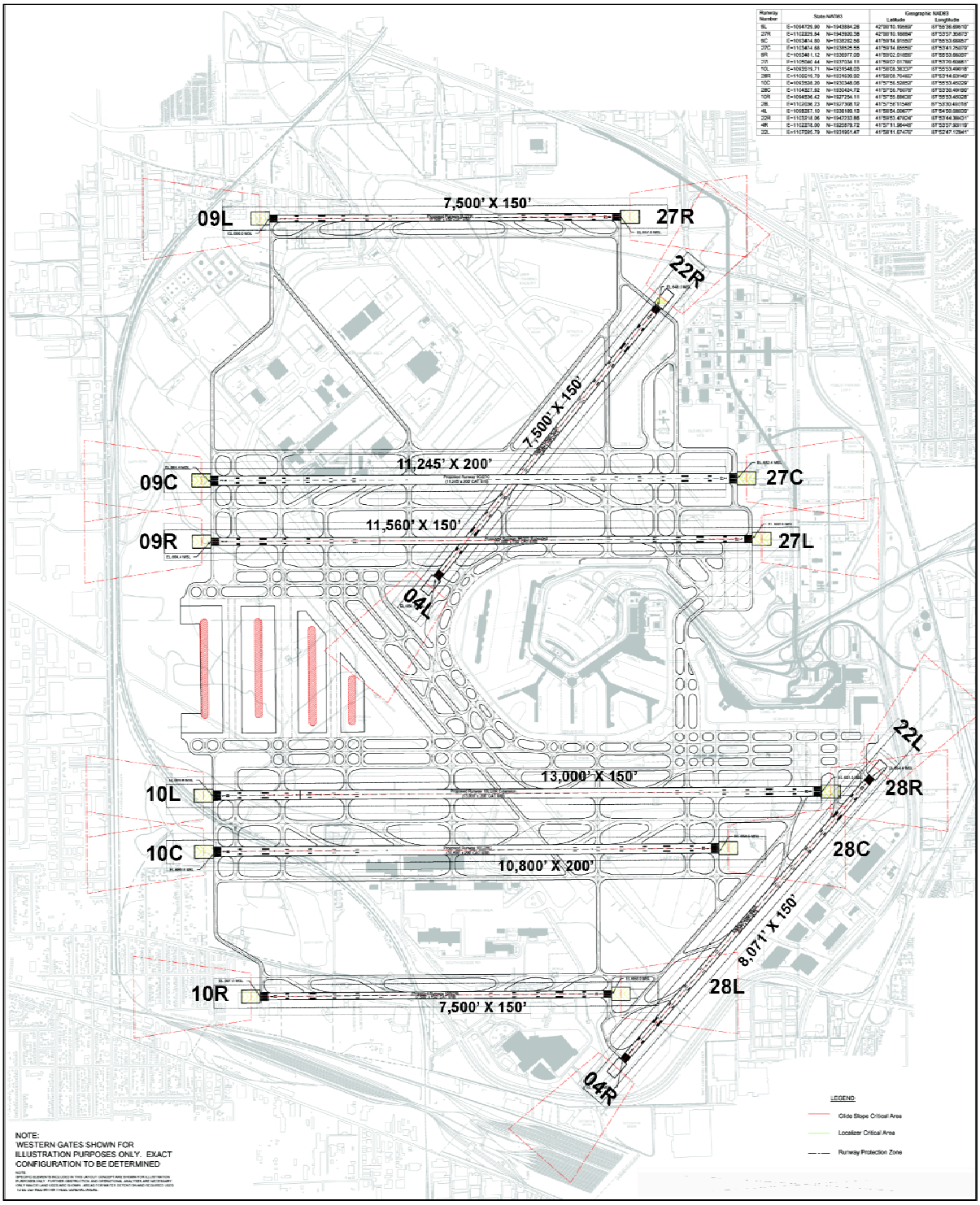
Exhibit II-42

0 N.T.S.

north

Future Airport Drawing Option 2 (As Simulated)

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-42.dwg_Layout: 8.5x11_Feb 27, 2003, 9:51am



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

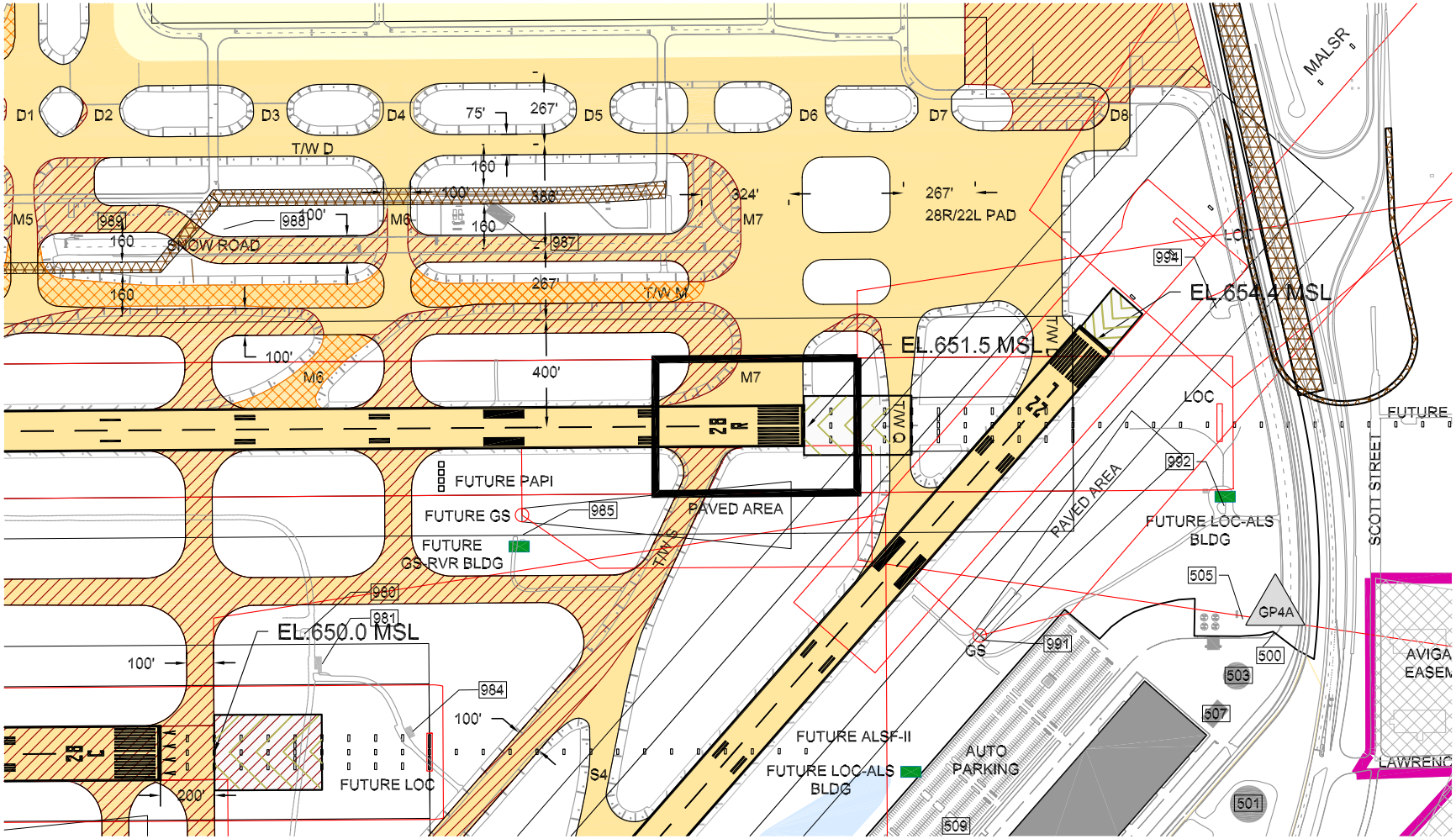
Exhibit II-43

0 N.T.S.

north

Future Airport Drawing Option 5 (As Simulated)

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-43.dwg_Layout: 8.5x11_Feb 26, 2003, 7:19pm



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

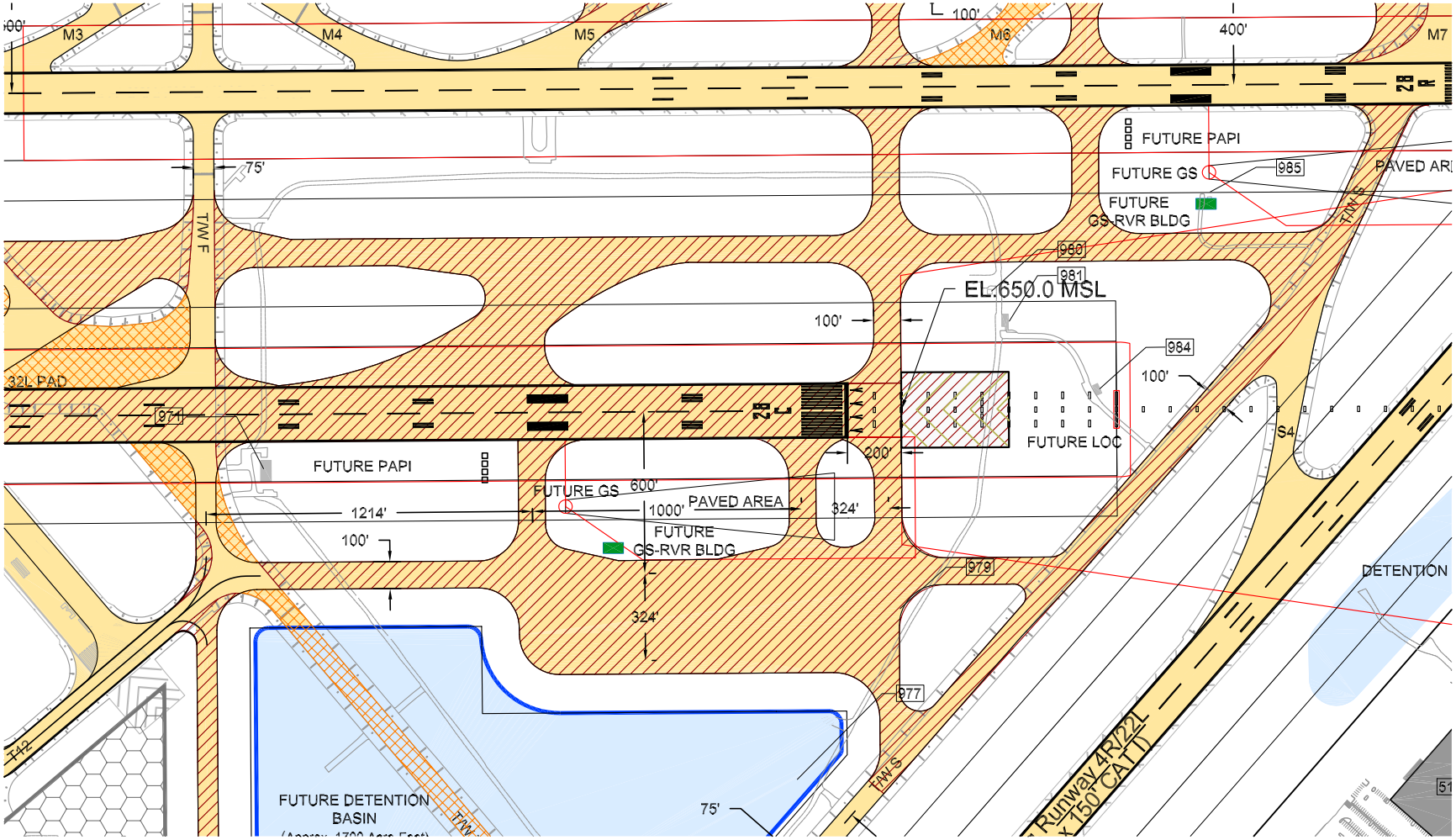
Exhibit II-44

0 600

north

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-44.dwg_Layout: 8.5x11_Feb 27, 2003, 2:01pm

