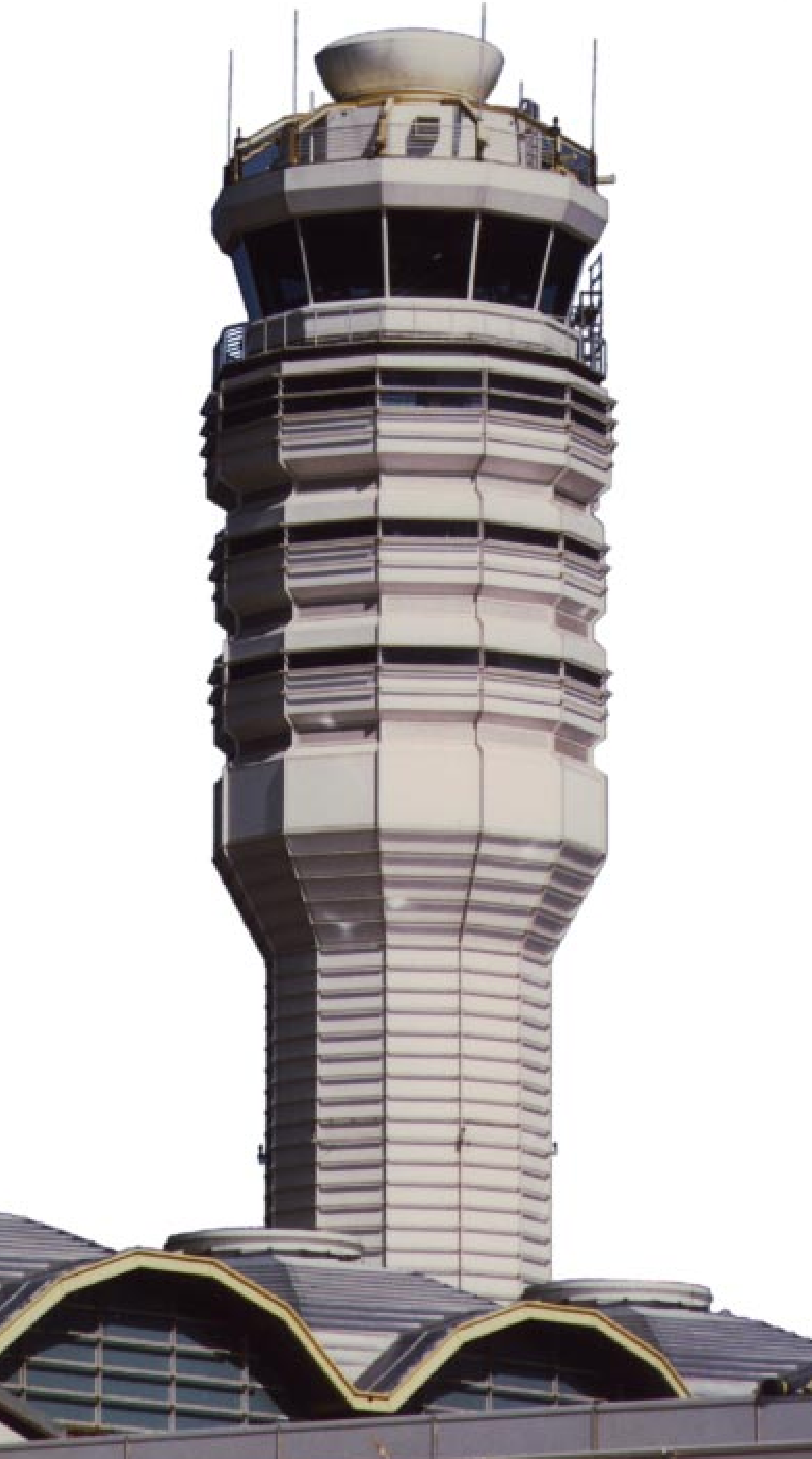

1996 ACE PLAN

Aviation Capacity Enhancement

U.S. Department
of Transportation

**Federal Aviation
Administration**

U.S. Department
of Transportation
**Federal Aviation
Administration**

800 Independence Ave., S.W.
Washington, D.C. 20591

In our efforts to continually improve the nation's aviation system capacity, and in support of the FAA Strategic Plan, we present to the aviation community the 1996 Aviation Capacity Enhancement Plan.

With an increasing number of operations at our busiest airports and a move towards a more collaborative decisionmaking environment, our mission to ensure that airspace and airport capacity continue to grow to meet user needs in the most cost-effective manner, becomes an even greater challenge. We must ensure that resources are fully utilized to meet the traffic demand and eliminate capacity-related delays, and that airport capacity in poor weather more nearly equals capacity in good weather conditions.

The FAA recognizes that delay is an incomplete measure of system capacity. In addition to delay statistics, the FAA is developing flexibility, predictability, and access performance measures to monitor both the capacity and performance of the aviation system. The same performance measures will also be used to evaluate proposed system capacity enhancements.

This year's plan identifies recommendations and actions which can be taken by both the public and private sectors to improve the National Airspace System capacity and reduce delays. It also updates the status of prior recommendations.

Realizing that both the quality and cost of air service in a large measure is dependent upon capacity, we continue to strive to ensure that aviation system capacity will grow to meet the demand.

Carl B. Schellenberg
Director of System Capacity

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16. Abstract

A comprehensive review of Federal Aviation Administration programs intended to improve the capacity of the National Air Transportation System. The Plan describes the extent of capacity and delay problems currently associated with air travel in the U.S. and outlines various planned and ongoing FAA projects with the potential to reduce the severity of the problems in the future. The major areas of discussion are:

1) Status of the National Aviation System
2) Airport Development
3) Airspace Development
4) New Operational Procedures
5) Emerging Technology

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Overview

The purpose of the Aviation Capacity Enhancement (ACE) Plan is to describe FAA initiatives to enhance the capacity and performance of the U.S. Aviation System. The ACE Plan is produced by the FAA Office of System Capacity (ASC). ASC identifies and evaluates capacity enhancements such as airport expansion, airspace redesign, and new operational procedures to ensure that the capacity of the U.S. Aviation System keeps pace with demand for aviation services. Although ASC is the only office with capacity enhancement as its primary mission, the activities of many offices within the FAA, and other agencies such as the National Aeronautics and Space Administration (NASA) and the Department of Defense (DoD) contribute to capacity enhancement. ASC coordinates the capacity-improvement efforts of these other offices and organizations.

The ACE Plan is one of several FAA documents that address system capacity goals and initiatives. The FAA Strategic Plan, the FAA's five-year Master Plan, provides high-level capacity goals and objectives. The National Airspace System (NAS) Architecture Plan, a 20-year roadmap for modernizing the National Airspace System, proposes detailed strategies for capacity improvements. The National Plan of Integrated Airport Systems (NPIAS), a biannual ten-year plan, sets forth the type and estimated costs of airport development considered necessary to provide a safe, efficient, and integrated system of airports. Recommendations from ASC's airport capacity studies provide input to the NPIAS.

One measure for assessing system capacity is aircraft delay. From 1991 to 1995, the number of air carrier operations increased from 35.5 million to 39.4 million. Over the same period, the number of air carrier operations delayed fifteen minutes or more fell from 298,000 to 237,000. However, the average delay per flight held steady at 7.1 minutes. Delays are still common, especially at certain capacity-constrained airports.

The FAA recognizes that delay is an incomplete measure of system capacity. In addition to reduced delay, aviation system users value other aspects of system capacity and performance such as the flexibility and predictibility of the air traffic control system as experienced by the user, and user access to FAA services. Through ASC the FAA has begun to asses these aspects of system performance and capacity and evaluate alternative approaches to capacity enhancement.

The FAA is beginning to transition from an environment of traditional air traffic control to a more flexible system of air traffic management, commonly referred to as free flight. Under the free flight concept, users would have significant autonomy in determining their routes and speeds in uncongested areas and would frequently make decisions collaboratively with controllers in congested conditions. Free flight requires an aviation system with the capacity to efficiently accommodate the demand for services. Thus, the system capacity enhancements discussed in the ASC Plan — airport development, airspace design, improved operational procedures, and emerging technologies — will contribute to successful implementation of free flight.

The ASC Plan is organized by chapters. Chapter 1: Status of the National Aviation System, describes changes in levels of aviation activity, presents delay trend data, and introduces baseline data for several new measures of system capacity (predictability, flexibility, and access). Chapter 2: Airport Development, describes ongoing airport construction projects and airport capacity enhancement studies. Chapter 3: Airspace Development, describes ongoing airspace analysis projects designed to achieve more efficient en route air traffic patterns in congested airspace. Chapter 4: New Operational Procedures, explains the concept of free flight and describes new en route and terminal approach procedures which increase system capacity and reduce restrictions on aircraft. Chapter 5: Emerging Technology, describes technological advances in the areas of: automation; information systems; communication, navigation, and surveillance; and weather, which will improve the quality of aviation services and support implementation of free flight.

The appendices contain useful data on the aviation system. Appendix A provides various aviation activity statistics. Appendix B contains diagrams of the Top 100 airports, with descriptions of new or planned construction. Appendix C is a list of acronyms, and Appendix D is an index.

Chapter 1: Status of the National Airspace System

Changes in aviation capacity requirements are primarily generated by increases in demand on the existing aviation system. Changes in capacity requirements are also generated by changes in user expectations regarding the quality and quantity of aviation services and by the introduction of new technology, which can contribute to capacity gains. The purpose of this chapter is to provide information on current and projected aviation activity and on changes in flight delay and other measures of system capacity and performance. The aviation activity data are indicators of demand on the system; the system performance measures are indicators of the ability of the aviation system to accommodate the demand.

1.1 Aviation Activity

Aviation activity in the U. S. is expected to grow significantly over the next decade. This increased demand will be placed on an aviation system in which key airports and terminal areas are already frequently congested.

1.1.1 U.S. Aircraft Operations and Enplanements

From 1991 to 1995 the number of aircraft operations in the U.S. held steady at about 62 million. Over the same period, the number of air carrier and regional /commuter enplanements increased steadily from 491.5 million in 1991 to 598.0 million in 1995, a 22 percent increase. By 2007, operations are expected to increase to 74.5 million (a 19 percent increase over 1995), and enplanements to 953.6 million (a 59 percent increase over 1995). The higher growth predicted for passenger enplanements relative to aircraft operations is primarily the result of higher load factors and larger seating capacity for air carrier aircraft. Figure 1-1 illustrates the trend in aircraft operations and passenger enplanements nationwide and at the top 100 airports in the U.S. [1]

1. 1995 data is used as a baseline throughout this Plan because 1996 data was not available and verified at publication time.

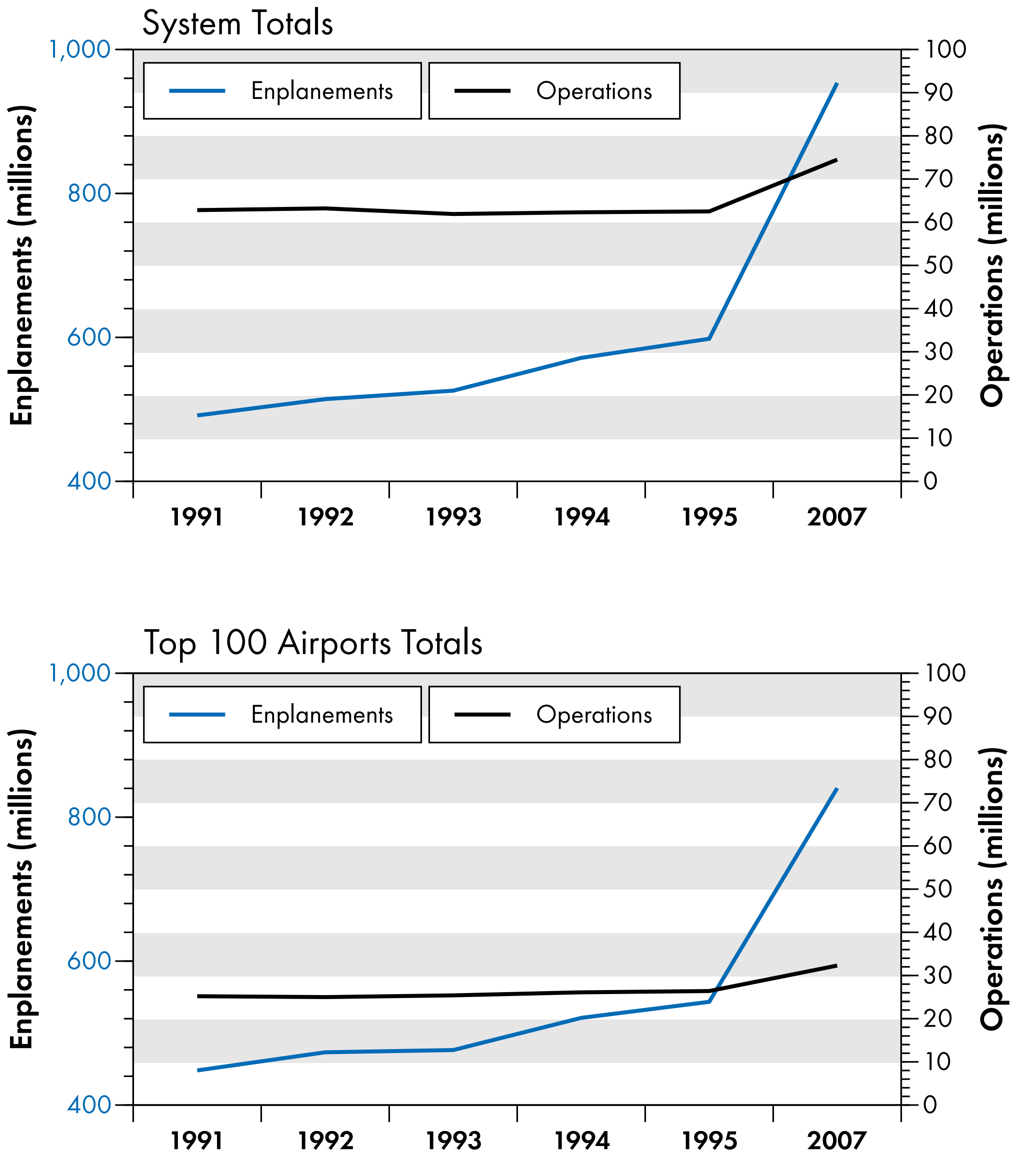

Figure 1-1.

Growth in U.S. Passenger Enplanements and Operations, 1991 to 2007*

* Enplanement totals include air carriers, both domestic and international, regionals and commuters.

Operation totals include air carriers, regional, commuter, air taxi, general aviation, and military.

1.1.2 Aircraft Operations and Passenger Enplanements at the Top 100 Airports

The top 100 airports in the United States, as measured by 1995 passenger enplanements, are shown in Figure 1-2.[2]

The 408.8 million passengers that enplaned at the top 100 airports in 1995 accounted for over 94 percent of all passengers in the U.S. in 1995.

The number of aircraft operations at the top 100 airports increased from 25.1 million in 1991 to 26.4 million in 1995, a 5.2 percent increase. Over the same period, the number of air carrier and regional/commuter enplanements increased from 408.8 million to 543.4 million a 32.9 percent increase. By 2007, aircraft operations at the top 100 airports are projected to increase to 32.3 million (a 22.3 percent increase over 1995), and enplanements to 840.4 million (a 105.6 percent increase over 1995).

Operations and enplanement data for 1993, 1994, and 1995 and forecasts of operations and enplanements for the top 100 airports in 2010 are included in Appendix A.