RSA Enhancement Approach End 28R



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

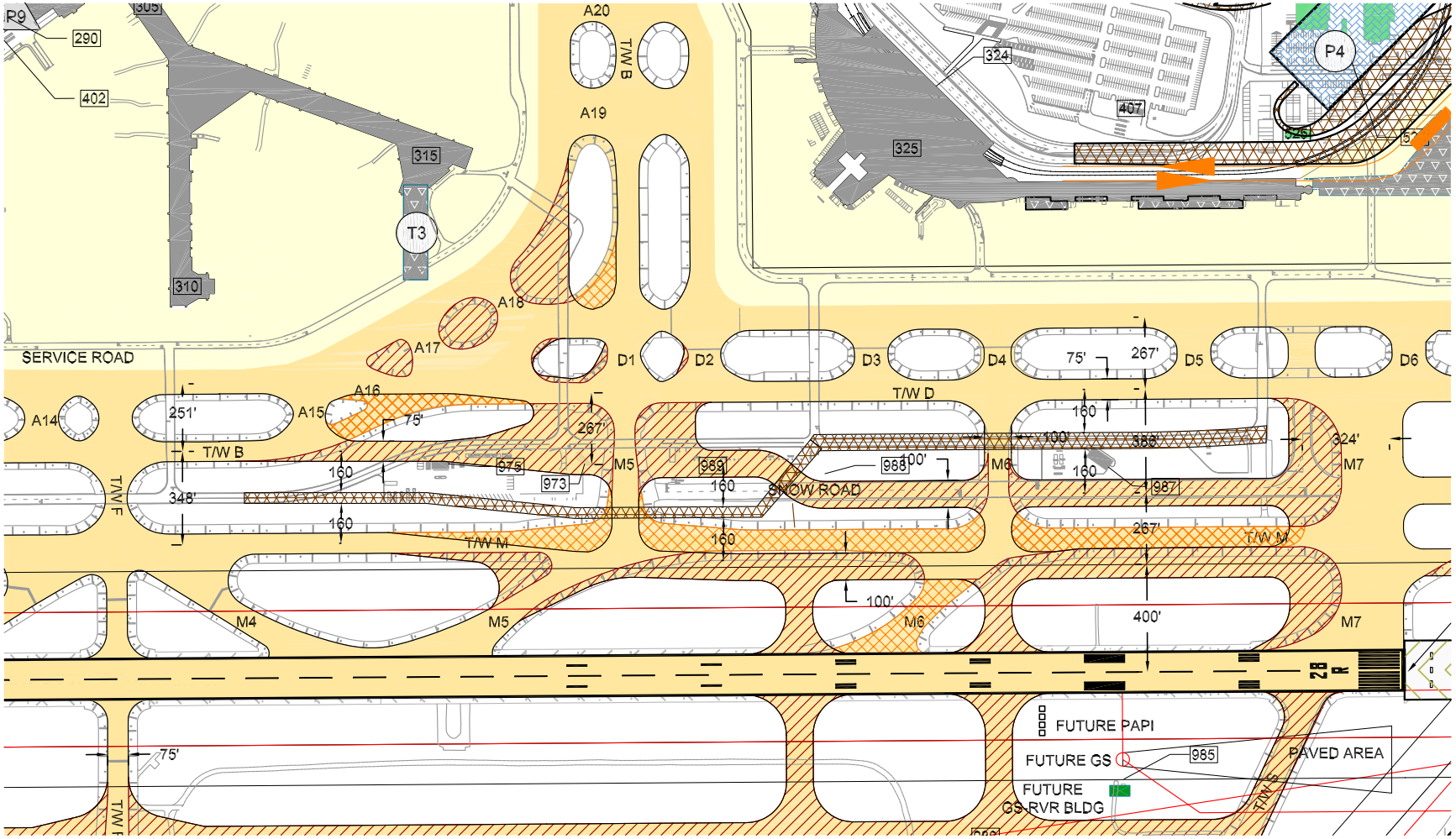
Exhibit II-45

0 600

north

Runway 28C
Localizer Protection

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-45.dwg_Layout: 8.5x11_Feb 27, 2003, 2:13pm



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

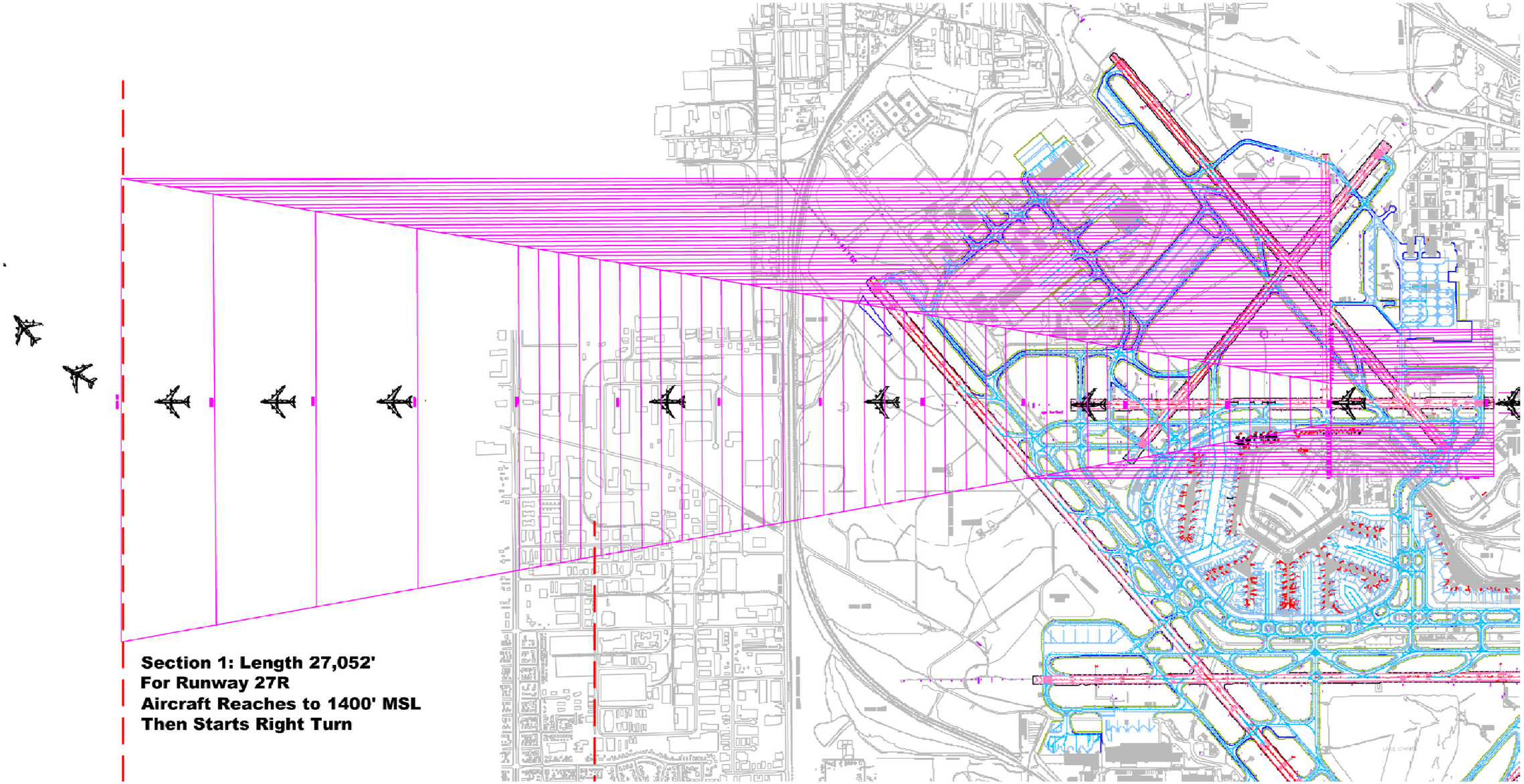
Exhibit II-46

0 600

north

Snow Road Reconfiguration

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-46.dwg_Layout: 8.5x11_Feb 27, 2003, 2:17pm