Aviation activity in the U. S. is expected to grow significantly over the next decade. This increased demand will be placed on an aviation system in which key airports and terminal areas are already frequently congested.

1.1.3 Traffic Volume in Air Route Traffic Control Centers (ARTCCS)

From 1994 to 1995 instrument flight rules (IFR) operations increased at 18 of the 20 Continental United States (CONUS) ARTCCs. The number of aircraft flying under IFR handled by ARTCCs totaled 40.2 million in 1995, an increase of 3.3 percent over 1994.

The busiest ARTCCs in 1995 were: Chicago, Cleveland, Atlanta, Washington, and Indianapolis. Forecasts for 2007 indicate a change in ranking of the busiest ARTCCs to: Chicago, Cleveland, Atlanta, Indianapolis, and Minneapolis. The ARTCCs with the highest average annual growth rates are Boston and Los Angeles, which are projected to grow by 2.6 and 2.5 percent respectively. Figure 1-3 provides a map of the 20 CONUS ARTCCs. Figure 1-4 shows the number operations by ARTCC for FY95 and FY96, and forecasted operations for FY07.

From 1994 to 1995 instrument flight rules operations increased at 18 of the 20 Continental United States ARTCCs. The number of aircraft flying under IFR handled by ARTCCs totaled 40.2 million in 1995, an increase of 3.3 percent over 1994.

2. Based on 1995 passenger enplanements in the FAA's *Terminal Area Forecasts.*

Figure 1-2.

Top 100 Airports Based on 1995 Passenger Enplanements

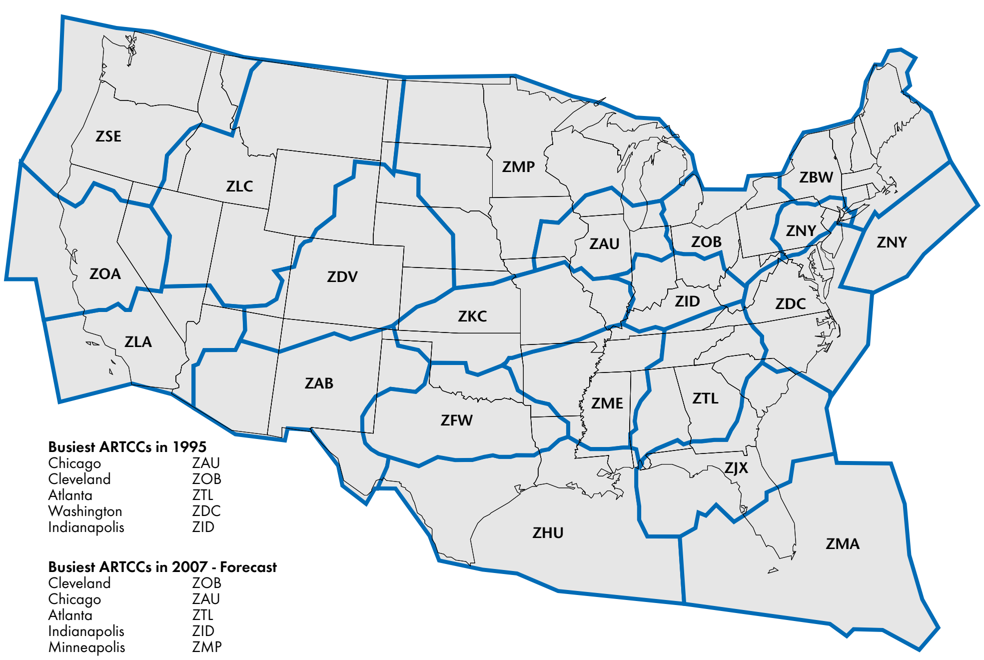

Figure 1-3.

CONUS Air Route Traffic Control Centers

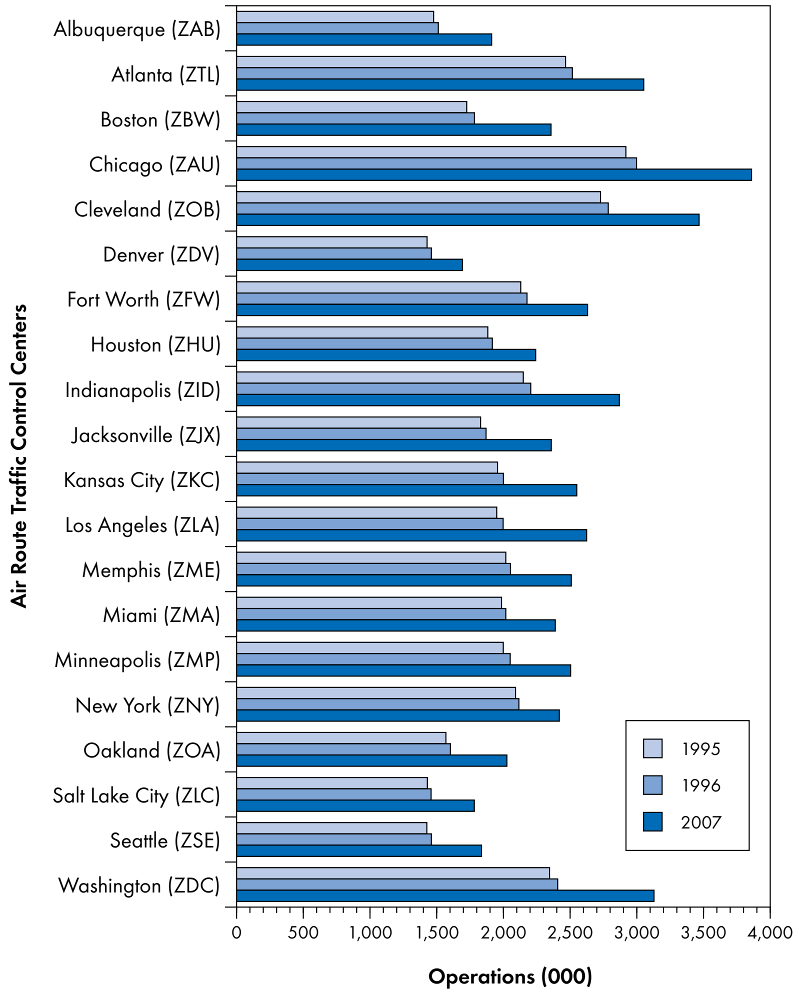

Figure 1-4.

Operations at CONUS ARTCCs

1.2 System Capacity Measures

The FAA measures system capacity primarily in terms of aircraft delay. Capacity enhancing programs have been targeted at airports, technology, and procedures that appear to be the cause of, or the solution to, flight delays. Although a principal goal of the FAA ATC system is to minimize the impact of poor weather on aircraft operations, poor weather continues to be a significant source of delay.

The FAA measures system capacity primarily in terms of aircraft delay. Capacity enhancing programs have been targeted at airports, technology, and procedures that appear to be the cause of, or the solution to, flight delays.

The FAA recognizes, however, that delay is an incomplete measure of system capacity. First, delays are somewhat cyclical; when delays are reduced due to capacity enhancements, airlines respond by designing more rigorous schedules, resulting in more delays. Also, the aviation system users value other aspects of system capacity and performance (in addition to delay), such as:

- Flexibility: the extent to which the air traffic control system allows users to optimize their operations based on their own objectives and constraints;
- Predictability: stability in the air traffic management system as experienced by the user; and
- Access: the ability of users to access airports, airspace, and services.

To ensure that capacity-enhancing efforts address these additional facets of system performance, the FAA has begun to develop flexibility, predictability, and access performance measures.

To ensure that capacity-enhancing efforts address these additional facets of system performance, the FAA has begun to develop flexibility, predictability, and access performance measures. Over the next several years, the FAA will continue to develop and refine the new measures, track their progress, and develop targets for improvement. The measures will be used in addition to delay statistics to monitor the capacity and performance of the aviation system and to evaluate proposed capacity and performance enhancements.

1.2.1 Delay

Delay is an indicator that capacity is being reached and, perhaps, exceeded. The FAA uses two sources of delay data. The first is the Air Traffic Operations Management System, and the second source of delay data is the Airline Service Quality Performance database.

Delay is an indicator that capacity is being reached and, perhaps, exceeded. It is also an indicator of the efficiency of the air traffic control system. The FAA uses two sources of delay data. The first is the Air Traffic Operations Management System (ATOMS), in which FAA personnel record aircraft that are delayed in any stage of flight by 15 minutes or more by specific cause (weather, terminal volume, center volume, closed runways or taxiways, and NAS equipment interruptions). A delay is recorded if an aircraft is delayed 15 minutes or more during taxi out or 15 minutes or more in any enroute center. Thus, an aircraft could be delayed 14 minutes during taxi out and 14 minutes in each ARTCC it passes through and not be recorded as a delay by ATOMS. Taxi-in delays are not counted.

The second source of delay data is the Airline Service Quality Performance (ASQP) database. ASQP data are collected only from airlines with one percent or more of the total domestic scheduled service passenger revenue. ASQP delay data are recorded by phase of flight (i.e., gate-hold, taxi-out, airborne, or taxi-in delays). ASQP delays range from 1 minute to greater than 15 minutes. ASQP is used primarily for consumer on-time performance reporting and is under DOT control.

1.2.1.1 Delay by Cause

Flight delays exceeding 15 or more minutes were experienced on approximately 237,000 flights in 1995, a decrease of 4 percent from 1994. Weather was attributed as the primary cause of 72 percent of operations delayed by 15 minutes or more in 1995, down from 75 percent in 1994. Terminal air traffic volume accounted for 18 percent of delays of 15 or more minutes in 1995, down from 19 percent in 1994. Table 1-1 illustrates trends in the distribution of flights delayed 15 minutes or more by primary cause. With the exception of the split between terminal and center volume delays, the basic distribution of delay by cause has remained fairly consistent over the past five years.

Flight delays exceeding 15 or more minutes were experienced on approximately 237,000 flights in 1995, a decrease of 4 percent over 1994. Weather was attributed as the primary cause of 72 percent of operations delayed by 15 minutes or more in 1995.

Weather-related delays are largely the result of instrument approach procedures, which are much more restrictive than the visual procedures used during better weather conditions. During the past few years the FAA has developed more efficient IFR approach procedures. These new procedures, which increase ruway capacity, are discussed in Chapter 4. Weather-related delays are also caused by the absence of precision landing aids at certain airports, preventing aircraft from landing at those airports in bad weather. The FAA continues to install and upgrade existing instrument landing systems (ILSs) to support continued operations during conditions of reduced visibility. Over the next 10 years, the FAA will transition to Global Positioning Satellite (GPS) approaches supplemented by the Wide Area Augmentation System (WAAS) and the Local Area Augmentation System (LAAS). The phase in of GPS will give users instrument appropach access to increasing numbers of runways in the U.S.

1.2.1.2 Delay by Phase of Flight

Table 1-2 presents the average delay in minutes by phase of flight. More delays occur during the taxi-out phase than any other phase. Airborne delays average 4.1 minutes per aircraft. To put this in perspective, there were approximately 6.2 million air carrier flights in 1995. With an average airborne delay of 4.1 minutes per aircraft, a total of over 424,000 hours of airborne delay occurred that year, costing the airlines $678 million at an estimated $1,600 per hour.[3]

3. The actual average aircraft operating cost is $1,587 per hour. The cost for heavy aircraft 300,000 lbs. or more is $4,575 per hour of delay, large aircraft under 300,000 lbs. and small jets, $1,607 per hour, and single-engine and twin-engine aircraft under 12,500 lbs., $42 and $124 per hour respectively. These figures are based on 1987 dollars.

Table 1-1.

Distribution of Delay Greater Than 15 Minutes by Cause

Distribution of Delay Greater than 15 Minutes by Cause					
Cause	**1991**	**1992**	**1993**	**1994**	**1995**
Weather	65%	65%	72%	75%	72%
Terminal Volume	27%	27%	22%	19%	18%
Center Volume	0%	0%	0%	0%	0%
Closed Runways/Taxiways	3%	3%	3%	2%	3%
NAS Equipment	2%	2%	2%	2%	3%
Other	3%	3%	2%	2%	4%
Total Operations Delayed (000s)	**298**	**281**	**276**	**248**	**237**
Percent of Total Operations	0.47%	0.44%	0.44%	0.40%	0.38%

Table 1-2.

Average Delay by Phase of Flight[4]

Average Delay by Phase of Flight (minutes per flight)					
Phase	**1991**	**1992**	**1993**	**1994**	**1995**
Gate-hold	1.1	1.1	1.0	1.1	1.1
Taxi-out	6.9	6.9	6.9	6.8	6.8
Airborne	4.1	4.1	4.1	4.1	4.1
Taxi-in	2.2	2.2	2.2	2.2	2.2
Total	14.3	14.3	14.2	14.2	14.2
Minutes per Operation	7.1	7.1	7.1	7.1	7.1

4. Gate-hold: The time held at the gate due to the ATC gate-hold.
Taxi-Out: The delay between gate departure and take-off.
Airborne: The delay while in flight.
Taxi-in: The delay between touchdown time and gate arrival.
Mins/op: Average delay in minutes per operation.

1.2.1.3 Identification of Delay-Problem Airports

For five consecutive years, the number of flights exceeding 15 minutes of delay has declined. From 1994 to 1995, the number of airline flight delays of 15 minutes or more decreased at 27 of the 55 airports at which the FAA collects air traffic delay statistics. Table 1-3 lists the number of operations delayed 15 minutes or more per 1,000 operations from 1991 to 1995 at 51 of these airports. These delays ranged from nearly 55 per 1,000 operations at San Francisco International Airport to 0.09 per 1,000 at Albuquerque International Airport. Three of the top ten airports with delays of 15 or more minutes were in the New York area.

For five consecutive years, the number of flights exceeding 15 minutes of delay has declined.

Figure 1-5 illustrates trends in operations and delays at ten of the busiest airports in the United States from 1991 to 1995. For most of the ten busiest airports, a smaller proportion of flights were delayed 15 minutes or more in 1995 than in 1991, while the number of operations increased. Exceptions are Atlanta, Los Angeles, and St. Louis, where delays were more common in 1995 than in 1991. In both St. Louis and Atlanta, completed capacity enhancements (see Table 2-3) and planned new runways (see Table 2-1) should help to reduce delays at these airports in the future.

1.2.1.4 Identification of Forecast Delay-Problem Airports

Despite ongoing capacity improvements and reduced delays system-wide, certain airports continue to account for significant delays. In 1995, 25 airports each exceeded 20,000 hours of annual aircraft flight delays. With an average aircraft operating cost of about $1,600 per hour of delay, each of these 25 airports contributed to at least $32 million dollars in annual delay costs. Assuming airport capacity is not improved, 29 airports are forecast to exceed 20,000 hours of annual aircraft flight delays each by the year 2005. Airports exceeding 20,000 hours of annual delay in 1995 and in 2005, assuming no capacity improvements, are listed in Table 1-4.

Despite ongoing capacity improvements and reduced delays system-wide, certain airports continue to account for significant delays.

Table 1-3.