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

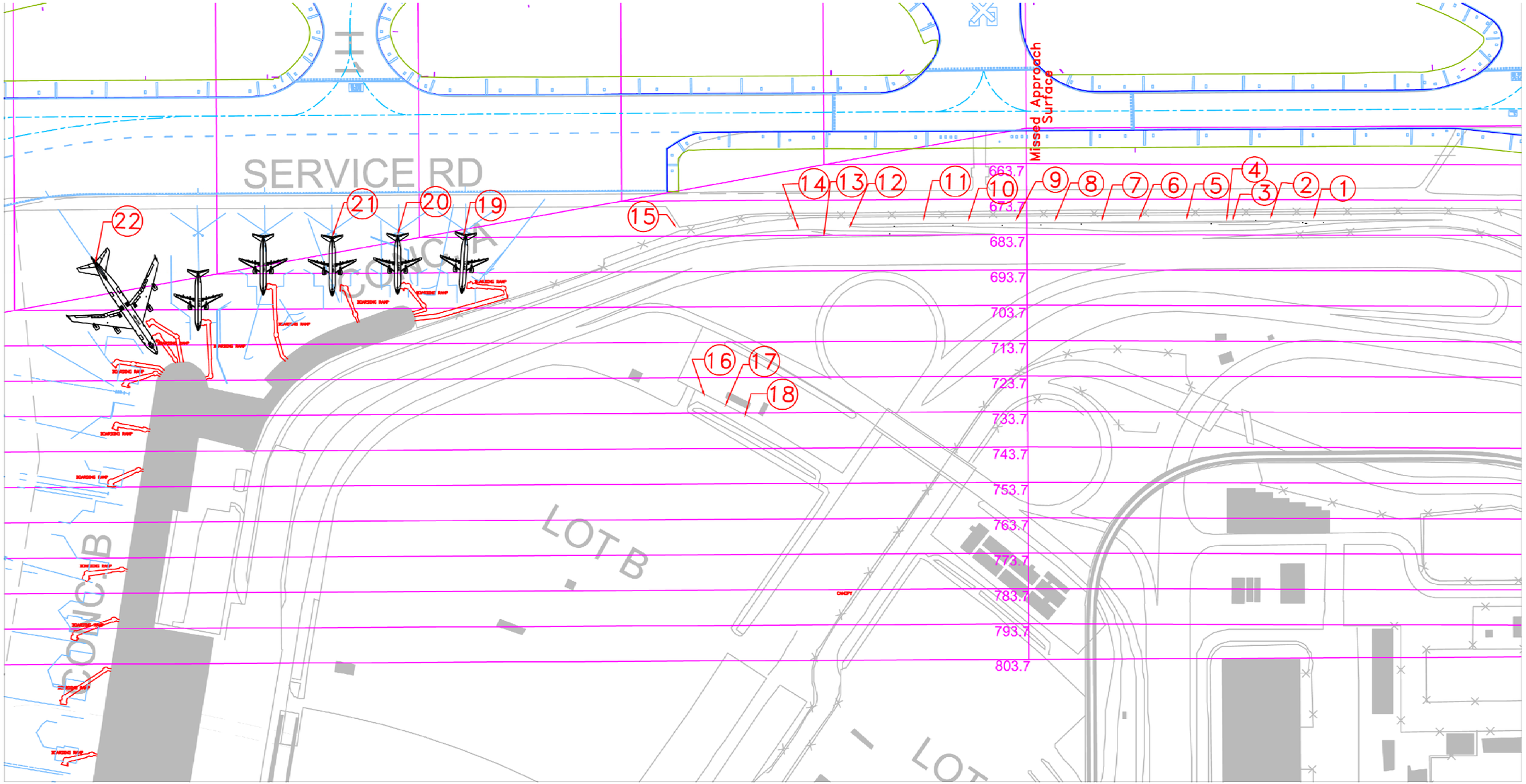
Exhibit II-47

0 2000

north

Missed Approach Surfaces
Runway 27R

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-47.dwg, Layout: 11x17_Feb 27, 2003, 11:48am



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

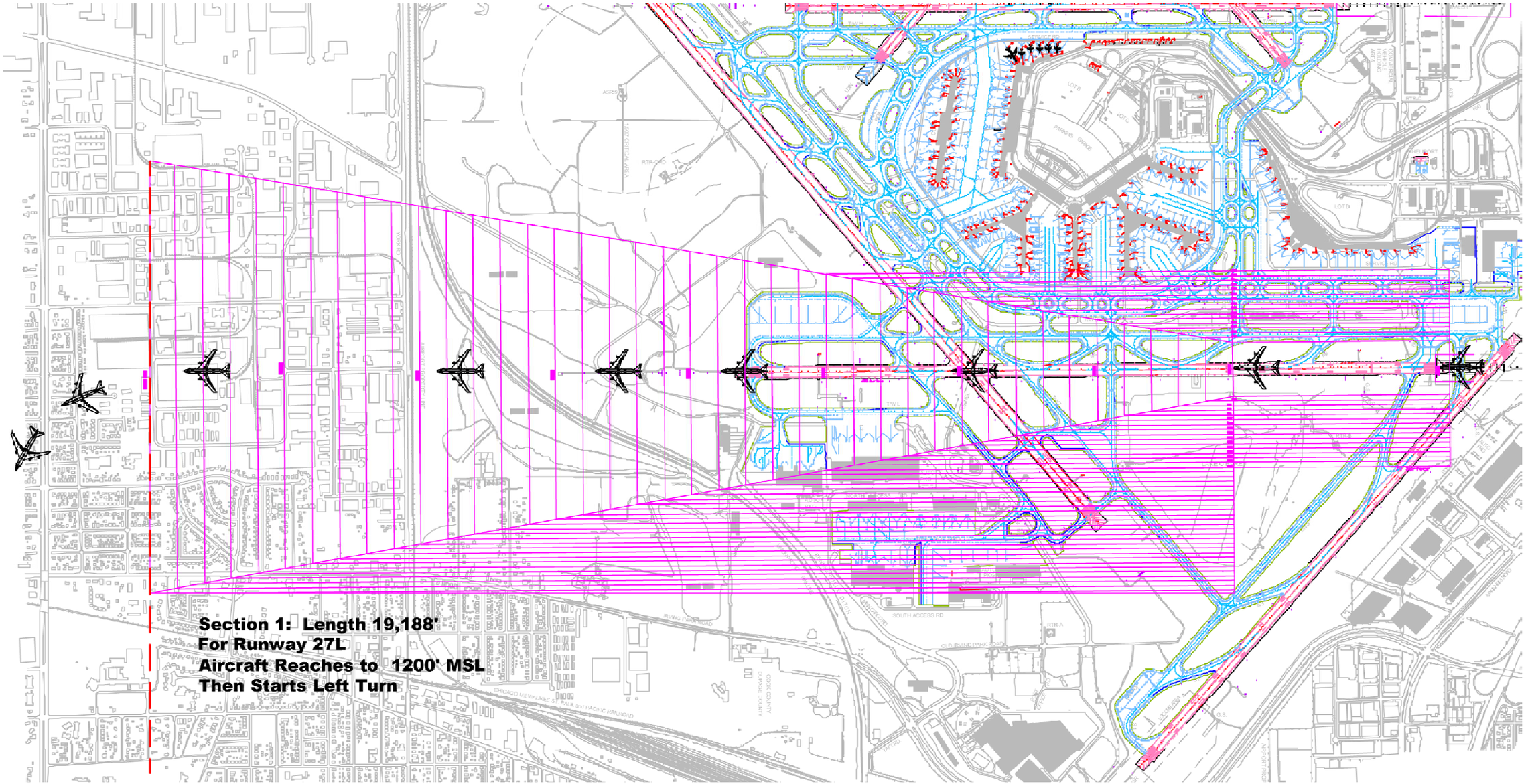
Exhibit II-48

0 N.T.S.

north

Runway 27R CAT-II/III Missed Approach Object Penetration

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-48.dwg, Layout: 11x17, Feb 27, 2003, 11:27am



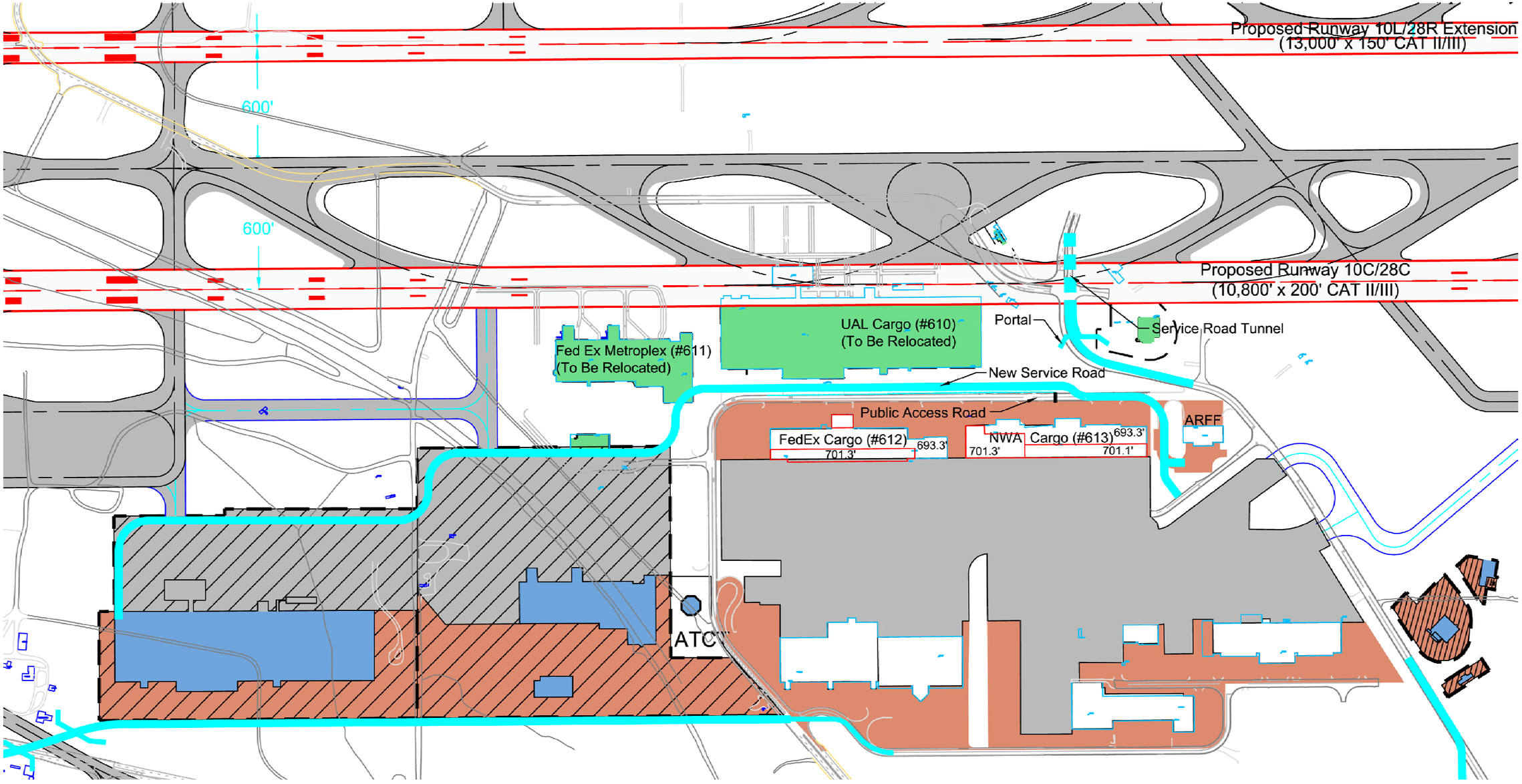
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-49

0 1500
north

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-49.dwg_Layout: 11x17_Feb 27, 2003, 11:51am