Delays of 15 Minutes or More Per 1,000 Operations at Selected Airports

Airport	ID	1991	1992	1993	1994	1995
San Francisco International Airport	SFO	58.13	30.18	23.79	28.46	54.71
Lambert St. Louis International Airport	STL	29.90	14.96	19.54	22.72	33.87
Newark International Airport	EWR	67.26	83.48	87.88	74.29	33.81
New York LaGuardia Airport	LGA	61.63	55.23	38.32	47.37	33.65
Chicago O'Hare International Airport	ORD	47.94	45.40	47.49	26.83	30.93
Los Angeles International Airport	LAX	14.80	19.75	9.15	10.96	27.03
Dallas-Fort Worth International Airport	DFW	35.32	29.82	33.71	37.65	26.80
Hartsfield Atlanta International Airport	ATL	22.09	29.90	23.28	19.98	24.26
Boston Logan International Airport	BOS	32.84	34.61	39.23	29.79	22.15
New York John F. Kennedy International Airport	JFK	41.67	41.23	35.68	35.79	17.38
Miami International Airport	MIA	23.96	9.68	10.48	10.47	11.00
Houston Intercontinental Airport	IAH	12.62	7.86	8.06	5.52	10.79
Detroit Metropolitan Wayne County Airport	DTW	9.26	11.24	9.05	6.95	10.52
Minneapolis-St. Paul International Airport	MSP	7.87	4.36	7.16	3.52	9.23
Philadelphia International Airport	PHL	16.87	18.47	18.75	20.85	6.89
Washington National Airport	DCA	5.61	11.03	9.34	10.44	5.61
San Juan Luis Muñoz Marín International Airport	SJU	0.14	0.56	0.30	0.71	5.29
Phoenix Sky Harbor International Airport	PHX	6.68	8.16	2.86	3.48	4.97
Greater Cincinnati International Airport	CVG	5.28	5.95	6.38	6.40	4.88
Seattle-Tacoma International Airport	SEA	18.85	13.19	6.78	6.09	4.77
Charlotte/Douglas International Airport	CLT	9.68	6.19	3.79	4.90	4.75
Washington Dulles International Airport	IAD	9.01	7.33	6.86	8.43	4.54
San Diego International Lindberg Field	SAN	10.16	3.03	3.91	2.51	4.41
Chicago Midway Airport	MDW	7.09	2.12	2.98	3.10	4.03
Denver International Airport*	DEN	28.44	26.26	37.92	18.14	4.01
Fort Lauderdale-Hollywood International Airport	FLL	2.09	3.69	3.77	2.92	3.98
Cleveland Hopkins International Airport	CLE	1.99	1.58	2.37	1.62	3.74
Orlando International Airport	MCO	6.42	8.95	4.72	5.37	3.61
Houston William P. Hobby Airport	HOU	5.04	2.74	3.49	2.96	3.36
Salt Lake City International Airport	SLC	3.73	5.07	3.86	2.79	3.16
Greater Pittsburgh International Airport	PIT	5.04	8.04	6.86	4.20	2.99
Baltimore-Washington International Airport	BWI	5.99	5.80	3.94	5.15	2.68
Kansas City International Airport	MCI	2.98	0.75	1.26	1.82	2.22
Ontario International Airport	ONT	1.62	1.33	1.24	0.96	1.96
Las Vegas McCarran International Airport	LAS	0.42	0.31	0.46	0.78	1.62
Tampa International Airport	TPA	2.88	4.29	3.88	3.22	1.62
Portland International Airport	PDX	1.42	1.78	1.94	2.41	1.47
Nashville International Airport	BNA	3.90	2.91	2.72	1.55	1.46
Bradley International Airport	BDL	2.36	1.96	0.95	1.15	1.29
San Jose International Airport	SJC	4.29	1.74	0.38	0.72	1.03
San Antonio International Airport	SAT	0.32	0.20	0.10	0.35	0.87
Memphis International Airport	MEM	2.43	1.10	1.03	0.79	0.86
New Orleans International Airport	MSY	1.09	0.62	0.33	0.21	0.60
Palm Beach International Airport	PBI	1.50	1.02	0.81	0.39	0.57
Anchorage International Airport	ANC	1.32	0.34	0.74	0.29	0.51
Raleigh-Durham International Airport	RDU	2.00	3.60	1.99	1.25	0.50
Indianapolis International Airport	IND	1.02	2.11	0.57	0.45	0.40
Dayton International Airport	DAY	1.05	0.29	0.29	0.76	0.24
Kahului Airport	OGG	0.13	0.13	0.05	0.03	0.20
Honolulu International Airport	HNL	0.38	0.13	0.19	0.08	0.17
Albuquerque International Airport	ABQ	0.68	0.69	0.27	0.21	0.09

* 1991 thru 1994 data is for Denver Stapleton Airport, which closed in 1995.
This accounts for the drastic reduction in delay for the 1995 data.

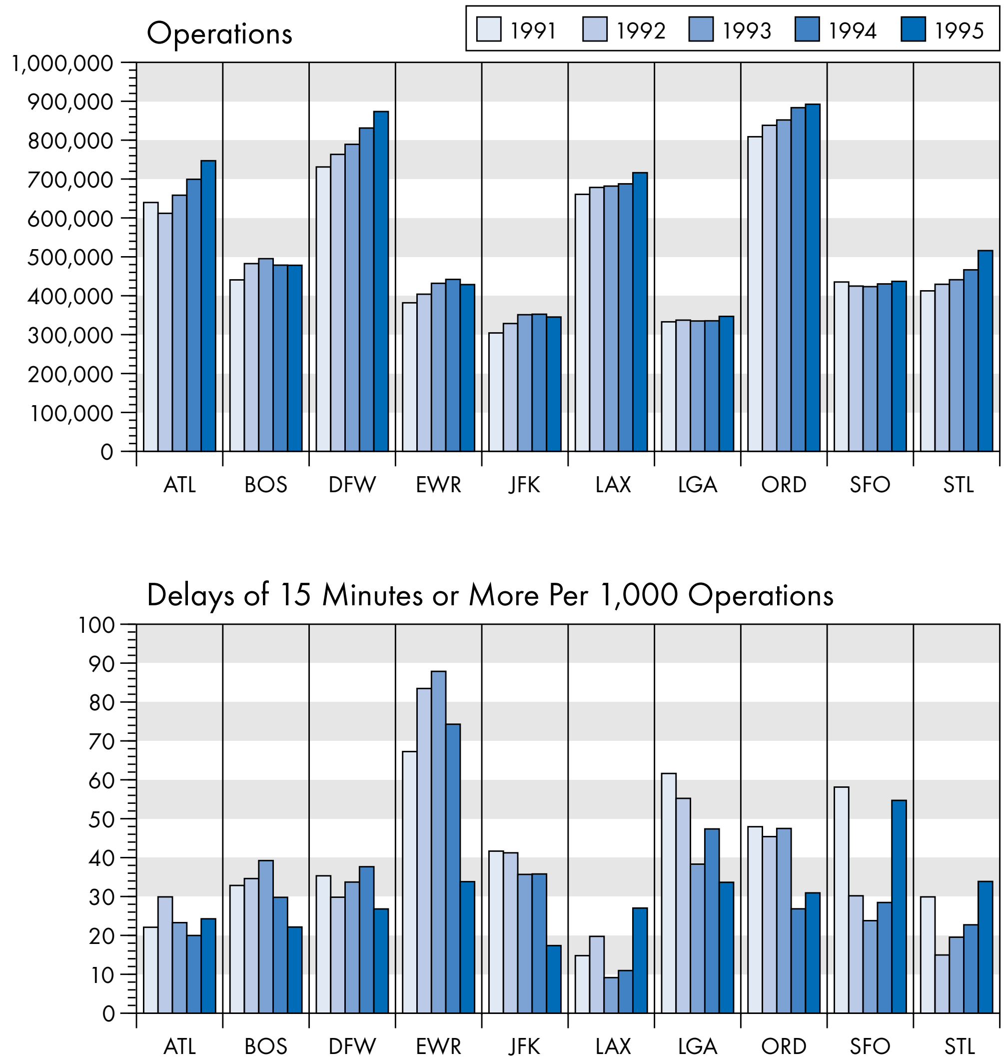

Figure 1-5.

Annual Operations and Delays of Fifteen Minutes or More Per 1,000 Operations at the Ten Busiest Airports

1.2.2 Flexibility

Airlines, GA pilots, and other aviation system users expect more from the air traffic management system than the minimization of delay. They desire the capability to optimize their operations based on their own objectives and constraints, which vary by flight and by user. Measuring the flexibility of the air traffic control system allows the FAA to evaluate its ability to permit users to adapt their operations to changing conditions. One measure of flexibility is the proportion of flights that are permitted to operate off ATC-peferred routes.

Measuring the flexibility of the air traffic control system allows the FAA to evaluate its ability to permit users to adapt their operations to changing conditions.

Table 1-4.

Airports Exceeding 20,000 Hours of Annual Delay in 1995 and 2005, Assuming No Capacity Improvements

Annual Aircraft Delay in Excess of 20,000 Hours			
1995		2005	
Atlanta Hartsfield	ATL	Atlanta Hartsfield	ATL
Boston Logan	BOS	Boston Logan	BOS
		Baltimore-Washington	BWI
Charlotte/Douglas	CLT	Charlotte/Douglas	CLT
		Cincinnati	CVG
Washington National	DCA	Washington National	DCA
Denver Stapleton	DEN		
Dallas-Ft. Worth	DFW	Dallas-Ft. Worth	DFW
Detroit	DTW	Detroit	DTW
Newark	EWR	Newark	EWR
Honolulu	HNL	Honolulu	HNL
Houston Intercont'l	IAH	Houston Intercont'l	IAH
New York John F. Kennedy	JFK	New York John F. Kennedy	JFK
Las Vegas	LAS	Las Vegas	LAS
Los Angeles	LAX	Los Angeles	LAX
New York La Guardia	LGA	New York La Guardia	LGA
Orlando	MCO	Orlando	MCO
		Chicago Midway	MDW
		Memphis	MEM
Miami	MIA	Miami	MIA
Minneapolis-Saint Paul	MSP	Minneapolis-Saint Paul	MSP
Chicago O'Hare	ORD	Chicago O'Hare	ORD
Philadelphia	PHL	Philadelphia	PHL
Phoenix	PHX	Phoenix	PHX
Pittsburgh	PIT	Pittsburgh	PIT
		San Diego	SAN
Seattle-Tacoma	SEA	Seattle-Tacoma	SEA
San Francisco	SFO	San Francisco	SFO
Salt Lake City	SLC	Salt Lake City	SLC
St. Louis	STL	St. Louis	STL

Source: FAA Office of Policy and Plans

1.2.2.1 Ability to Operate Off ATC-Preferred Routes

ATC-preferred routes are important tools that help air traffic controllers organize traffic flows around major airports. It may never be possible or desirable to eliminate all published ATC-preferred routes. However, the FAA is studying the ATC-preferred route system to determine if certain ATC-preferred routes could be eliminated without negatively impacting system operations. Initial analysis indicates that at selected locations, primarily in the western United States, many ATC-preferred routes could be canceled.

On a given day, approximately 30 per cent of flights operate between cities with published ATC-preferred routes. Once airborne, the majority of these flights are allowed to deviate from these published routes. This ability to deviate off the ATC-preferred route structure represents a significant portion of the flexibility allowed to users in the air traffic management system. It is possible to quantify this flexibility by examining the percentage of segments that were flown off of the ATC-preferred routes in each of the 20 en route air traffic control centers. Figure 1-6 illustrates the percentage of flight segments off the ATC-preferred route over a four day period.

On a given day, approximately 30 per cent of flights operate between cities with published ATC-preferred routes. Once airborne, the majority of these flights are allowed to deviate from these published routes.

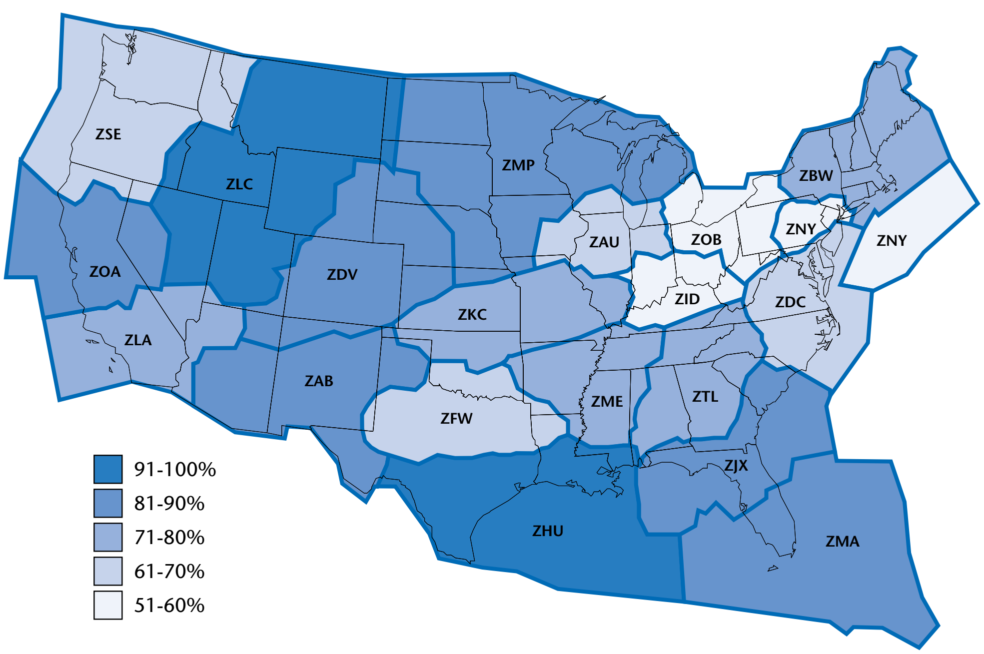

Figure 1-6.

Percentage of Flight Segments Off ATC-Preferred Routes Over a 4 Day Period

1.2.3 Predictability

One of the most unpredictable portions of a flight is the time the aircraft spends on the ground, moving to the terminal (taxi-in) and from the gate to the end of the runway (taxi-out).

The majority of system users rely on schedules that define when aircraft take-off and land. These schedules are central to the operations of almost all commercial flights, driving crew scheduling, ground service operations, and other operational components. Even the smallest deviation from the planned schedule can cause drastic impacts. One of the most unpredictable portions of a flight is the time the aircraft spends on the ground, moving to the terminal (taxi-in) and from the gate to the end of the runway (taxi-out). There are many factors that impact ground movement times, including level of demand, weather, and airport runway configuration. Figure 1-7 illustrates monthly variability in ground-movement times at the busiest 25 airports from January 1995 to October 1996. Monthly variability in taxi-out times ranges from 18 to 55 minutes. There is less variability in taxi-in times, with monthly averages of about 3 minutes.

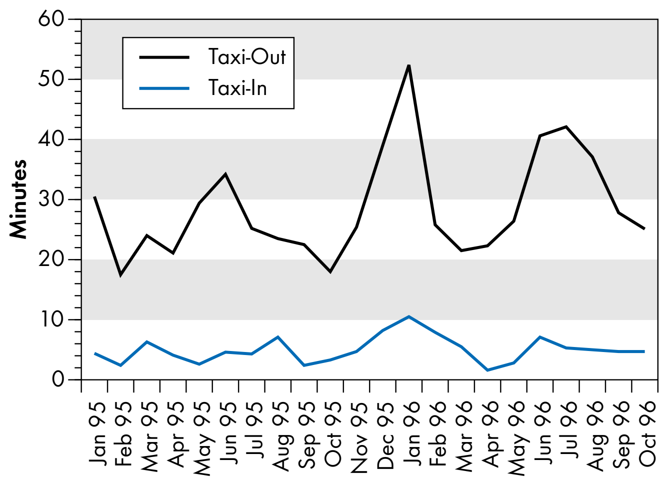

Figure 1-7.

Monthly Variability in Ground Movement Times at the Busiest 25 Airports

1.2.4 Access

Access to airports can be assessed by counting the number of airports with published approaches and with precision approach capability.

Access to the air traffic management system, airports, airspace, and other FAA services is a basic need of all airspace users. The FAA is beginning to measure access to flight services by measuring call waiting times. Access to airports can be assessed by counting the number of airports with published approaches and with precision approach capability. In 1995, 2,010 airports had published approaches, and 659 airports had precision approach capability. Increases in the number of airports with published approaches and precision-approach capability will be tracked by the FAA over time.

Chapter 2: Airport Development

Over the past five years, flight delays have been steadily decreasing while operations have increased. The success in reducing delays is due to airport and airspace development and the adoption of new operational procedures and technologies. According to the National Airspace System (NAS) Architecture, a 20-year evolutionary plan for modernizing the U.S. aviation infrastructure, the effectiveness of proposed NAS improvements will be constrained by the number of runways available; more runways need to be built to increase airport capacity commensurate with air traffic growth. The FAA's National Plan of Integrated Airport Systems (NPIAS) shows that planned improvements will produce adequate capacity to meet the forecasted growth in aggregate demand, but that additional enhancements will be required to relieve congestion in certain airports and regions.

2.1 Airport Construction and Expansion

Airport development frequently entails the construction of new terminals, new and expanded runways, and improved airfield design. In large metropolitan areas with frequent flight delays but limited airport expansion possibilities, other options must be explored. New airports, expanded use of existing commercial-service airports, civilian development of former military bases, and joint civilian and military use of existing military facilities are some of the additional options available for meeting expanding aviation needs.

2.1.1 Construction of New Airports

The largest aviation system capacity gains result from the construction of new airports; however, given the high cost of airport construction (e.g., more than $4 billion for new Denver International Airport, which opened in 1995), building a new airport is not a common capacity enhancement technique.

The only large new airport currently under construction is in Austin, Texas. Bergstrom AFB is being converted to an airport for civilian use to replace Robert Mueller Airport, which can no longer meet growing demand. The new airport is scheduled to open for cargo service in June 1997 and for passenger service by May 1999. The conversion of Bergstrom from a military to a civilian facility is a success from the perspectives of efficiently using a closed military base and expanding civil aviation airport capacity.

2.1.2 Construction of New Runways and Runway Extensions

Over the past five years, flight delays have been steadily decreasing while operations have increased. The success in reducing delays is due to airport and airspace development and the adoption of new operational procedures and technologies.

The construction of new runways and extension of existing runways are the most direct and significant actions that can improve capacity at existing airports.

The construction of new runways and extension of existing runways are the most direct and significant actions that can improve capacity at existing airports. Large capacity increases, under both visual flight rules (VFR) and instrument flight rules (IFR), result from the addition of new runways that are properly placed to allow additional independent arrival/departure streams.

Of the top 100 airports, seven completed runway construction projects in 1996, and nine are presently constructing new runways or runway extensions. Sixty-four of the top 100 airports have recently completed, or are in the process of developing, new runways or runway extensions to increase airport capacity. Table 2-1 lists new runways and runway extensions that were completed in 1996, are under construction, or are planned or proposed at the top 100 airports.

Of the 25 airports exceeding 20,000 hours of air carrier flight delay in 1995 (see Table 1-4) 16 are in the process of constructing, or planning the construction of, new runways or extensions of existing runways. Of the 29 airports forecast to exceed 20,000 hours of annual air carrier delay in 2005, 20 are building, or propose to build, new runways or runway extensions.

Table 2-1.

New and Extended Runways — Completed in 1996, Under Construction, and Planned or Proposed

Airport	Runway	Est Cost ($M)	Operational Date	Completed in 96	Under Construction
Albany (ALB)	10/28 extension	5.8	2000		
	1R/19L parallel	7.5	2010		
Atlanta (ATL)	5th E/W parallel	418	2000		
Baltimore (BWI)	10R/28L parallel	n/a	2003		
Bergstrom (new Austin)	17L/35R parallel	46	1998		
	west runway renovation	10	1996		X
Boise(BOI)	10L/28R extension	8	1998		
Boston (BOS)	14/32	n/a	n/a		
Charlotte (CLT)	18W/36W 3rd parallel	122	2000		
Chicago Midway (MDW)	4R/22L reconstruction	32	1997		X
Cleveland-Hopkins (CLE)	5W/23W replacement	180	2000		
	5L/23R extension	40	2005		
Port Columbus (CMH)	28R extension			X	
	10L extension	na	1997		X

Table 2-1 (continued).

New and Extended Runways — Completed in 1996, Under Construction, and Planned or Proposed

Airport	Runway	Est Cost ($M)	Operational Date	Completed in 96	Under Construction
Dallas-Fort Worth (DFW)	18L/36R extension	20	1999		
	18R/36L extension	20	1999		
	17L/35R new parallel			X	
	18R/36L new parallel	150	2001		
	17C/35C extension	15	1998		X
Denver International (DEN)	16R/34L parallel	75	2000		
Des Moines (DSM)	05 extension	21.5	1999		
Detroit (DTW)	4/22 parallel	116.5	2001		
El Paso (ELP)	8L/26R parallel	30	2010+		
	22 extension	8	2000		
Fort Lauderdale (FLL)	9R/27L extension	270	2002		
Fort Myers (RSW)	6R/24L parallel	80	2002		
Grand Rapids (GRR)	18/36 extension	58	1997		X
Greensboro (GSO)	5L/32R parallel	n/a	2020		
	14/32 extension	15.7	2005		
Greer (GSR)	3R/21L parallel	50	2015		
	3L21R extension	34.1	1999		
Houston Intercontinental (IAH)	14R/32L extension	8	n/a		
	8L/26R parallel	44	n/a		
	9R/27L parallel	44	n/a		
Jacksonville (JAX)	7R/25L parallel	50	2006		
Kahului (OGG)	2/20 extension	40	1998		
Kansas City (MCI)	1L/19R extension	12	n/a		
Las Vegas (LAS)	1L/19R reconstruction	50	1997		X
Little Rock (LIT)	4L/22R extension	31	1998		X
Louisville (SDF)	17R/35L parallel	59	1997		X
Lubbock (LBB)	8/26 extension	5	2005		
Memphis (MEM)	18E/36E new parallel		1997	X	
	18C/36C extension	94.6	1999		
Miami (MIA)	8/26 new parallel	149	2000		
Midland (MAF)	10/28 extension	5	2008		
Milwaukee (MKE)	7R/25L parallel	n/a	n/a		
	7L25R realignment			X	
	7L/25R extension	n/a	n/a		
Minneapolis (MSP)	17/35 air carrier	120	2003		
	4/22 extension			X	
Nashville (BNA)	2E/20E parallel	n/a	n/a		
	2R/20L extension	n/a	n/a		
New Orleans (MSY)	1L/19R parallel	400	2005		
	10/28 parallel	n/a	n/a		
Newark (EWR)	4L/22R extension	n/a	2000		
Norfolk (ORF)	5R/23L parallel	75	2005		
Oakland Metropolitan (OAK)	11R/29L parallel	n/a	n/a		
	11/29 extension	n/a	n/a		
Oklahoma City (OKC)	17L/25R extension	8	2014		
	17R/35L extension	8	2014		
	17W/35W parallel	13	2004		
	13/31 extension	5	2005		
Omaha Eppley Field (OMA)	14R/32L extension			X	

Table 2-1 (continued).

New and Extended Runways — Completed in 1996, Under Construction, and Planned or Proposed

Airport	Runway	Est Cost ($M)	Operational Date	Completed in 96	Under Construction
Orlando (MCO)	17L/35R 4th parallel	137	2002		
	17R/35L extension	n/a	n/a		
Palm Beach (PBI)	9L/27R extension	10	1999		
	9R/27L extension	.5	2001		
Philadelphia (PHL)	8/26 parallel-commuter	220	n/a		
	9L/27R relocation	n/a	n/a		
Phoenix (PHX)	7/25 3rd parallel	88	1998		
	8L26R extension	7	2000		
Pittsburgh (PIT)	4th parallel 10/28	150	n/a		
	5th parallel 10/28	n/a	n/a		
Raleigh-Durham (RDU)	5R/23L extension	n/a	2005		
	3rd parallel	n/a	n/a		
Richmond (RIC)	16/34 extension	45	1997		X
Reno/Tahoe (RNO)	7/25 extension	n/a	n/a		
	34R extension	n/a	n/a		
Rochester (ROC)	4R/22L parallel	10	2010		
	4/22 extension	4	2000		
	10/28 extension	3.2	2000		
St. Louis (STL)	12R/30L	500	2002		
San Antonio (SAT)	12L/30R reconstruction	20	2006		
	12N/30N new runway	400	n/a		
San Jose (SJC)	12L/30R extension				
Santa Ana(SNA)	1/19R extension	n/a	n/a		
Sarasota-Bradenton (SRQ)	14L/32R parallel	10	2002+		
	14/32 extension	5.1	2002+		
Savannah (SAV)	9L/27R new parallel	20	2020		
Seattle-Tacoma (SEA)	16W/34W parallel	400	n/a		
Spokane (GEG)	3L/21R	11	2001		
Syracuse (SYR)	10L/28R	55	n/a		
Tampa (TPA)	18W/36W 3rd parallel	n/a	n/a		
	9/27 reconstruction	n/a	2010+		
	18L extension	n/a	2005+		
Tucson (TUS)	11R/29L parallel	30	2005		
Tulsa (TUL)	18L/36R parallel	115	2005		
Washington Dulles (IAD)	1L/19R parallel	n/a	2009		
	12R/30L parallel	n/a	n/a		

Total of Available estimated costs: $4,018.5M

n/a = no data available at press time

2.2 Airport Capacity Studies

As environmental, financial, and other constraints continue to restrict the development of new airports in the United States, increased emphasis has been placed on the redevelopment and expansion of existing airport facilities. ASC forms Airport Capacity Design Teams, Tactical Initiative Teams, and Regional Design Teams to focus on maximizing the capacity at existing airports through improvements in runways and taxiways, navigational and guidance aids, and operational procedures. Table 2-2 lists the completed airport capacity, tactical initiative, and regional studies and the year in which they were published. Ongoing capacity studies are described below.

As environmental, financial, and other constraints continue to restrict the development of new airports in the United States, emphasis has been placed on the redevelopment and expansion of existing airport facilities.

2.2.1 Airport Capacity Design Teams

Airport Capacity Design Teams are formed to address capacity problems at airports with significant flight delays. The teams are composed of: FAA representatives from ASC, the Technical Center, Air Traffic, and the appropriate FAA Region; airport operators; airlines; and other aviation industry representatives. The goal of Airport Capacity Design Teams is to identify and evaluate proposals to increase airport capacity, improve airport efficiency, and reduce aircraft delays while maintaining or improving aviation safety.

The goal of Airport Capacity Design Teams is to identify and evaluate proposals to increase airport capacity, improve airport efficiency, and reduce aircraft delays while maintaining or improving aviation safety.

To achieve their objectives, the Capacity Design Team:

- Assesses the current airport capacity;
- Examines the causes of delay associated with the airfield, the immediate airspace, and the apron and gate-area operations; and
- Evaluates capacity and delay benefits of alternative air traffic control (ATC) procedures, new technologies, airfield development, and operational improvements.

Airport Capacity Design Teams consider capacity improvement alternatives proposed by ASC and the other Team members. The impacts of alternatives that are considered technically feasible are evaluated by computer simulation modeling conducted by the FAA Technical Center's Aviation Capacity Branch. The product of the study is a set of capacity-increasing recommendations, complete with planning and implementation time horizons. Environmental, socioeconomic, and political implications of the alternatives are not evaluated by the design teams. These implications are addressed by the FAA and local authorities if and when the airport authority chooses to pursue one or more of the design alternatives.

Table 2-2.

Completed Airport Capacity, Tactical Initiative, and Regional Design Studies

Study	Date
Capacity Enhancement Plans	
Albuquerque Int'l	1993
Boston Logan Int'l	1992
Charlotte/Douglas Int'l	1991
Chicago Midway	1991
Chicago O'Hare Int'l	1991
Cleveland-Hopkins Int'l	1994
Dallas-Ft. Worth Int'l	1994
Detroit Metropolitan Wayne County	1988
Eastern Virginia Region	1994
Fort Lauderdale-Hollywood Int'l	1993
Greater Pittsburgh Int'l	1991
Hartsfield Atlanta Int'l	1987
Hartsfield Atlanta Int'l Update	1995
Honolulu Int'l	1992
Houston Intercontinental	1993
Indianapolis Int'l	1993
Kansas City Int'l	1990
Lambert St. Louis Int'l	1988
Las Vegas McCarran Int'l	1994
Los Angeles Int'l	1991
Memphis Int'l	1988
Metropolitan Orlando Int'l	1990
Miami Int'l	1989
Minneapolis-Saint Paul Int'l	1993
Nashville Int'l	1991
New Orleans Int'l	1992
Oakland Int'l	1987
Philadelphia Int'l	1991
Phoenix Sky Harbor Int'l	1989
Port Columbus Int'l	1993
Portland Int'l	1996
Raleigh-Durham Int'l	1991
Salt Lake City Int'l	1991
San Antonio Int'l	1992
San Francisco Int'l	1987
San Jose Int'l	1987
San Juan Luis Muñoz Marín Int'l	1991
Seattle-Tacoma Int'l	1991
Seattle-Tacoma Int'l Update	1995
Washington Dulles Int'l	1990
Tactical Initiatives	
Charlotte Douglas Int'l	1995
Los Angeles Int'l (Commuter Gates)	1996
Los Angeles Int'l (TBIT Expansion)	1993
New York La Guardia Airport	1994
Orlando Int'l	1995

The presence of a recommended improvement in a Capacity Design Team report does not obligate the FAA to provide Facilities and Equipment (F&E) or Airport Improvement Program (AIP) funds. Demands for F&E and AIP funds exceed the FAA's limited resources, and projects recommended by a Design Team must compete with all projects for these limited funds.

2.2.1.1 Recommendations from Previous Airport Capacity Studies

Since 1985, 39 Airport Capacity Design Team studies have been completed. The typical Airport Capacity Design Team makes 20 to 30 recommendations for improvements to reduce delay at each airport. Table 2-3 lists completed airport capacity studies and their recommendations according to generalized categories of improvements. The table indicates those recommendations that were implemented, have been completed, and are no longer under consideration.

Since 1985, 39 Airport Capacity Design Team studies have been completed. The typical Airport Capacity Design Team makes 20 to 30 recommendations for improvements to reduce delay at each airport, covering airfield, F&E, and procedural improvements.

Airfield improvements were recommended for all of the 39 airports studied. Common airfield recommendations include building or extending runways and taxiways, and improving exits and staging areas to increase efficiency of the existing runways. At least one of the recommended airfield improvements has been completed at 28 of the 39 airports. Airfield improvements such as construction of new runways and runway extensions may take more than ten years from proposal to completion due to financing constraints and the need to study and address environmental concerns.

Common recommendations for improving F&E are the installation or upgrade of ILSs to improve runway capacity during IFR operations, and the installation of RVRs and lighting systems. Improvements to F&E and operations are generally less expensive and time consuming to implement than airfield improvements. However, like airfield improvements, the ability to implement F&E recommendations is contingent upon the ability to obtain financing. F&E improvements such as the installation of RVRs and lights generally follow the completion of a new runway or runway extension.