Missed Approach Surfaces
Runway 27L



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

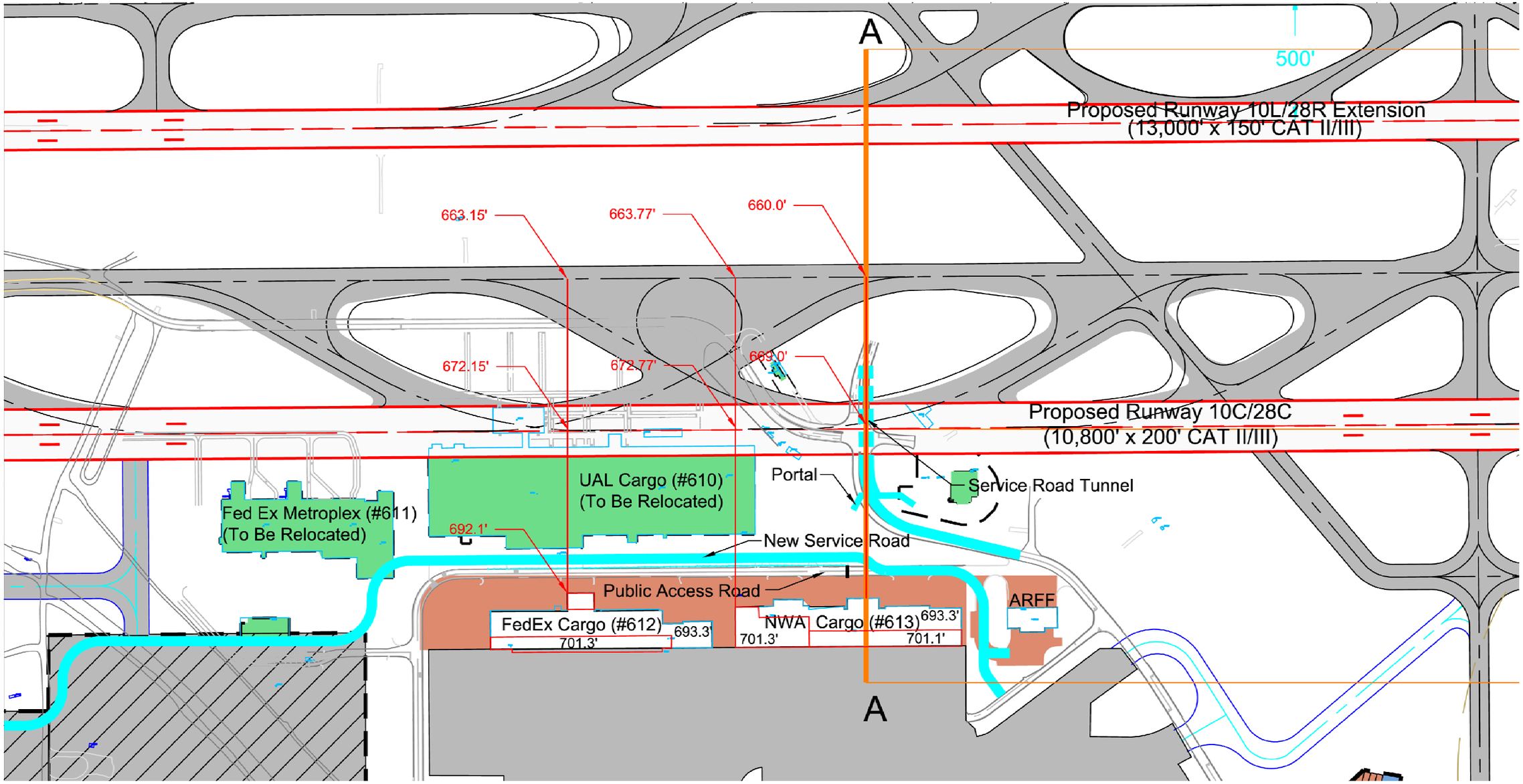
Exhibit II-50

0 N.T.S.

north

Cargo Area Site Plan

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-50.dwg Layout: 11x17_Feb 27, 2003, 11:54am



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-51

0 N.T.S.

north

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-51.dwg, Layout: 11x17_Feb 27, 2003, 12:04pm

Runway/Taxiway Elevations
Abeam Buildings

750' MSL
700' MSL
650' MSL
Roof Elevation: 701.3' MSL
NWA Cargo (Bldg. # 613)
15' Roadway Clearance
5. Tunnel Roof Clearance
RSA
TSA
669' MSL
5' Tunnel Roof
15' Tunnel Clearance
Part-77 Transitional (7:1)
A
A
1. Typical Offset of Airside Light Pole 734.5' MSL
2. North Edge of Building
3. Service Road (Non-Secure)
4. Typical Offset of Landside Light Pole at 698.1'
Service Road (Secure)
Service Road & Extended Tunnel Entrance 2% Slope
6. RWY 10C/28C 669' MSL
Existing Service Road Entrance to Tunnel
7. Parallel Taxiway 660' MSL
Anticipated Ground
Existing Ground
8. Existing Runway 9R-27L
1000'
500'
0'
500'
1000'
1500'

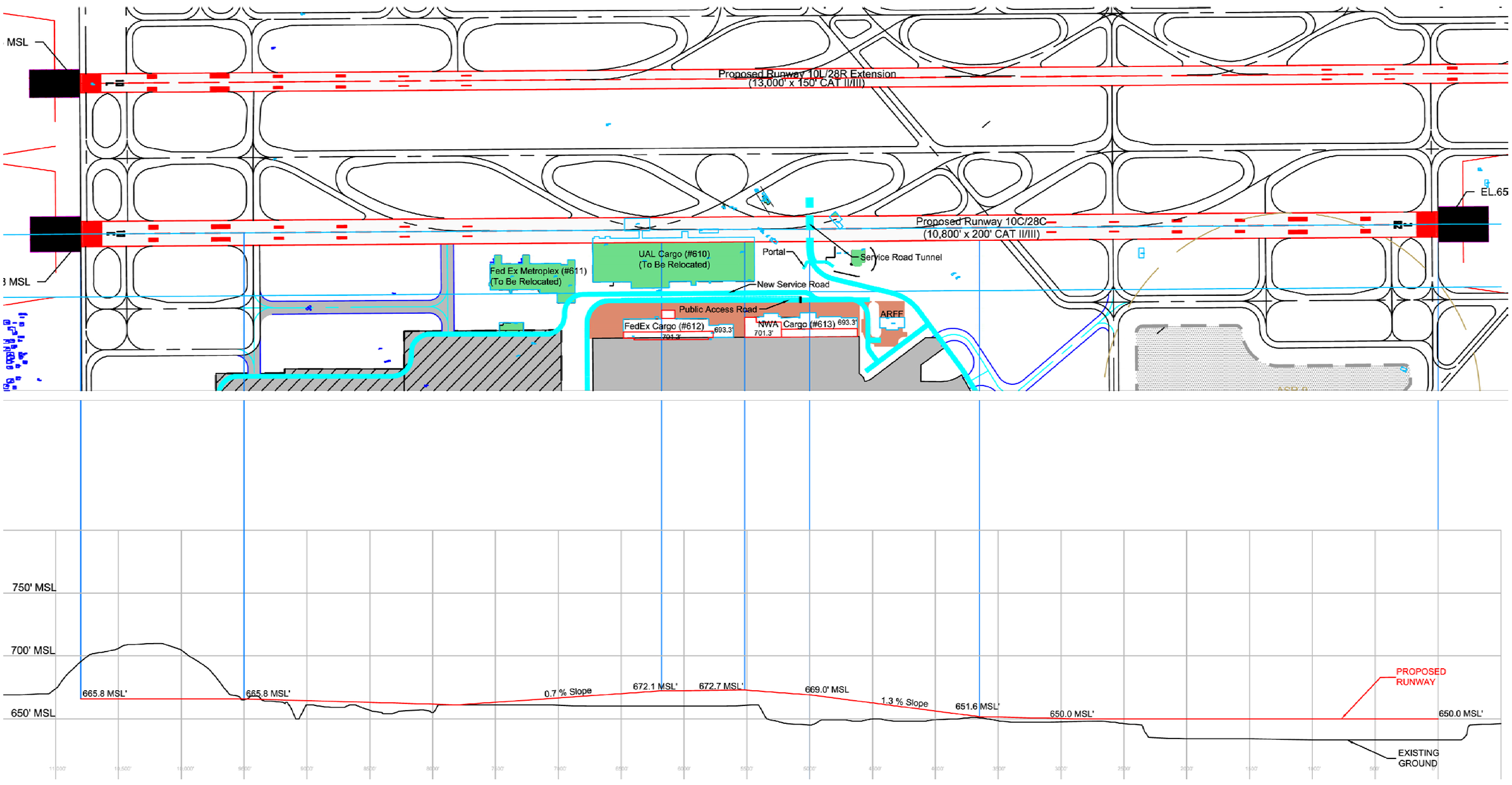
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-52

0 N.T.S.
north

Runway 10C/28C Section A-A
FAR Part 77 Surface-Runway Raised

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-52.dwg, Layout: 11x17, Feb 27, 2003, 12:11pm



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

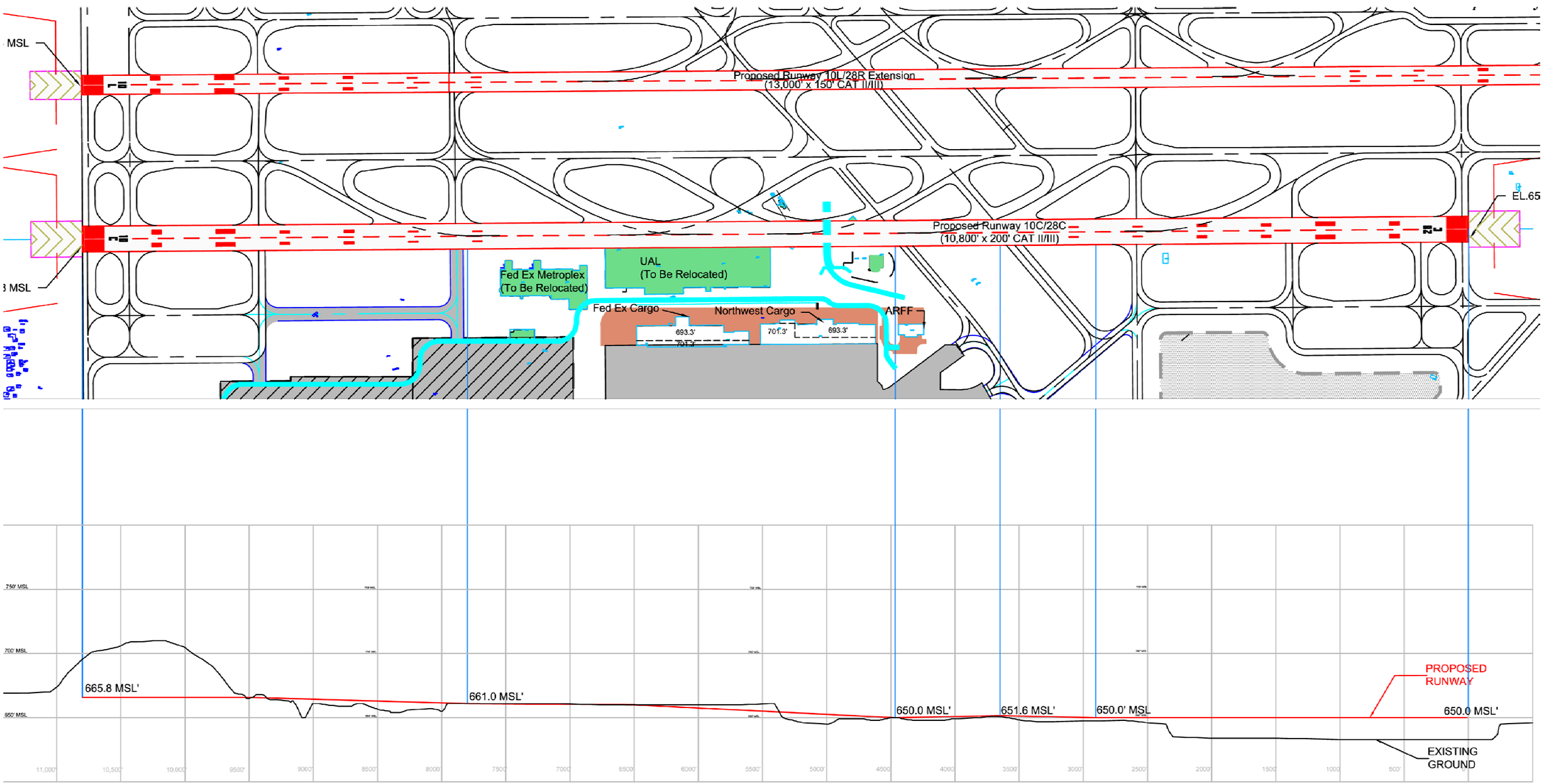
Exhibit II-53

0 N.T.S.

north

Runway 10C/28C Profile
FAR Part 77 - Raised Runway Scenario

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-53.dwg, Layout: 11x17_Feb 27, 2003, 1:26pm



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

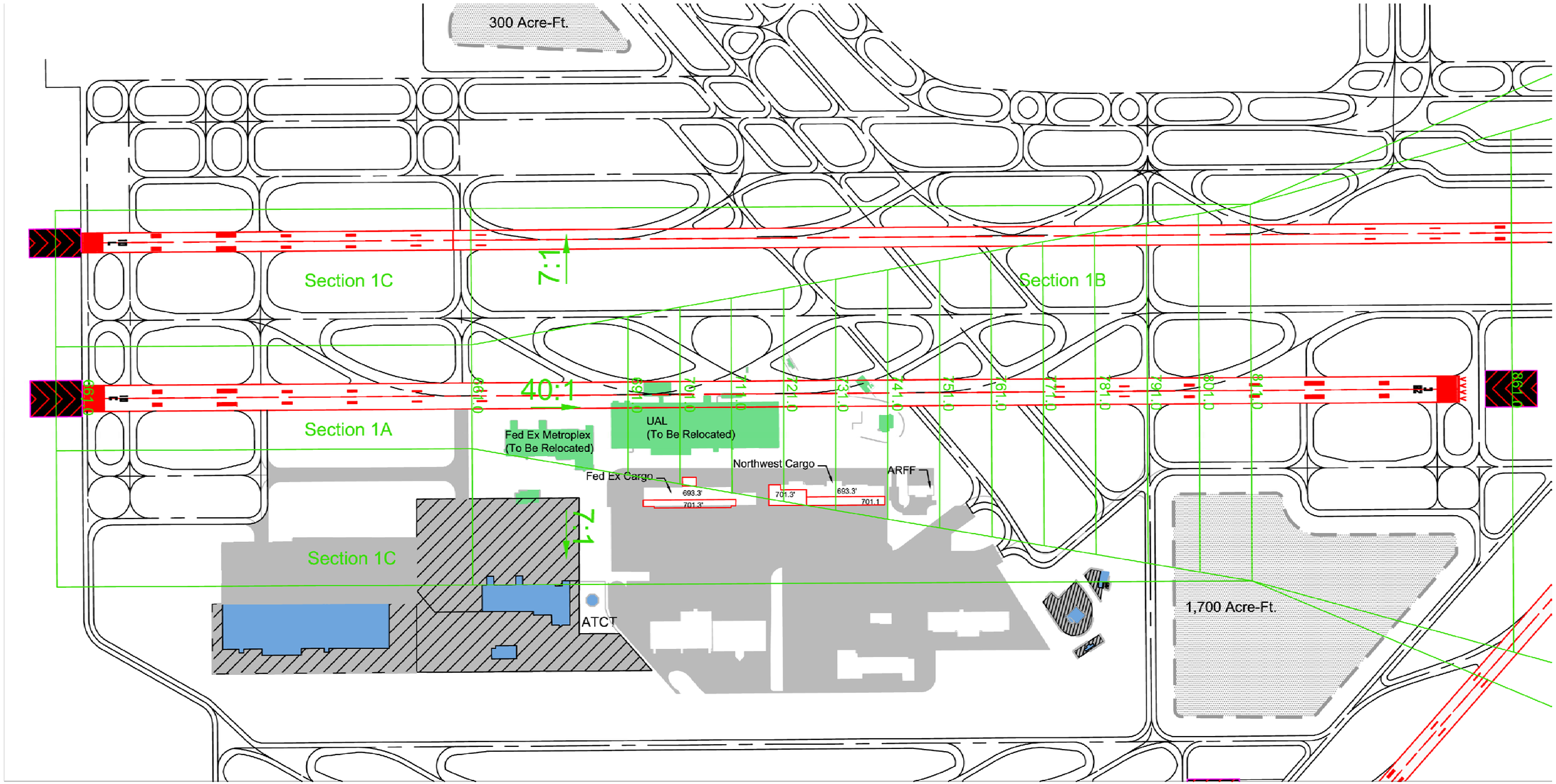
Exhibit II-54

0 N.T.S.

north

Runway 10C/28C Profile
Flat Runway (At-Grade)

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-54.dwg, Layout: 11x17_Feb 27, 2003, 1:44pm



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

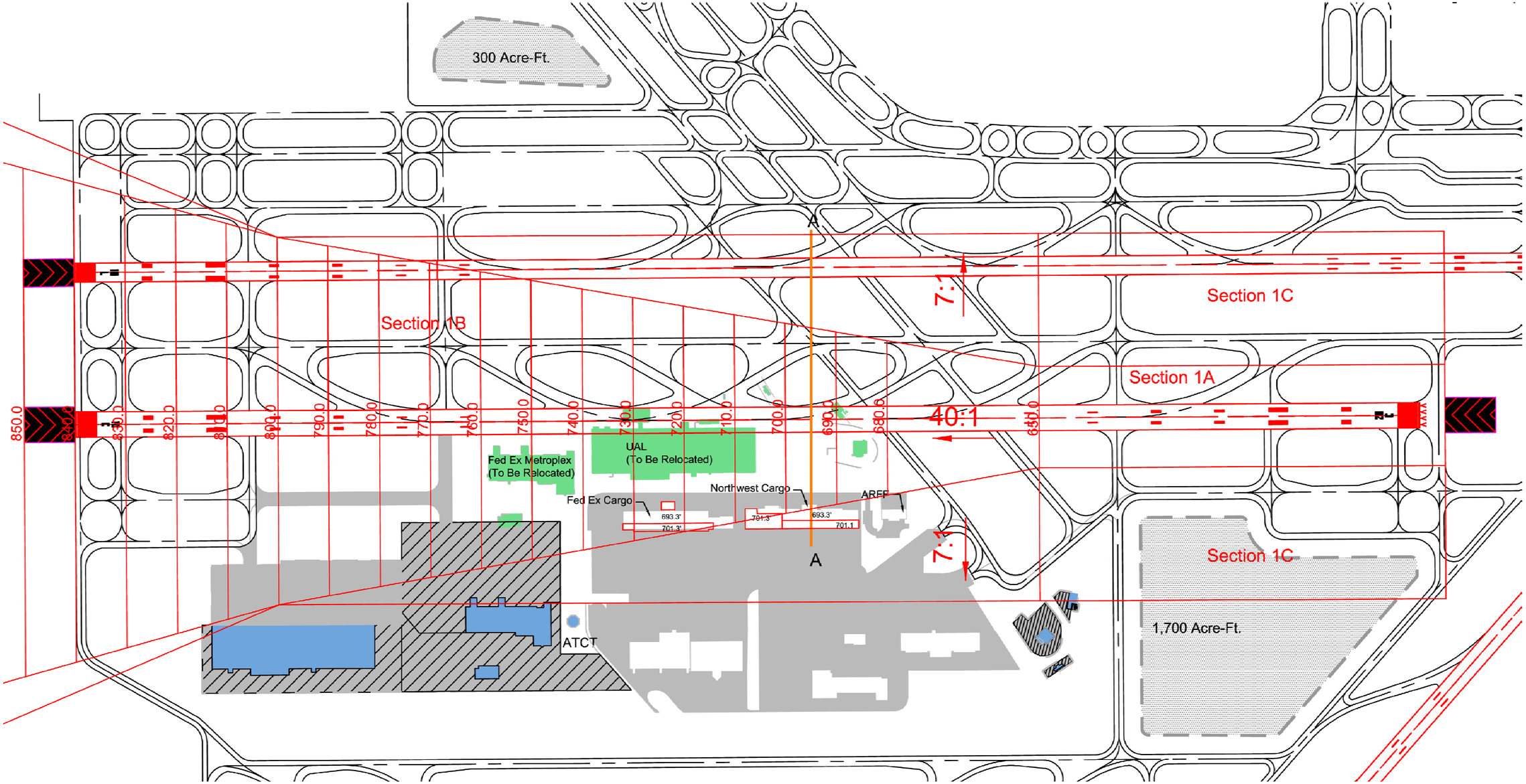
Exhibit II-55

0 N.T.S.

north

Runway 10C TERPS Obstructions

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-55.dwg, Layout: 11x17, Feb 27, 2003, 1:01pm