Common procedural recommendations include improved IFR approach procedures and reduced separation standards for arrivals. Enhancement of the reliever and general aviation airport system is also a frequent recommendation for moderating the demand on a given airport. Improved IFR approach procedures and reduced separations between arrivals have been implemented at several of the airports studied by the Capacity Design Teams.

Table 2-3.

Completed Airport Capacity Studies and Recommendations

√ Recommended

C Completed

⊗ No Longer Under Consideration

Airports / Recommended Improvements	Airfield Improvements	Construct third parallel runway	Construct fourth parallel runway	Relocate runway	Construct new taxiway	Runway extension	Taxiway extension	Angled exits/improved exits	Holding pads/improved staging areas	Terminal expansion	Facilities and Equipment Improvements	Install/upgrade ILSs	Install/upgrade RVRs	Install/upgrade lighting system	Install/upgrade VOR	Upgrade terminal approach radar	Install ASDE	Install PRM	New air traffic control tower	Wake vortex advisory system	Operational Improvements	Airspace restructure/analysis	Improve IFR approach procedures	Improve departure sequencing	Reduced separations between arrivals	Intersecting operations with wet runways	Expand TRACON/Establish TCA	Segregate traffic	De-peak airline schedules	Enhance reliever and GA airport system
Albuquerque					C	C	C	C	√	√		C			√								√		√					√
Atlanta					C			C	C	C		C	C	C		C	C	√		√					C				⊗	
Boston					⊗	⊗	⊗	√	C			√								√			C			√				
Charlotte-Douglas						C	√	C	√			√		√			√	√								√	C			√
Chicago Midway					√	C			C														√		√					
Chicago O'Hare				√	⊗	√		C	C			C											√			C				
Cleveland		√		√	√	√	√	√		√		√			√			√					√	√	√					√
Dallas-Ft. Worth					C	√		C															C	C	C					C
Port Columbus		√	⊗	√	√	√		√	√	√		√		√			√	√	√			√	√		√				√	√
Fort Lauderdale					√	⊗		√	√	√		√			√	C		√		√		√	√		√				√	√
Honolulu		√				√		√	√	√		√																	√	C
Houston Intercontinental		√	√		√	√		√	√	√		√											√						√	√
Indianapolis		√	√	C	√			√	√			√	√	√			√						√		√					√
Kansas City		√	⊗				C	√	√	√		√	√				C						√		√				√	
Las Vegas					√	C	C		C	√		√											√			√				C
Los Angeles					C	√	C	√	C	√		C							C			√								
Memphis		C			√	√	C	√				C											C		⊗				√	
Miami					C		√	C	C			C	C	C			C						C							C
Minneapolis-Saint Paul		√	√		√	√		√	√	√		√	√	√	√			√				√			√					√
Nashville			⊗	C	C	√	√		√			C								√		C	√				√		⊗	√
New Orleans					C										√				C			√	C		C					C
Newport News						√		√															√		√					
Norfolk						√						√	√	√											√					
Oakland					√			√	√																					
Orlando			√		√		C		√			√			√		√	√				C	√					√		√
Philadelphia		√		√		√												√				√	√	√						
Phoenix		√			√		C	√	C	C		C		√	C								√	√	√			√	√	C
Pittsburgh			√			C				√		C						√				√								
Portland					√		√	√															√	√	√			√		
Raleigh-Durham		√	⊗	⊗	√			√	√			√	√				√			√		√	√		√		√			
Richmond						√		√				√	√	√									√		√					
St. Louis		√					C	√	√			√		√			C			√			C		C				⊗	
Salt Lake City		C					C	C	√	√		C	C	C			C	√					C		C					√
San Antonio		√			√	√	√		C			C	C	√				√		√		√	√		√					√
San Fransisco		⊗	⊗			√	C	√	√															C					√	C
San Jose						C		C	C															C						
San Juan, Puerto Rico					√		√	√	√	√				√	√				C	√					√					√
Seattle-Tacoma		√						C				√								√			√		C				⊗	
Washington-Dulles		√			C	C	C		C	√			C	C									C		C				⊗	⊗

1. Recommendations summarized and grouped in generalized improvement categories.

2.2.1.2 Ongoing and Recently Completed Airport Capacity Design Team Studies

In FY96, seven Airport Capacity Design Team studies or updates of previous studies were completed or in progress. The studies are summarized briefly below.

Atlanta International Airport Update (ATL)

The Airport Capacity Design Team update for Atlanta Airport analyzed the separation of new runways, taxiway design, and routing for the weight-restricted arrival-only commuter runway. Land acquisition for the new runway is underway.

Reno/Tahoe International Airport (RNO)

An Airport Capacity Design Team for Reno/Tahoe International Airport (RNO) was formed in February 1995. The report is expected to be published in April 1997. Reno has experienced steady and sustained growth over the last decade. Passenger enplanements increased over 106 percent from 1.4 million in 1983 to 2.9 million in 1995. Recommended airfield improvements included construction of a new apron, a new concourse, deicing facilities, and runway and taxiway extensions. F&E recommendations for improvements included development of precision approaches and installation of Doppler radar and runway visual range (RVR) systems. Procedural recommendations included adoption of land, hold short procedures, and 2.5 NM in-trail separation.

Dallas/Fort Worth International Phase II (DFW)

Phase II of the Dallas/Fort Worth study was completed in April 1996. It examined the delay associated with runway crossings and the benefits of perimeter taxiways. The study also addressed how to maintain capacity during the reconstruction of one or possibly two of the existing east parallel runways. Runway reconstruction will occur in phases, with portions of runways remaining open for commuter operations. Evaluation of cost/benefits of perimeter taxiways will continue as part of the DFW Airport Development Plan update.

Portland International Airport (PDX)

A Capacity Design Team was formed in 1994 to identify and assess various options for increasing capacity and operational efficiency and for reducing aircraft delays at PDX. The study was completed in December 1996. Some of the various proposals were:

- 1.5 NM stagger when utilizing the ILS to runways 10L and 28L;
- Immediate north divergent turns for turbo prop aircraft in both flow directions;
- Peak period use of runway 3 for arrivals by small cargo aircraft;
- Immediate divergent turns for all aircraft; and
- Construct north/south taxiway connecting the east ends of the parallel runways.

Memphis International Airport Update (MEM)

The primary goals of the capacity plan update, which began in May 1995, are to update the Memphis Master Plan and conduct computer modeling to determine how best to use the new third parallel runway, to be operational in early 1997, while existing runways are being reconstructed.

Miami International Update (MIA)

The Miami update study began in September 1995. The Capacity Design Team will analyze a new, closely-spaced parallel runway and "Super" Terminal. Both an airfield study and a limited airspace study are being conducted.

Newark International (EWR)

A study of Newark began in November 1996. Capacity improvements under consideration include: the extension of runway 22R/4L; various facility and equipment upgrades; and the adoption of improved approach procedures such as reducing minimum IFR separations on final approach, and permitting simultaneous parallel visual approaches.

2.2.2 Tactical Initiative Teams

Tactical Initiative Teams are focused on providing immediate relief to airports with chronic delay through capacity improvements that can be implemented in the near term. The recommendations of Tactical Initiative Teams generally focus on procedural changes that can be implemented quickly with little financial investment. Tactical Initiative projects that were completed or ongoing in 1996 are summarized below.

Tactical Initiative Teams are focused on providing immediate relief to airports with chronic delay through capacity improvements that can be implemented in the near term.

San Diego International (SAN)

The San Diego study began in May 1996. The Tactical Initiative Team is analyzing the airport operatio's Immediate Action Plan which includes near-term improvements such as an additional terminal concourse, taxiway development, and remote aircraft parking areas. The study will analyze major airfield improvement concepts developed in the 1997 airport master plan study.

Charlotte/Douglas International (CLT)

The Charlotte/Douglas (CLT) study was completed in September 1995. The CLT Tactical Initiative Team analyzed near-term taxiway improvements to facilitate traffic flows and to reduce delays in every configuration.

Los Angeles International (LAX)

Over the past six years, the number of commuter aircraft using the Los Angeles Airport has significantly increased. As a result, gates designed for large carriers are frequently used for commuter operations. To resolve the problem of insufficient gate capacity, the Tactical Initiative Team examined the delay implications of several alternative gate locations for the commuter carriers. All of the alternatives resulted in a negligible increase in overall delays under current demand levels. The preferred option lowered total travel time for both arrivals and departures. Delays would increase at projected higher demand levels regardless of the chosen option, but the preferred option would provide the smallest increase in total travel time.

Las Vegas McCarran International (LAS)

The Las Vegas McCarran International Airport is adding another gate complex, Terminal D, to the airport. The FAA is examining the impacts of an initial increase in traffic on existing taxiways and gates. This new study is an extension of the previous Las Vegas study completed in 1994. In addition, the ability of the new terminal complex to accommodate future traffic levels will be tested. Other issues such as off-gate and overnight parking will also be examined.

2.2.3 Regional Capacity Design Teams

Looking beyond the individual airport and its immediate airspace, the Office of System Capacity is planning a series of Regional Capacity Design Team studies. These regional studies will analyze all the major airports in a metropolitan or regional system and model them in the same terminal airspace environment. This regional perspective will show how capacity-producing improvements at one airport will affect air traffic operations at the other airports and within the associated airspace. The first regional study is of the Northeastern United States.

Northeast Region Capacity Design Study

The Northeast Region study began in September 1996. The study will analyze the impacts of the decentralization of northeastern airports as the passengers migrate from the primary airports (BOS, EWR, JFK, and LGA) to the secondary airports (six for each metropolitan area). The study will also analyze the impacts of increases in operations on delay. Technical analysis for Phase I of the Northeast study is being conducted by the Volpe National Transportation Systems Center.

Airspace development studies strive to relieve congestion and improve capacity by determining how to restructure airspace; reroute traffic; or modify arrival, departure, or en route flow patterns. Terminal Airspace Studies address only the terminal area, while En Route Airspace Studies may extend to one or more Air Route Traffic Control Centers (ARTCCs) encompassing traffic flowing into and out of several airports. Airspace studies may be prompted by experienced or projected congestion and delays, airport development, improved operational procedures, or resectorization of the airspace, which provides the opportunity to modify traffic flow. Table 3-1 lists completed En Route and Terminal Airspace Studies.

Table 3-1.

Completed En Route and Terminal Airspace Studies

Terminal Airspace
Houston Intercontinental
Minneapolis-St. Paul Int'l
San Bernardino/Ontario
En Route Airspace
Chicago
Dallas-Ft. Worth
Denver
Expanded East Coast Plan
Houston-Austin
Kansas City
Los Angeles
Oakland
New York
Jacksonville
Atlanta
Maimi

3.1 En Route Airspace Studies

En Route Airspace Studies are initiated in response to airport and/or airspace congestion, airport modifications, the construction of new air traffic facilities, and the installation of updated air traffic equipment.

Table 3-2 lists the various alternatives proposed for improving the flow of air traffic for each airspace region studied to date. Common airspace improvement alternatives analyzed include: relocating arrival fixes, creating new arrival and departure routes, modifying ARTCC traffic flows, and redefining TRACON boundaries.

Table 3-2.

Airspace Design Alternatives by Airspace Region

Studied Alternatives / Airspace Regions	Chicago	Dallas-Ft. Worth	Denver	Expanded East Coast Plan	Houston-Austin	Kansas City	Los Angeles	Oakland	New York	Jacksonville	Atlanta	Miami
Relocating arrival fixes	√	√				√					√	
New arrival routes		√	√	√	√	√		√	√	√	√	√
New departure routes	√		√	√	√	√	√	√	√	√	√	√
Modifications to ARTCC traffic		√		√	√	√	√	√	√	√	√	
New airport			√		√							
Hub/non-hub alternatives					√							
Change in metering restrictions	√			√				√				√
Redifining TRACON boundaries		√		√	√		√	√			√	
Redifining sector ceilngs									√	√	√	
Resectorization									√	√	√	√
Military traffic considered		√			√		√	√				
New runways at existing airports	√	√				√						
Specific modeling of 2 or more airports for interactions analysis	√	√				√			√	√	√	√

3.1.1 En Route Airspace Study Methodology

En route airspace capacity studies are conducted jointly by the Office of System Capacity (ASC), Air Traffic (AAT), and the Office of Environment and Energy (AEE). From the analysis stage to implementation, major redesign of en route airspace is a complex process that may take up to ten years.

After determining that airspace redesign may be required, AAT develops alternative airspace structures. Sophisticated computer modeling is used for analyzing the problem and evaluating alternative solutions. The computer model uses baseline data to emulate the status quo. Then, the model is modified to reflect the impacts of proposed solutions. The difference in the behavior of the system between the baseline and each of the modeled solutions is used to measure the relative value of the solutions. The model captures a number of variables such as travel time, delay, sector occupancy, and airspace saturation. The model reports the likely impact of developments such as increased traffic, the opening or closing of runways, and changes in separation standards or procedures.

Once alternatives have been investigated fully, decision makers must weigh environmental, social, political and cost factors against the relative efficiency of the airspace alternatives.

Airspace development studies strive to relieve congestion and improve capacity by determining how to restructure airspace; reroute traffic; or modify arrival, departure, or en route flow patterns.

Once alternatives have been investigated fully, decision makers must weigh environmental, social, political and cost factors against the relative efficiency of the airspace alternatives.

Before the chosen solution can be implemented, any required modifications to ATC and airport facilities and equipment must be completed. Implementation of the new airspace also requires rerouting and redistribution of air traffic, development of new air traffic control procedures, and redistribution of responsibilities among air traffic controllers.

3.1.2 Ongoing En Route Airspace Studies

ASC is presently involved in three en route airspace studies, each at a different stage of development. The study of airspace around and between the Northern and Southern California TRACONs is in the planning and analysis stage; data have been collected on current airspace operations, but alternative designs have not yet been identified. In the Chicago Metroplex Airspace Analysis Project, alternatives have been identified, but not selected. Finally, the Dallas/Fort Worth Metroplex Area study is coming to closure. The problems were studied, alternative designs were identified, and preferred alternatives were chosen and implemented. The next phase is to assess the impact of the new airport and airspace design.

3.1.2.1 Dallas/Forth Worth (DFW) Metroplex Airspace Analysis

In 1987 the DFW airport board, in conjunction with the FAA, developed plans to ensure that the airspace and airport capacities in the Dallas/Fort Worth area kept pace with demand which was forecasted to increase for the next 20 years. Additional runways were required to accommodate increased operations projected for major users of the DFW airport. Since the existing airspace design was never intended to accommodate three or four approach streams, the need for a completely redesigned arrival and departure system was evident. This ambitious study addressed navigation and communication facilities and equipment, airspace realignment, and procedural development.

The FAA's Airspace and Airport Simulation Model (SIMMOD) was used to evaluate airport and airspace design alternatives. The model used delay data from the year 1987 to establish a baseline level of service. Simulations indicated that improving upon the baseline level of service would require: a new commuter runway by 1990, a new air carrier runway by the mid 1990's, a new commuter and a new air carrier runway by around 2000, and two new air carrier runways by the year 2005.

Modifications for DFW traffic flows included establishing demand-responsive dual jet arrival routings over each cornerpost, establishing additional terminal departure routings, and segregating DFW arrival traffic from satellite operations in the terminal area. The new airspace design included an expansion of TRACON airspace 15 NM into the existing en route system to incorporate moving the cornerpost navigational aids.

SIMMOD analysis of the new airspace design indicated that the new airspace would provide substantial capacity gains over the old system and would efficiently accommodate the increased traffic levels forecast through 2010, including traffic associated with the two new air carrier runways at DFW International Airport. The new airspace design would also decrease delays at other satellite airports including Dallas Love Field.

With the implementation of a new TRACON airspace structure and procedures for the Dallas/Fort Worth Metroplex area in October 1996, the Dallas/Fort Worth metroplex project is nearly complete. The new east side air carrier runway (Runway 17L/35R) also became operational at DFW International Airport in October 1996. GRADE (a three dimensional airspace design environment and traffic analysis tool) will be used to evaluate the impact of the new airspace and airport design. In addition, analysis will be conducted to verify projected delay reductions and to schedule the installation of an additional air carrier runway for the west side of DFW International Airport.

3.1.2.2 Chicago Metroplex Airspace Analysis Project (CMAAP)

The goal of the CMAAP is to increase the efficiency of existing airport capacity by improving airspace traffic flow. A desire to optimize the utilization of a new TRACON equipped with an updated area route terminal system (ARTS) motivated the analysis. Another motivation was frequent observations by air traffic controllers at O'Hare that runways were underutilized, while incoming aircraft were delayed in Chicago Center and adjacent ARTCCs by air traffic controllers trying to moderate traffic that was unevenly distributed to the arrival fixes.

The area of study consists of Chicago Center, which includes traffic operations within Chicago and Milwaukee TRACONs, and en route portions of the four adjacent ARTCCs. The graphical tool GRADE was used to conduct a sector-by-sector analysis of current traffic operations. CMAAP analysts identified the time and location of traffic bottlenecks and other constrained operations by animating traffic flows, computing traffic count statistics, calculating time and distance relationships, and querying flight plan data. Figure 3-1 illustrates the system inefficiencies identified. Wavering flight paths indicate that flights were being path-stretched by air traffic controllers to regulate traffic flow approaching the terminal area.

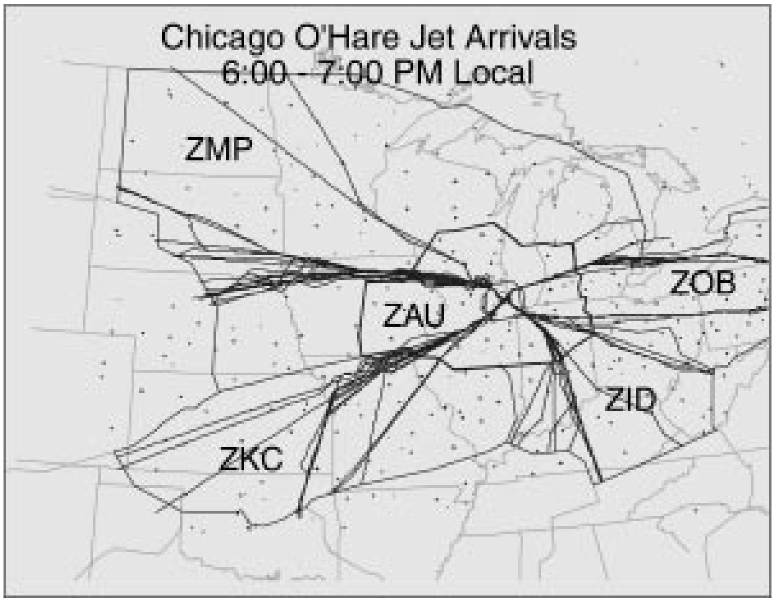

Figure 3-1.

Flight Paths Over Five-Center Area

In conjunction with GRADE analysis of the existing airspace structure, analysts examined ATC facility records and logs along with airline data for evidence of flow restrictions, ground stops, implementation of the en route spacing program (ESP), air carrier recorded delays, and other documented traffic flow problems. The CMAAP team also investigated trends in runway use and airfield conditions.

After an analysis of the existing airspace structure, the following conclusions were reached:

- The existing airspace and route structure are more than adequate to meet the configuration capacity of dual approaches;
- There is insufficient airspace and route capacity for the preferable triple approach configurations;
- Triple approaches are not always used to the fullest potential;
- The system does not take full advantage of the improved operating characteristics and navigational systems of today's fleet; and
- Improvements could also be made to other routes servicing the Chicago area.

Based on these conclusions, the CMAAP team developed alternatives that would provide an airspace structure to increase airspace capacity for O'Hare International Airport arrivals.

Three alternatives were developed for alleviating the constraint caused by the inefficiency of the cornerposts. The first alternative is to add four arrival routes to Chicago TRACON for O'Hare International Airport arrivals. During heavy traffic periods, two additional dual routes (Alterative 1A) or one dual route (Alternative 1B) could be activated as required. The second alternative is to rotate the existing four cornerposts by 45 degrees, allowing redistribution of traffic flow and an additional arrival fix from east and west. The third alternative is to establish two additional arrival cornerposts (totaling six) for O'Hare Airport International arrivals. Figure 3-2 is a simplified diagram illustrating the basic routing concepts behind the proposed alternatives.

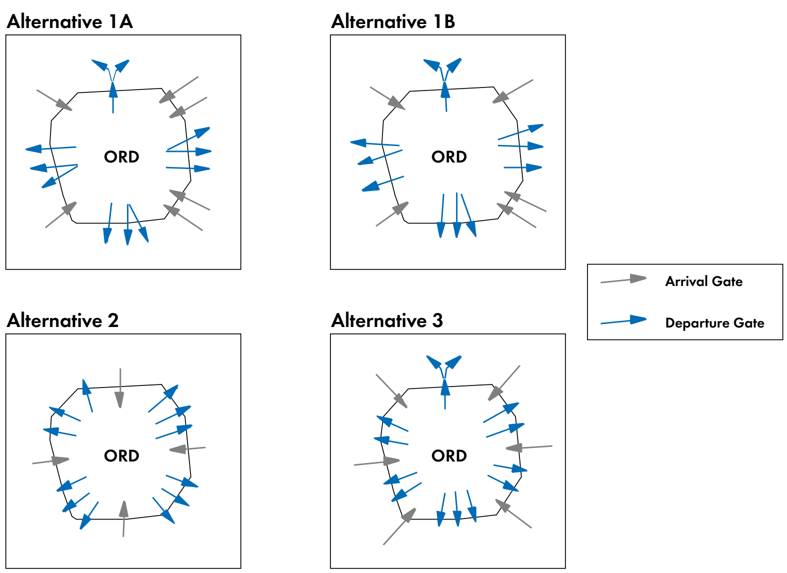

Figure 3-2.

Airspace Design Alternatives for Chicago TRACON

The delay and capacity impacts associated with the airspace alternatives then were evaluated using the FAA's SIMMOD software. All of the alternatives show significant annual aircraft operating cost savings. Savings at the baseline level of demand would range from $40 to $62 million. At future demand levels, savings could be as high as $103 million annually.

After choosing its preferred airspace design alternative, the FAA will refine the design for the new airspace based on the input of FAA facility personnel, thorough testing (via simulation) under potential operating conditions (weather, runway use configuration, traffic demand, etc.) and preliminary noise assessment results.

3.1.2.3 SCT/NCT Airspace Analysis and Design Project

In California the airspace of two major new facilities, the Southern California TRACON (SCT) and the Northern California TRACON (NCT), has to be coordinated. Due to the close proximity and congested flows between these facilities, the SCT/NCT Airspace Analysis and Design Project will streamline the coastal traffic flow while addressing the long-haul traffic problems specific to each facility. The SCT controls terminal airspace in the Los Angeles-San Diego area and consolidates the operations of the former Los Angeles, Coast, Burbank, Ontario, and San Diego TRACONs into a single facility. The NCT (which has been proposed but not yet constructed) will control airspace in San Francisco, Sacramento, and surrounding areas. The FAA's Western-Pacific Region is redesigning airspace operations to recognize potential efficiency and capacity gains with the consolidation of SCT and NCT. The scope of this project encompasses NCT, SCT, Los Angeles and Oakland ARTCCs, and portions of the four surrounding ARTCCs.

The SCT/NCT airspace design project is at the data gathering and modeling stage. Airspace analysis and modeling tools were used to create graphic displays of existing flight tracks within the Los Angeles and Oakland Centers and portions of the four abutting ARTCCs. The next phase of the SCT/NCT project will be to evaluate proposed airspace improvement alternatives. Preliminary design options will be evaluated via simulation to assess their operational feasibility and impact on performance. Based on the results, the FAA will formulate a proposed design for the SCT/NCT system. Additional simulations will evaluate the performance of the proposed integrated design.

3.2 Terminal Airspace Studies

Terminal airspace studies, generally intended to follow Airport Capacity Design Team studies, examine ways to ensure that the airport's airspace can accommodate the increase in traffic that may result from airport capacity improvements. Terminal airspace studies are conducted by the capacity design team that worked on the airport capacity study, with the assistance of the FAA technical center. ASC has completed three terminal airspace studies to date: Houston (1993), San Bernardino/Ontario (1994), and Minneapolis-St. Paul (August 1996). The Minneapolis-St. Paul study is described in more detail below.

3.2.1 Minneapolis-St. Paul International Airport Terminal Airspace Study

The purpose of the study was to determine how the terminal airspace would accommodate the addition of a new north-south runway at Minneapolis/St. Paul Airport (MSP). The study was the second phase of an analysis of the MSP airfield capacity initiated at the request of the Minnesota State Legislature. The airspace study concluded that:

- the existing airspace could be reconfigured;
- the airspace could be made more efficient by adding either a new jet arrival fix or a new parallel jet arrival stream;
- none of the satellite airports would be adversely impacted; and
- the addition of the new runway would result in a change to the MSP Class B airspace.

The estimated construction period for the new runway is 2002-2005.

3.3 Commercial Space Transportation

One of the goals of the FAA's 1996 Strategic Plan under System Capacity is to assess the space launch infrastructure needs of the U.S. commercial space transportation industry and alternative policies to meet those needs.

To date, there have been over 65 licensed launches, all of which have occurred from 5 different federal launch ranges, (Cape Canaveral, White Sands Missile Range, Vandenberg, Wallops Island and Barking Sands Hawaii). The future will include non-federal launch sites (Spaceports), such as California, Florida, Virginia, Nevada, New Mexico, Alaska, overseas, and from the ocean. The United States is about to enter a new era and the FAA/DOT aviation community needs to make provisions to accommodate launches from non-federal ranges.

Chapter 4: New Operational Procedures

A less expensive alternative to building new airports or runways to expand aviation system capacity is modifying air traffic control procedures to improve the flow of aircraft en route and in the terminal area. In FY95, more than two-thirds of all delays were attributed to adverse weather conditions. These delays are partly the result of restrictive instrument approach procedures applied during adverse weather conditions. The FAA's efforts to reduce weather-related delays include developing approach procedures for instrument meteorological conditions (IMC) that are similar to those observed during visual meteorological conditions (VMC). The FAA is also developing more flexible en route procedures. Initial improvements in en route procedures increase pilot discretion in determining routes and pilot/air traffic controller collaborative decisionmaking. Long-term goals for operational procedures focus on free flight, in which air traffic controllers will intervene only to prevent conflicts.

The following sections describe the most promising procedural changes, beginning with a description of free flight and programs such as the National Route Program (NRP) and in-trail climb (ITC) and in-trail descent (ITD) which entail procedural changes consistent with free flight. Next, improved instrument approach procedures are described. Finally, new wake vortex separation standards, which restrict capacity to ensure safety, are discussed.

4.1 Free Flight

Free flight is a plan to improve the efficiency of the Nation's airspace system by allowing pilots, under most circumstances, to choose the most efficient and economical routes. The pilot's flexibility would be restricted only to ensure separation when traffic density precludes free flight, to prevent unauthorized entry into special use airspace, and to ensure safety. Hence, free flight will benefit airspace users and passengers by saving fuel and time.

Transitioning to free flight requires changes in philosophy, procedures, and technology. The principal philosophical change is shifting from the concept of air traffic control to air traffic management. Air traffic management differs from air traffic control in several ways: the increased extent of collaboration between users and air traffic managers; greater flexibility for users to make decisions to meet their unique operational goals; and the replacement of broad restrictions with user-determined limits and targeted restrictions only when required.

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Free flight is a plan to improve the efficiency of the Nation's airspace system by allowing pilots, under most circumstances, to choose the most efficient and economical routes.

The procedural changes required for free flight correspond directly to the change in philosophy from air traffic control (ATC) to air traffic management (ATM). Under the current air traffic system, aircraft are frequently restricted to ATC-preferred routes, which are not necessarily the routes preferred by the pilot or airline. Air traffic controllers instruct pilots how to change their direction, speed, or altitude to avoid storms or traffic congestion. Free flight will grant pilots additional discretion in determining routes. In the event of a thunderstorm or congestion, the pilot would choose the new route, speed, and altitude and notify the air traffic manager of the new route. Other decisions would be collaborative between the air traffic manager and pilot to maximize the information on flying conditions available to each.

The use of protected and alert zones around aircraft will help pilots and air traffic managers to realize the benefits of free flight while maintaining safety. The sizes of the protected and alert zones are based on the aircraft's speed, performance characteristics, and communication, navigation, and surveillance equipment. An aircraft's protected zone, the one closest to the aircraft, can never meet the protected zone of another aircraft. The alert zone extends well beyond the protected zone, and upon contact with another aircraft's alert zone, a pilot or air traffic controller will determine if a course correction is required. Aircraft can maneuver freely until alert zones touch. In the event that alert zones touch, a controller may provide one or both pilots with course corrections or restrictions to assure separation.

Several technological changes must be made to fully implement free flight concepts. The architecture and technology for free flight will rely heavily on: GPS satellites for navigation; Automatic Dependent Surveillance (ADS) in which aircraft automatically broadcast their positions over datalink (a network of air, ground, and airborne communications systems); new displays in aircraft and air traffic facilities to improve situational awareness; revised air traffic procedures and facilities to capitalize on digital communication, satellite-based navigation, and computer-based decision support systems. See Chapter 5 for more information on these developing technologies.

The move toward free flight is already underway. Two programs that have implemented operational procedures consistent with free flight are the National Route Program and the program to improve in-trail climb (ITC) and in-trail descent (ITD) procedures.

4.2 National Route Program (NRP)

The NRP is supporting the transition toward free flight by eliminating certain ATC restrictions. NRP flights are only subject to route limitations within a 200 nautical mile radius of take-off or landing; they are not limited to published ATC-preferred routes. This allows airlines to plan the most cost-effective routes in advance and to fly them, thus, increasing the capacity, flexibility, and efficiency of the aviation system. From January 1995 to November 1996, the NRP was expanded in ten phases, with each phase lowering the base altitude for participation. NRP operations are currently authorized at and above FL290 across the contiguous United States. Participation has increased with the implementation of each phase. In October 1995, there were 600 NRP flights daily. By October 1996, the average had increased to 1,000 NRP flights daily. Future plans to build on the NRP include reducing the 200 nautical mile requirement where appropriate and lowering the base altitude below FL290. The FAA estimates that the NRP saved the aviation industry $40 million in 1994, or about $150 per flight, by allowing pilots to fly more optimal routes.

The NRP is supporting the transition toward free flight by eliminating certain ATC restrictions. NRP flights are only subject to route limitations within a 200 nautical mile radius of take-off or landing; they are not limited to published ATC-preferred routes.