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

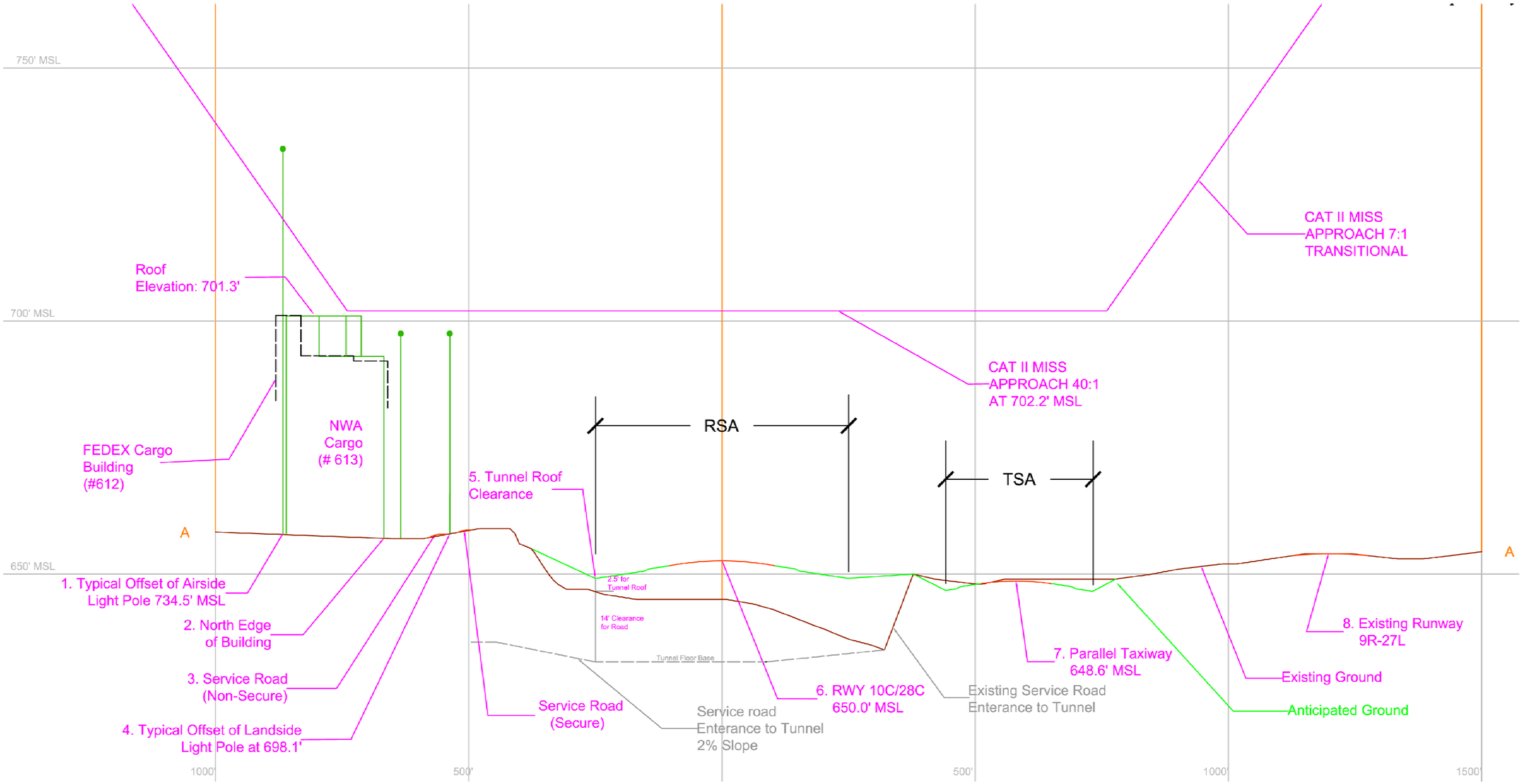
Exhibit II-56

0 N.T.S.

north

Runway 28C TERPS Obstructions

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-56.dwg, Layout: 11x17, Feb 27, 2003, 1:29pm



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

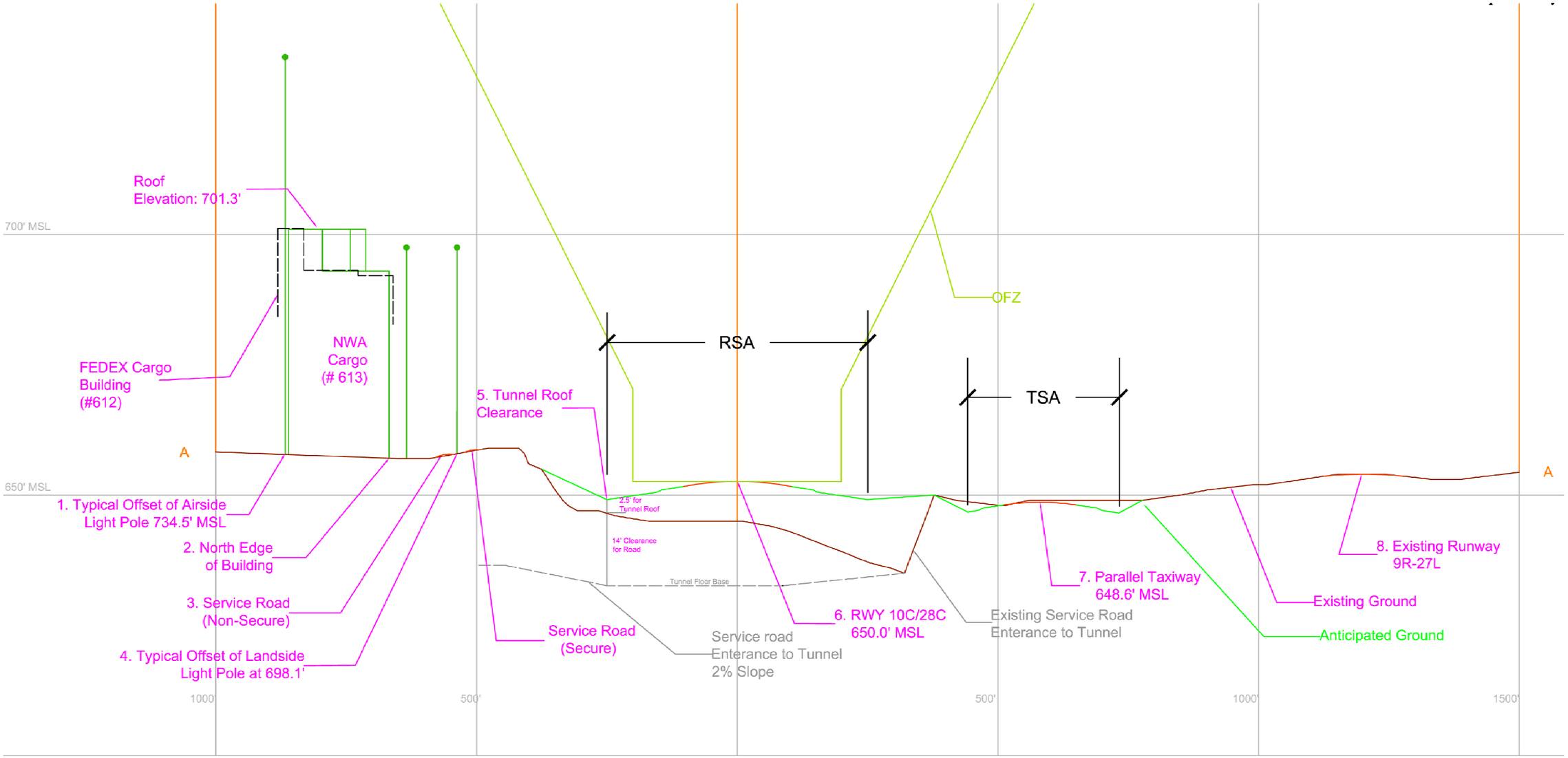
Exhibit II-57

0 N.T.S.

north

Runway 28C Section A-A
TERPS CAT II Missed Approach

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-57.dwg, Layout: 11x17, Feb 27, 2003, 12:38pm



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

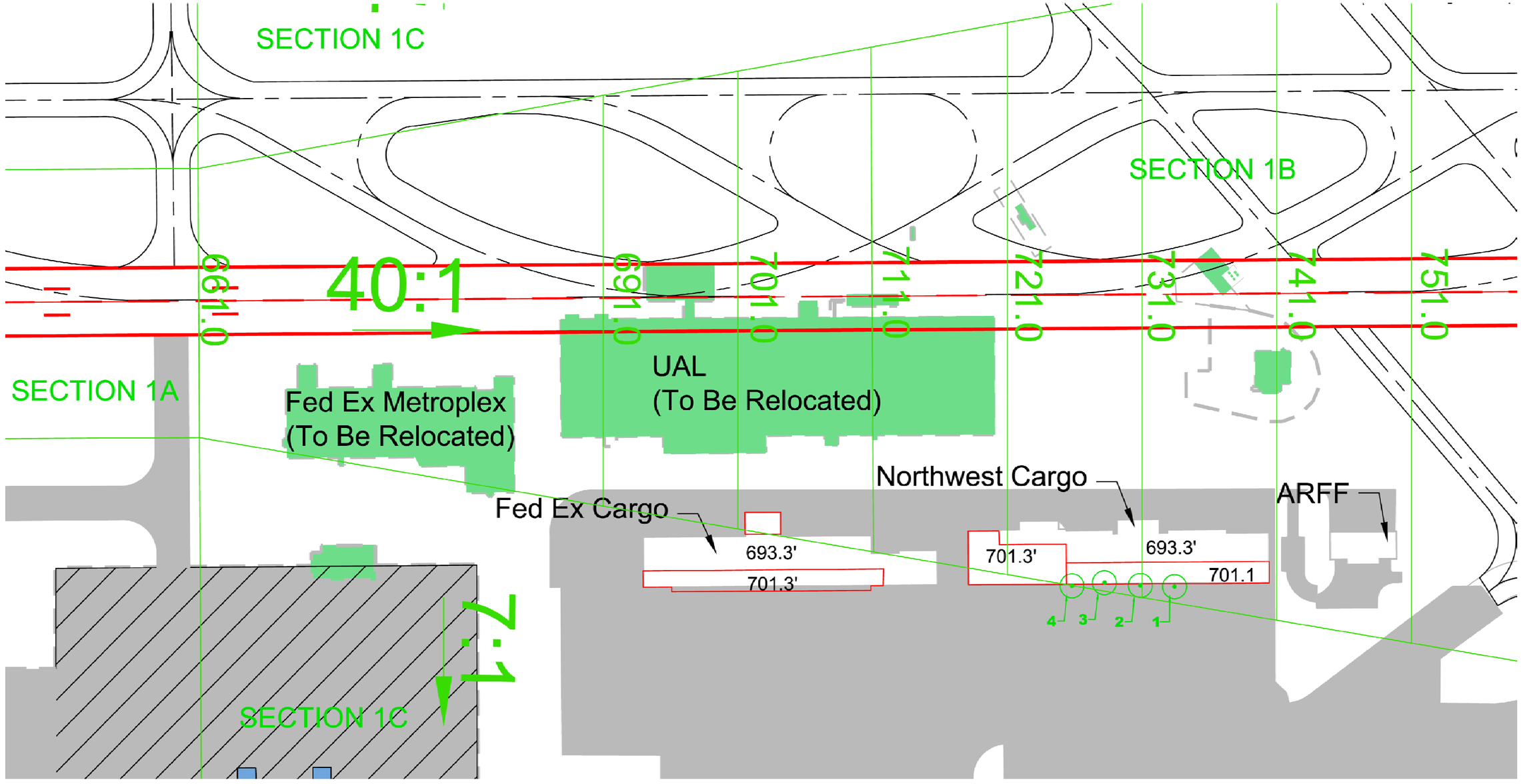
Exhibit II-58

0 N.T.S.

north

Runway 28C Section A-A
Typical OFZ Cross-Section

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-58.dwg_Layout: 11x17_Feb 27, 2003, 1:10pm