4.3 ITC and ITD Using the TCAS Cockpit Traffic Display for Separation Assistance

The ITC and ITD procedures are designed to enable a trailing aircraft in a non-radar (oceanic) environment to climb or descend through the altitude of an aircraft moving in the same direction to a more desirable cruising altitude. Under these procedures the pilot wanting to ascend or descend uses the TCAS traffic display to positively identify the lead aircraft and to determine the distance to the lead aircraft. Before applying the in-trail climb or in-trail descent procedure, the aircraft must be at the minimum vertical separation and be horizontally separated by at least 15 NM, with a ground speed closure rate of 20 knots or less. The trailing aircraft initiates this procedure, coordinates with the lead aircraft, and obtains climb or descent clearance from ATC. ATC maintains responsibility for separation during the maneuver. Standard non-radar spacing criteria are then applied by ATC after these procedures are completed. The ITC and ITD procedures reduce the non-radar in-trail distance necessary to approve a climb or descent from 100 NM to a minimum of 15 NM. Without this capability, an aircraft traveling at 33,000 feet may be trapped below an aircraft traveling at 35,000 feet at a similar speed. With the ITC procedure, the lower aircraft can ascend through the altitude of the higher aircraft to an altitude where it can fly more efficiently. The inability to gain a higher altitude significantly increases fuel burn. Figure 4-1 illustrates the ITC and ITD procedures.

Operational trials for the ITC procedure began within the Oakland and Anchorage Flight Information Regions (FIRs) in September 1994 with United Airlines and Delta Air Lines participating. Data collected during the trials indicated that pilots and controllers find the procedure useful and are using it correctly, safely, and cooperatively. Both pilots and controllers have recommended adoption of this procedure. In the second phase of the trials, beginning in early 1997, additional airlines will participate, and the ITD procedure will be tested. American, Hawaiian, Singapore, and Cathay Pacific airlines (in addition to United and Delta) have requested approval to participate in the trials. Several nations have expressed interest in these procedures for use in their own airspace. In addition, the FAA plans to propose to ICAO that the procedure be adopted.

ITC and ITD are the first procedures to utilize the display of traffic information on the flight deck to assist air traffic controllers in monitoring and reducing aircraft spacing requirements. When Automatic Dependent Surveillance (ADS-B), which includes positive aircraft ID in the cockpit display, becomes operational, opportunities for collaborative ATC/pilot decisionmaking will increase. These are critical steps in the movement toward free flight.

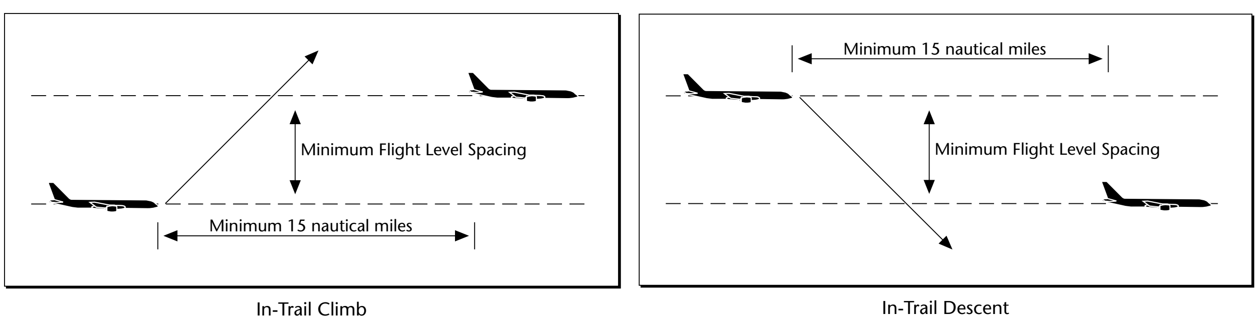


Figure 4-1.

In-Trail Climb and In-Trail Descent Using TCAS

4.4 Improved Instrument Approach Procedures

This section describes new instrument approach procedures that will enhance runway capacity in IMC.

4.4.1 Independent Parallel Approaches Using the Precision Runway Monitor (PRM)

The FAA authorized independent (simultaneous) instrument approaches to dual parallel runways in 1962. The spacing requirement between the parallel runways was initially a minimum of 5,000 feet, but was reduced to 4,300 feet in 1974. The separation was reduced to 3,400 feet with a PRM installed in 1991. Approval has recently been given for simultaneous approaches to dual parallel runways spaced 3,000 feet apart with one localizer offset 2.5 degrees using a precision runway monitor with a 1.0 second radar update. The first airports to apply this new procedure will most likely be JFK and Philadelphia. The average capacity gains expected from the use of the new approach procedure will be 15-17 arrivals per hour. Figure 4-2 illustrates the new approach procedure.

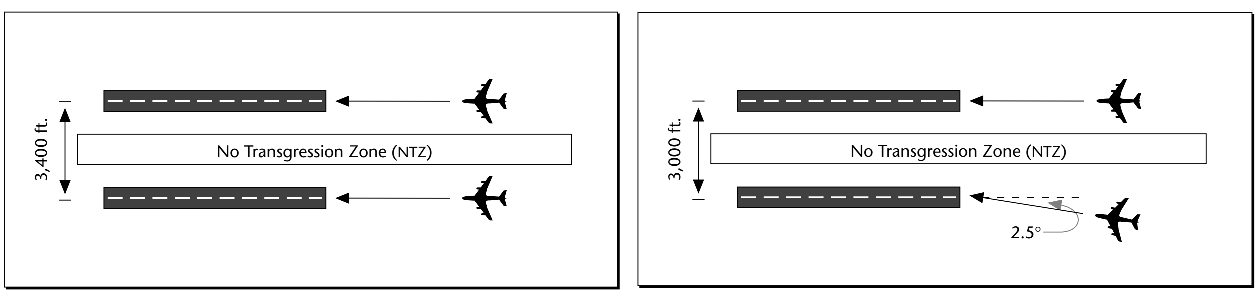


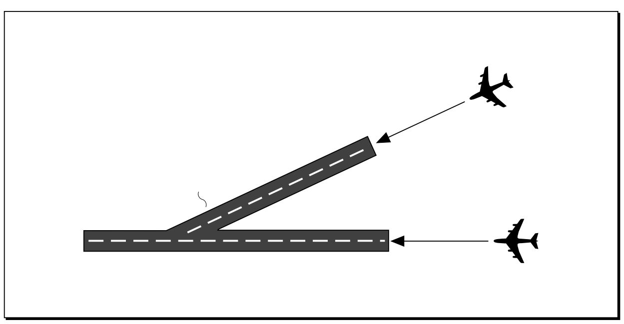
Figure 4-2.

Independent Parallel Instrument Approaches Using the Precision Runway Monitor (PRM)

4.4.2 Simultaneous Operations on Wet Intersecting Runways

Simultaneous operations on intersecting runways are a type of "land and hold short operation" (LAHSO). LAHSOs include landing and holding short of an intersecting runway, an intersecting taxiway, or some other predetermined point. Currently, simultaneous operations on intersecting runways require that they be dry. Of the top 100 airports, 60 currently conduct simultaneous operations on intersecting runways. Over the past several years, demonstrations of simultaneous operations on wet runways have been ongoing at Boston Logan, Greater Pittsburgh, and Chicago O'Hare. Special criteria for LAHSO in wet conditions are being established. For example, to be approved for LAHSO in wet conditions, runways must be grooved and exceed minimum levels of friction to prevent skidding or hydroplaning. At O'Hare, capacity increases of up to 25 percent have been experienced using simultaneous operations during wet runway operations. Future demonstrations are planned at New York's Kennedy, Philadelphia, and Miami International Airports.

An FAA team is currently formalizing procedures for these types of operations so that a National Standard for simultaneous operations on wet intersecting runways can be established. The target implementation date is Spring 1997. Figure 4-3 illustrates simultaneous operations on wet intersecting runways, and lists candidate airports.



Candidates Among Top 100 Airports		
Boston	Minneapolis-St. Paul	Philadelphia
Charlotte/Douglas	New York (JFK)	Pittsburgh
Chicago O'Hare	New York (LGA)	San Francisco
Detroit	Newark	Washington National
Miami	St. Louis	

Figure 4-3.

Simultaneous Operations on Wet Intersecting Runways

4.4.3 Simultaneous Approaches to Three Parallel Runways

In April 1996, real-time simulations were conducted to evaluate the air traffic control system's ability to support simultaneous independent ILS approaches to three runways spaced 4,000 and 5,300 feet apart. Controllers monitored traffic using a simulated PRM system, consisting of Final Monitor Aid (FMA) displays and a radar sensor with a 1.0-second update rate. The triple approach configuration was tested to emulate proposed procedures at Pittsburgh International and Atlanta International Airports.

The test results demonstrated a successful procedure. The procedure, therefore, was recommended for approval in the operational environment, when the PRM system with a 1.0-second update rate is used. Figure 4-4 illustrates simultaneous approaches to three parallel runways.

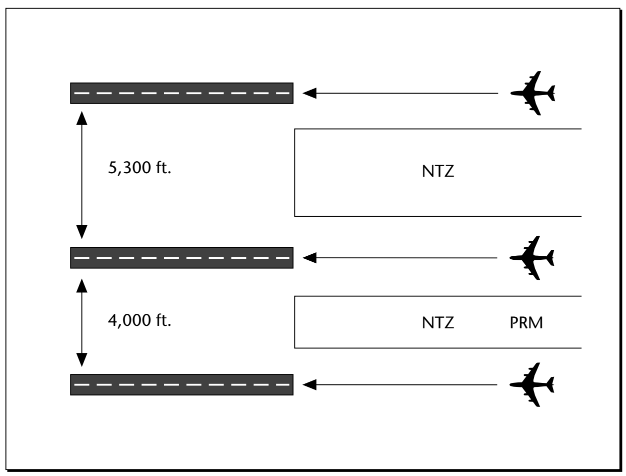


Figure 4-4.

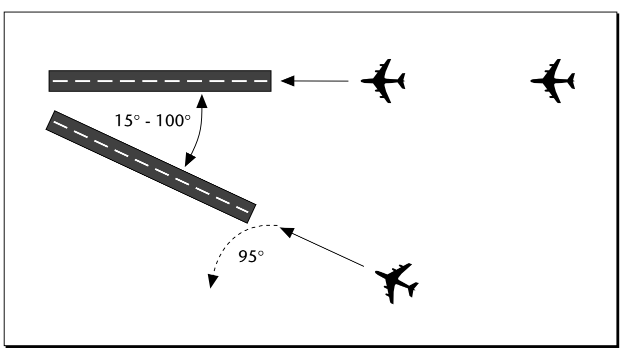
Simultaneous Independent Approaches to Three Parallel Runways

4.4.4 Simultaneous (Independent) Converging Instrument Approaches

Under existing approach procedures, converging runways can be used for independent streams of arriving aircraft only when the ceiling is at least 900 - 1,000 feet and visibility is at least three statute miles. This requirement decreases runway capacity in IRF conditions and causes weather-related delays. Simultaneous approaches cannot be conducted at all under IRF conditions if the converging runways intersect.

In an effort to refine the converging approach procedures and obtain greater operational efficiency for the users, the Converging Approach Standards Technical Work Group (CASTWG) was formed. The goal of the workgroup is to reduce landing minimums for aircraft conducting simultaneous converging instrument approaches, using new technology and procedures to ensure required aircraft separation is provided in the event of a simultaneous missed approach.

The CASTWG developed and tested a new missed approach procedure using a 95 degree turn from the localizer course, which can be implemented at 650 feet minimums. The procedure requires flight testing and validation prior to initial implementation. Once the new 650 feet minimums are implemented, efforts to further reduce the minimums to as low as 500 feet will continue. Average capacity gains expected using the new minimums with missed approach guidance is expected to be 30 arrivals per hour at each airport. Figure 4-5 illustrates the missed approach for the new simultaneous converging instrument approach and lists candidate airports for the new procedure.



Candidates Among Top 100 Airports		
Boston	Houston Intercont'l	Newark
Charlotte	Miami	Philadlephia
Chicago O'Hare	Nashville	St. Louis
Dallas-Ft. Worth	New Orleans	Washington Dulles

Figure 4-5.

Independent Converging Approach and Missed Approach Procedure

4.5 Wake Vortex Separation Standards

When a small aircraft trails too close behind a large aircraft, the small aircraft may be destabilized by wake vortex generated by the large aircraft. The FAA recently revised aircraft weight classes and separation standards to minimize the possibility of accidents or incidents due to wake vortex. These changing standards exemplify procedural changes that may decrease system capacity as a means to improve safety.

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An ongoing, cooperative FAA-NASA wake vortex research program is attempting to minimize the capacity restrictions imposed by efforts to prevent wake vortex-related incidents.

Small aircraft are subject to separation standards of four nm behind large aircraft, whereas large and heavy aircraft may follow other large aircraft by 3 NM. The weight ceiling of the small category was raised from 12,500 pounds to 41,000 pounds, increasing the number of aircraft included in the small category. In addition, separation was increased from 4 to 5 NM when a small aircraft follows a B-757. Two aircraft weighing less than 41,000 pounds (SAAB-340 and ATR-42) maintained the large aircraft classification based on performance characteristics.

The projected capacity impacts of the new standards were analyzed using the FAA Airfield Capacity Model, Quickpak, and SIMMOD. These modeling and simulation programs enabled the FAA to estimate changes in delay due to the new procedure factoring in runway and approach configurations, traffic composition, approach speeds, and weather. The simulations predicted increases in system delay of 17 percent in good weather and nine percent with widespread IRF. The actual impact of the new separation procedures is presently being analyzed; preliminary results show much smaller increases in delay than were predicted by the simulations.

An ongoing, cooperative FAA-NASA wake vortex research program is attempting to minimize the capacity restrictions imposed by efforts to prevent wake vortex-related incidents. The goals of the research program are: to significantly increase capacity by safely reducing aircraft separations; to increase capacity and maintain safety in VMC; and to bring IMC capacity closer to VMC capacity. FAA is focused primarily on achieving near-term capacity enhancements by addressing specific wake vortex problems at LaGuardia and JFK airports and providing wake turbulence training to pilots and air traffic controllers.

The NASA portion of the research program is targeted toward the development of an automated Aircraft Vortex Spacing System (AVOSS). Development activities include development of vortex motion and decay models, prediction of meteorological conditions affecting vortex behavior, development of a vortex encounter hazard model, implementation of vortex sensors, and development of automated aircraft spacing systems.

Chapter 5: Emerging Technology

Over the next two decades, the FAA will introduce numerous capacity enhancing changes to the civil aviation system that reflect advances in technology related to:

- Automation;
- Information systems;
- Communications, Navigation, and Surveillance; and
- Weather.

Figure 5-1 provides examples of the technology enhancements that will take place throughout the civil aviation system. The technology enhancements in one area are often closely related and coordinated with changes in other areas. For example, the automation enhancements in many facilities will provide the hardware and software platforms required to process and display data from new information systems incorporating the latest advances in information technology. In turn, the sharing of this new information between controllers and flight crews required by the free flight concept is dependent on technological advances in communications.

The FAA's NAS Architecture Plan outlines the "grand design" for the technology employed throughout the NAS and will ensure that enhancements to the system provide the maximum safety and capacity benefits to users. The FAA has recently released version 2.0 of this plan, and it will continue to evolve as opportunities for new system enhancements develop.

The sections below provide an overview of the emerging technologies that will enhance the capacity of the civil aviation system as we move into the 21st century. A number of the programs identified in this overview are described in more detail in the FAA's Capital Investment Plan (CIP), the FAA's Research, Engineering, and Development Plan (R,E&D Plan), or documents describing NASA's research and development program.