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

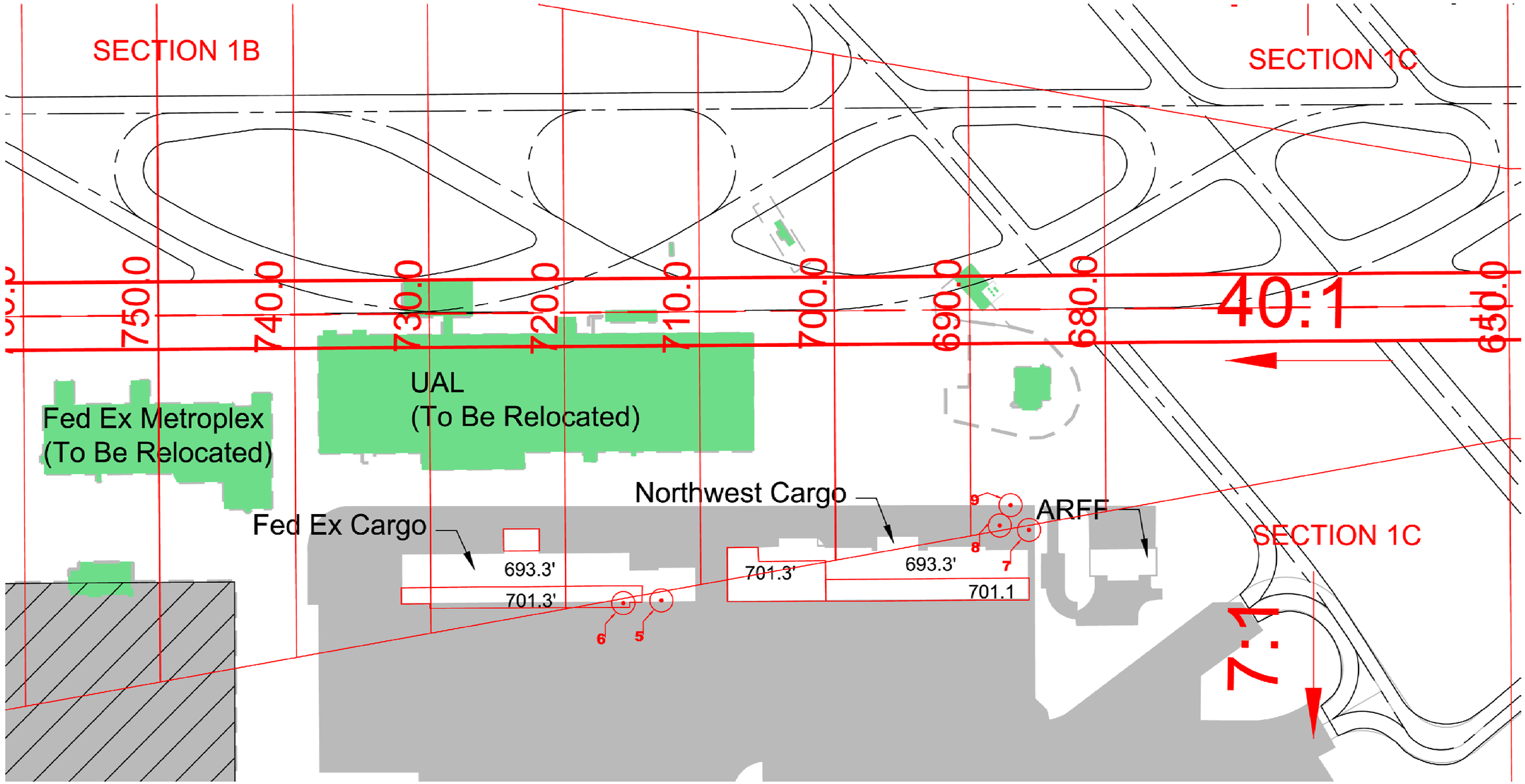
Exhibit II-59

0 N.T.S.

north

TERPS Missed Approach Surfaces
Runway 10C Obstructions

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-59.dwg, Layout: 11x17_Feb 27, 2003, 12:27pm



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

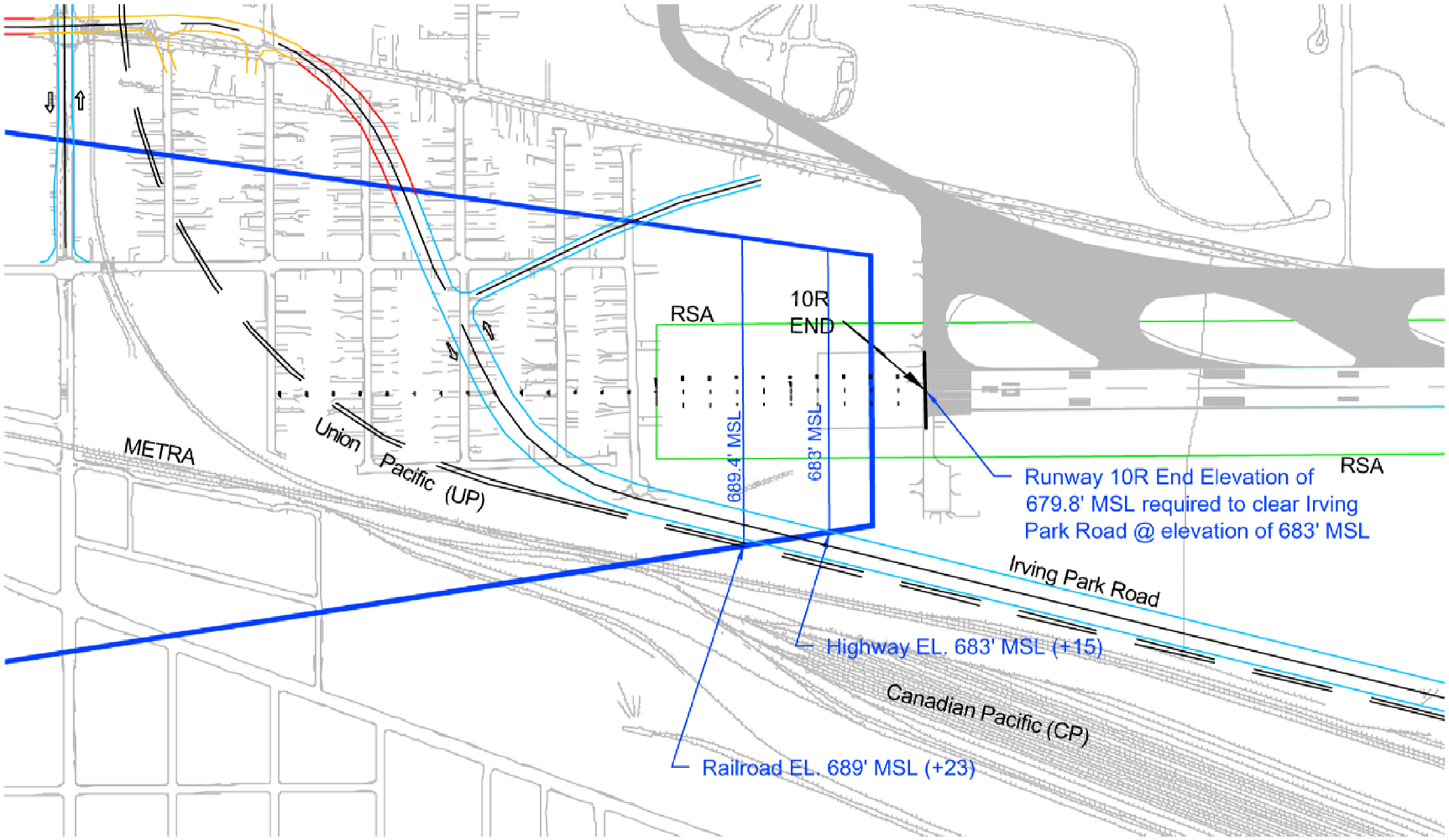
Exhibit II-60

0 N.T.S.

north

TERPS Missed Approach Surfaces
Runway 28C Obstructions

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-60.dwg, Layout: 11x17_Feb 27, 2003, 12:52pm



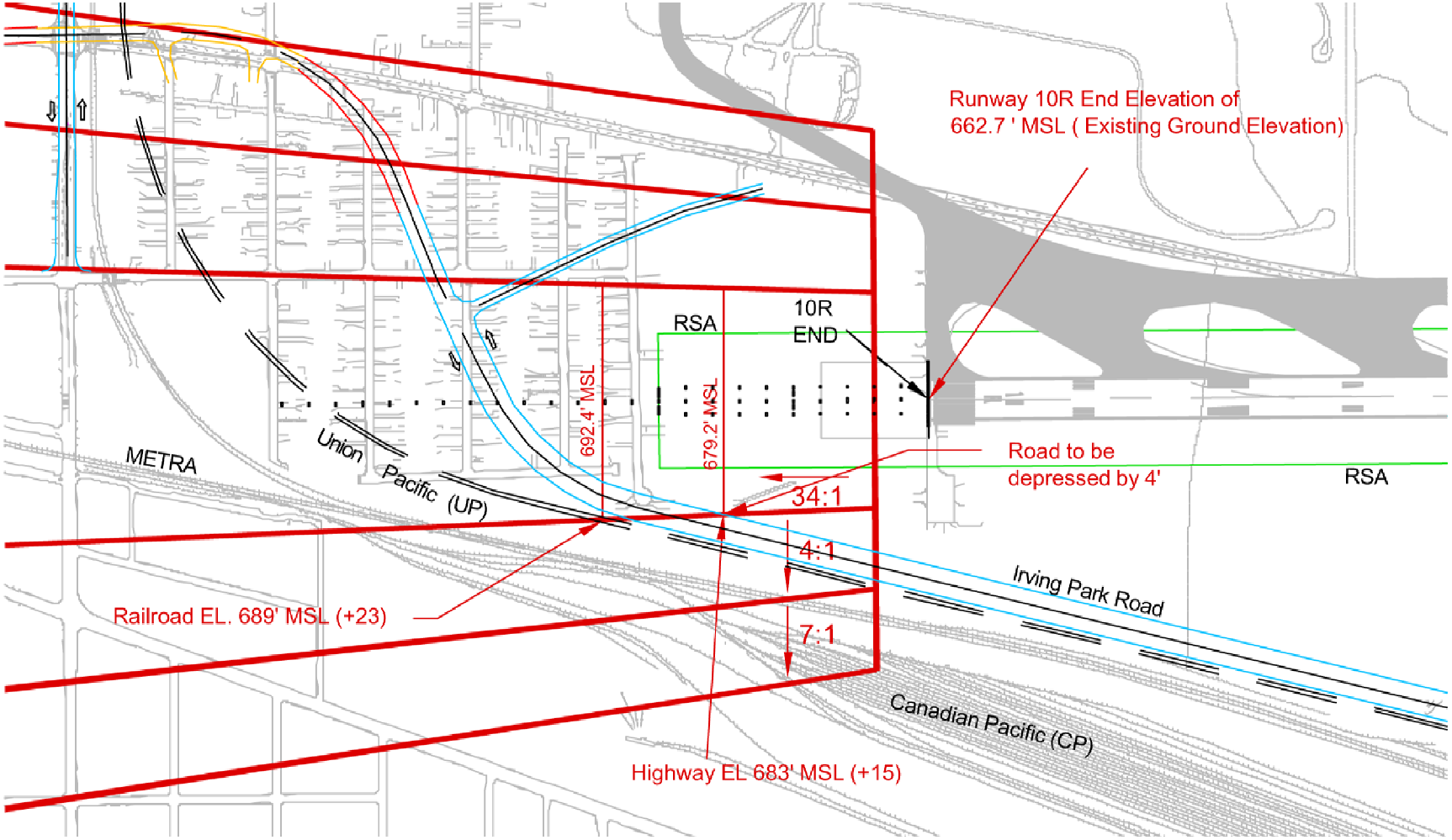
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-61

0 600
north

Part 77 Approach
Runway 10R End

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-61.dwg_Layout: 8.5x11_Feb 26, 2003, 7:17pm



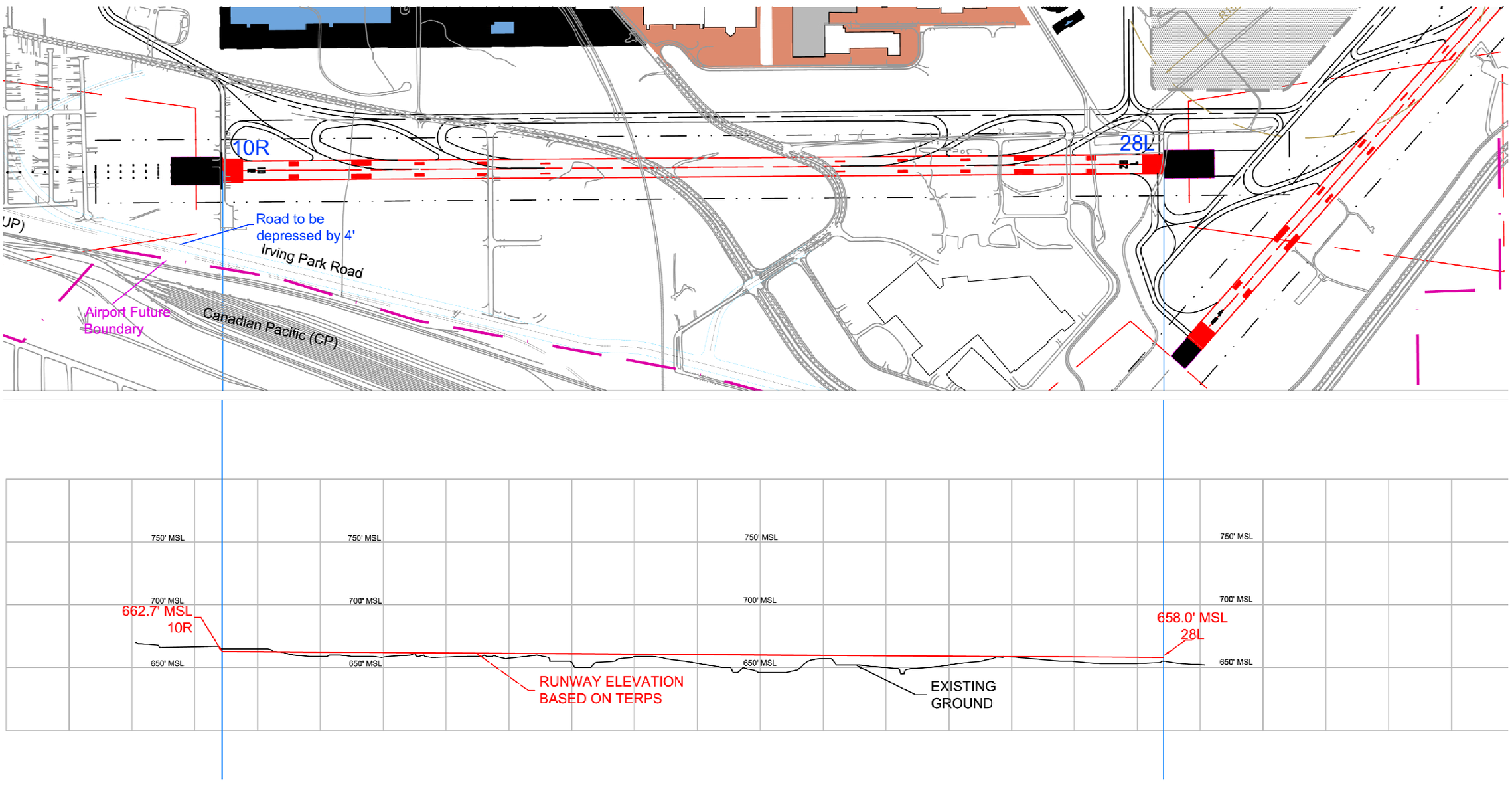
Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-62

0 600
north

Terps Approach
Runway 10R End

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-62.dwg_Layout: 8.5x11_Feb 26, 2003, 7:25pm



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

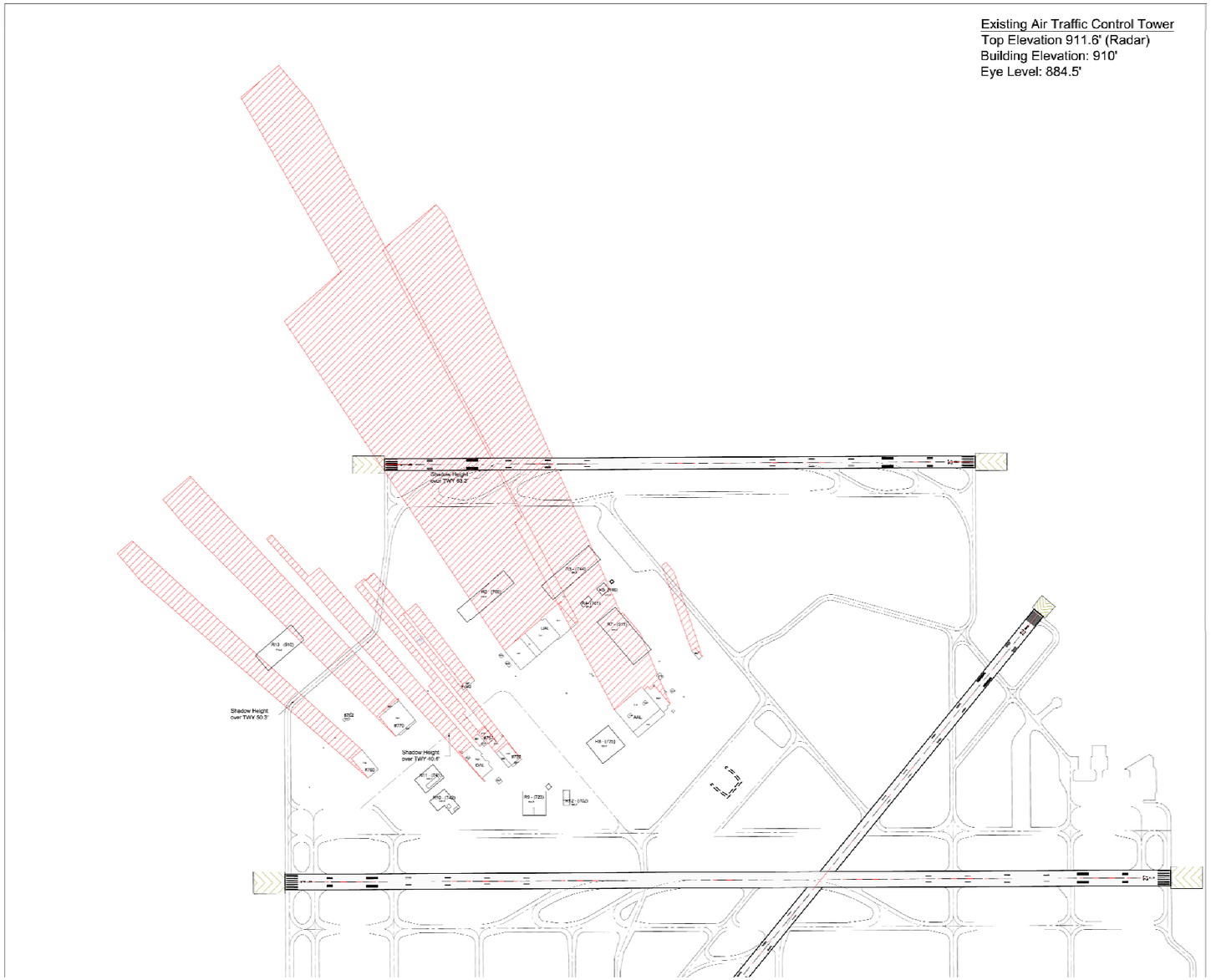
Exhibit II-63

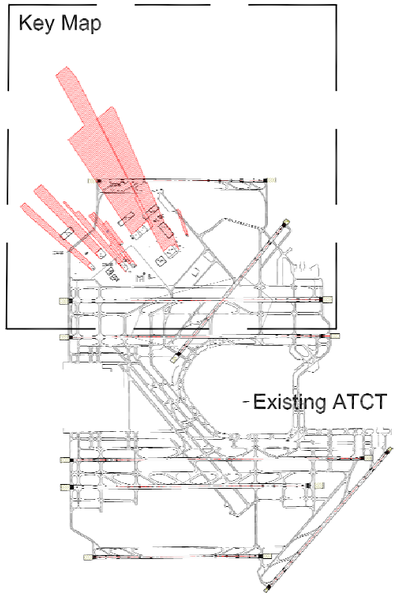
0 N.T.S.

north

Runway 10R/28L Profile

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-63.dwg Layout: 11x17_Feb 27, 2003, 12:19pm





Legend

- Existing Building Shadows
- Existing Building
- Future Building

Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-64

0 N.T.S.

north

North Runway and West Taxiway Sight Only
Existing Building Shadows

Drawing: Z:\Chicago\ORD\OMP\Airfield\Concept Refinement\Current\Exhibit II-64.dwg, Layout: 11x17_Feb 27, 2003, 12:33pm