Dozens of R&D and capital improvement projects will impact the capacity of the civil aviation system over the next two decades. In many cases, such as the Automated Radar Terminal System (ARTS) improvement, Voice Switching and Control System (VSCS), or Airport Surface Detection Equipment (ASDE-3) projects, improvements will be gained from incremental upgrades to existing systems or application of existing technology to new locations. Many of these programs have been addressed in previous volumes of the ACE Plan. The sections below do not attempt to provide a comprehensive treatment of all of these projects. Instead, they focus on relatively new and innovative technology advances that will have the greatest impacts on the capacity of the aviation system.

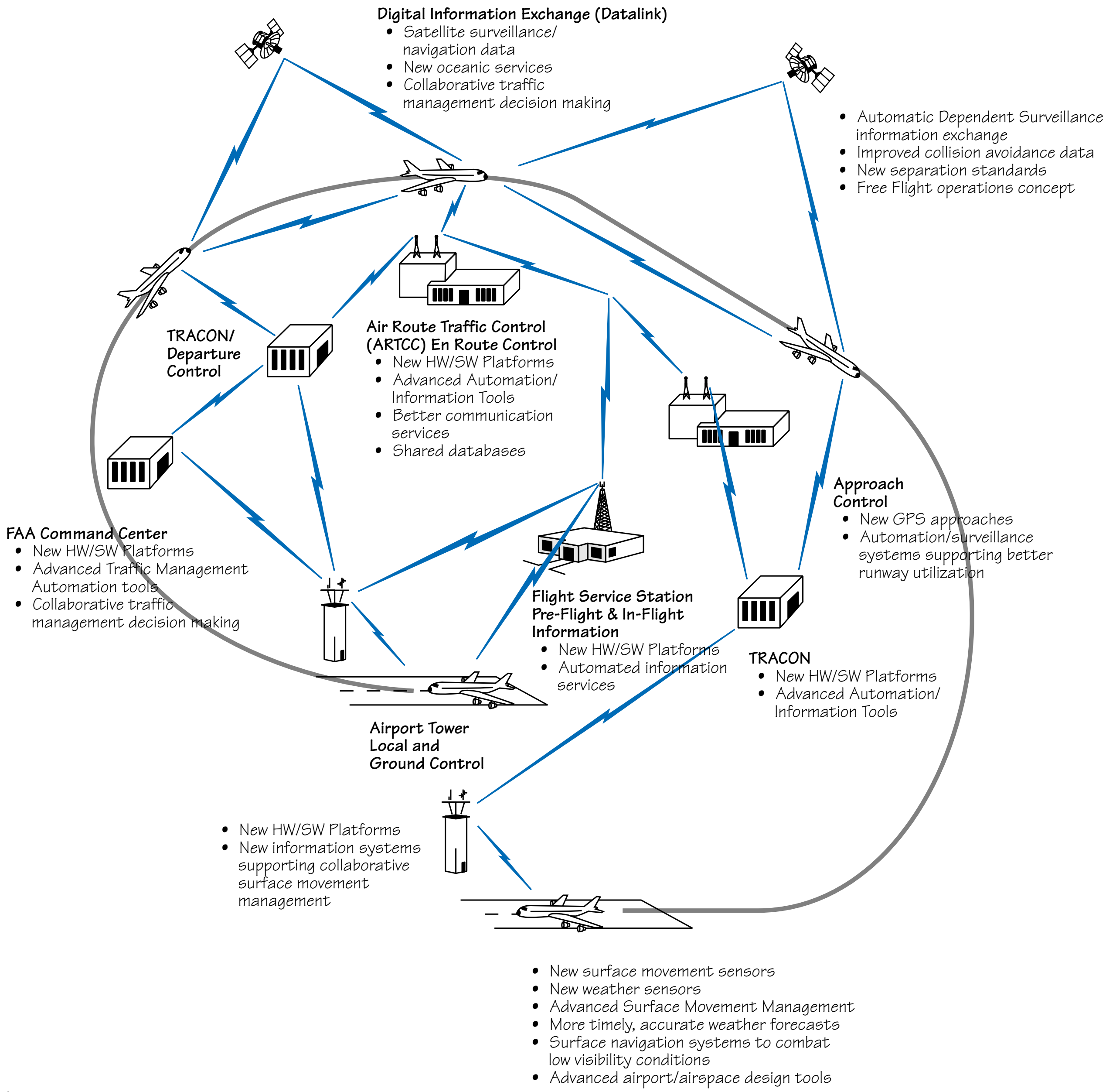


Figure 5-1.

Technology Advancements in the National Airspace System

5.1 Automation

The FAA is in the midst of a major modernization effort that will upgrade the automation technology used throughout facilities comprising the NAS. In many instances, the modernization efforts will utilize commercial off-the-shelf (COTS) hardware and software systems or components to facilitate long-term maintenance and upgrades to the NAS. These automation efforts include major programs such as the Display System Replacement (DSR) program in the en route environment and the Standard Terminal Automation Replacement System (STARS) in the terminal environment.

The implementation of the numerous automation systems will enhance the overall capacity of the NAS by:

- Increasing the reliability or availability of information and analytic tools supporting existing air traffic control capabilities; and
- Providing controllers and flight service specialists with the hardware and software platforms needed to process and display data from new information systems being developed to give controllers the tools necessary to increase NAS throughput, flexibility, etc. while maintaining or enhancing safety.

Table 5-1 provides a list of major automation efforts, references to the Capital Investment Plan (CIP) and the R,E&D plans where more information on the projects can be obtained, identification of the component(s) of the aviation system where the technology enhancements will be implemented, and the primary purpose and/or anticipated impact of the program.

The FAA's NAS Architecture Plan outlines the "grand design" for the technology employed throughout the NAS and will ensure that enhancements to the system provide the maximum safety and capacity benefits to users.

The FAA is in the midst of a major modernization effort that will upgrade the automation technology used throughout facilities comprising the NAS.

Table 5-1.

Automation Technology Enhancement Programs

Program	CIP/R,E&D Plan Number	Facility/Civil Aviation System Component(s) Affected	Program Purpose/ Expected Capacity Benefits
En Route Automation Program	A-01	En Route/Oceanic	Projects in this program will replace aging and unsupportable equipment and allow continued system growth in the present air traffic control system, providing a safe and efficient air traffic environment that contributes to the evolution toward a free flight environment.
Tower Automation Program	A-02	Airport	To solve the problems of controllers having minimal flexibility to rearrange operational positions for various tower operating conditions and the inefficient placement of individual control systems, the program will integrate new and existing safety systems in a consolidated automation platform with a common computer/human interface.
Automated Radar Terminal System (ARTS) Improvements	A-03	Terminal	This program will provide radar approach services where none currently exist and increased processor capacity and more displays at existing facilities. New and modified equipment will maintain or improve safety levels while increasing traffic capacity. The development of stand-alone, simulation based training systems for terminal and metroplex control facilities will permit training of Air Traffic personnel in a realistic environment without taking operational equipment out of service, risking injury to personnel, or damaging system equipment.
Standard Terminal Automation Replacement System (STARS)	A-04	Terminal	This program reflects the long-term aproach to improving the FAA's automation capabilities in the terminal environment. STARS will deploy a new automation system that uses a modern, commercially-open architecture that solves current capacity problems and that supports future demands.
Traffic Management System (TMS)	A-05	Airport, Terminal, En Route/Oceanic	By replacing outdated equipment and existing system architecture with an architecture that complies with FAA and National Institute of Standards and Technologies (NIST) documentation, the TMS will maximize air traffic throughput, minimize air traffic delays, and establish a reliable, serviceable automation platform.
En Route Software Development	A-06	En Route/Oceanic	The program provides the necessary support for the continuing development, integration and implementation of NAS en route software changes to correct operational problems and provide systems enhancement.

Table 5-1.

Automation Technology Enhancement Programs

Program	CIP/R,E&D Plan Number	Facility/Civil Aviation System Component(s) Affected	Program Purpose/ Expected Capacity Benefits
Flight Service Automation System (FSAS)	A-07	Flight Service Stations	The FSAS provides a flight service specialist with automated advancements that improve weather and Notice to Airmen (NOTAM) briefings and simplify flight plan filing. Replacing the 318 manual Flight Service Stations (FSSs) with 61 Automated Flight Service Stations (AFSSs) will enhance the current system by replacing capacity components and by incorporating a uniform graphic weather display system capability.
Oceanic Automation Program (OAP)	A-10	Flight Service Stations, En Route/Oceanic	The OAP will provide an automation infrastructure including oceanic flight data processing, a computer-generated situation display, and a strategic conflict probe for alerting controllers to potential conflicts hours before they would occur. Ultimately, controllers will be able to grant more fuel-efficient flexible routes, which will significantly impact fuel costs and delays.
Airport Surface Target Identification System (ATIDS)	A-12	Airport	ATIDS will develop aids such as airport surface surveillance, communications and automation techniques to provide all-weather runway incursion alerts and prevention capability, thereby, reducing taxi delays by 5-15 percent.
Traffic Alert and Collision Avoidance System (TCAS)	022-110	Aircraft/Aircrew, Terminal, En Route	The primary role of TCAS is to avoid collisions; however, its capabilities offer the potential to improve the overall efficiency and safety of routine flight operations.
General Aviation and Vertical Flight Program	022-140	Aircraft/Aircrew, Airport, Terminal, Flight Service, En Route, R,E&D Internal Services	This project will aid the expansion of technology related to general aviation and vertical flight into the NAS. Efforts will focus on air traffic system design and advanced operational procedures; heliport/vertiport/intermodal design and planning; aircraft/crew certification, training, and human factors; and emerging technology applications. The general aviation element is a collaborative NASA/FAA/industry technology program which will implement an economically viable short-haul transportation system to augment the existing national airspace system, to stimulate industry and to create jobs.

5.2 Information Systems

A number of advanced information systems are being developed as joint research projects between FAA and other agencies such as NASA. These advanced systems include new analytic tools and data systems designed specifically to facilitate the sharing of data between controllers, airport officials, airlines, and pilots.

Beyond the replacement of existing hardware and software platforms, many of the FAA's automation programs include plans for evolutionary software enhancements. The Automated En Route ATC (AERA), Terminal Air Traffic Control Automation (TACTA), and Advanced Traffic Management System (TMS) exemplify this type of technology enhancement. In each of these programs, software is being developed to provide automation aids/tools to controllers that will enable them to plan for and implement actions that will ultimately improve the flexibility and efficiency of NAS operations. Typically, these new information systems integrate data from a variety of sources into a single database. The integration of these data provides the opportunity for new analytic tools that controllers and/or flight crews may use to plot fuel efficient routes, identify potential conflicts with other aircraft, or adjust routing during a flight. The output of these analytic tools is often presented in graphic forms to assist users in effective and efficient decision making. The tools will enable controllers throughout the system to provide greater flexibility in user routing, reduce delays in congested airspace, and enhance the safety of the system simultaneously.

The technology used in these complex information systems relies not only on new automation platforms, but also on new communication systems that will rapidly move large amounts of data from ground-to-ground locations as well as from ground-to-air or air-to-ground. The information systems will provide data that must be available simultaneously to controllers and flight crews as part of the FAA's movement to a free-flight operating environment and collaborative decision making in traffic management.

A number of advanced information systems are being developed as joint research projects between FAA and other agencies such as NASA. These advanced systems include new analytic tools and data systems designed specifically to facilitate the sharing of data between controllers, airport officials, airlines, and pilots. The technology under development includes projects such as new aviation capacity planning tools that utilize computer simulations and the Surface Movement Advisor (SMA) project.

Table 5-2 provides a list of projects that fall into the information system category.

Table 5-2.

Information Enhancement Programs

Program	CIP/R,E&D Plan Number	Facility/Civil Aviation System Component(s) Affected	Program Purpose/ Expected Capacity Benefits
En Route Automation Program (AERA)	A-01	En Route/Oceanic	AERA is a long-term program that will increasingly allow aircraft to fly their preferred routes safely with a minimum of air traffic control intervention. It will help increase airspace capacity by improving the ATC system's ability to manage more densely populated airspace and will improve the ability of the ATC to accommodate user preferences. In more advanced AERA applications, the integration of ground-based ATC and cockpit automation will be investigated to fully exploit the potential for computer-aided interactive flight planning between controller and pilot.
Operational Data Management System (ODMS)	A-08	Flight Service Stations, Airport, Terminal, En Route/Oceanic	This project will modernize the Aeronautical Information System (AIS) and the United States Notices to Airmen (NOTAM) System (USNS). This system is a key component of the traffic flow management (TFM) program and will provide air traffic static and operational data for the traffic flow management functions.
Terminal ATC Automation (TATCA)	A-11	Terminal	The purpose of TACTA is to develop automation aids to assist air traffic controllers and Traffic Management Unit (TMU) coordinators in enhancing the terminal area air traffic management process and to facilitate the early implementation of these aids at busy airports. Longer term activities include the integration of traffic flow management tools with other air traffic control systems and cockpit automation capabilities.
Advanced Traffic Management System (ATMS)	021-110	Flight Service, Airport, Terminal, En Route	The ATMS will allow air traffic managers to identify in advance when en route or terminal weather or other factors require intervention to expedite and balance the flow of traffic. Furthermore, this effort to research automation tools will minimize the effects of NAS overload on user preferences without compromising safety.
Oceanic Air Traffic Automation	021-140	En Route	This project aims to increase oceanic air traffic capacity and efficiency without degrading safety. Research and development in this project will lay the foundation for new F&E initiatives leading to the introduction of free flight in oceanic airspace.

Table 5-2.

Information Enhancement Programs

Program	CIP/R,E&D Plan Number	Facility/Civil Aviation System Component(s) Affected	Program Purpose/ Expected Capacity Benefits
Surface Movement Advisor (SMA)	021-200	Airport	The SMA will interface with and improve other NAS management systems and coordinate surface activities with air traffic control, the airlines, and airport operators through an unprecedented sharing of operationally-crucial surface movement information.
Traffic Alert and Collision Avoidance System (TCAS)	022-110	Aircraft/Aircrew, Terminal, En Route	TCAS will develop and assist in implementing an independent airborne collision avoidance capability. TCAS will reduce midair collision risks and increase capacity such as simultaneous approaches to parallel runways and pilot-maintained in-trail spacing via the improved cockpit display capability.
General Aviation and Vertical Flight (VF) Program	022-140	Aircraft/Aircrew, Flight Service, Airport, Terminal, En Route, R,E&D Internal Services	This program will provide a safer and more efficient use of the NAS for the general aviation industry by identifying, initiating and performing research activities to safely introduce critical technologies applicable to general aviation and vertical flight needs and requirements.
Aviation System Capacity Planning	024-110	Airport, Terminal, En Route	The program supports development of an overall capacity strategy; the conduct, measurement, and assessment of airports and technologies; and development and application of electronic tools that aid in the formulation of that strategy to reduce delays, increase the number of operations per hours and to decrease maintenance/operating costs.
National Simulation Capability (NSC)	025-110	Aircraft/Aircrew, Airport, Terminal, En Route, R,E&D Internal Services	The NSC supports the R,E&D and systems engineering missions of the FAA by horizontally integrating the various R,E&D program elements across the NAS environment. By exploiting the latest simulation technology, the NSC permits the evaluation of new operational concepts, human interfaces and failure modes in a realistic, real-time, interactive ATC environment capable of simulating new or modified systems at forecast traffic levels.
Air Traffic Models and Evaluation Tools	025-130	Airport, Terminal, En Route, R,E&D Internal Services	By producing modeling and analytic tools to support operational improvements, air space and airport design, environmental analysis, investment decision making, and ATC system design analysis; the project will provide ATC with the ability to plan, evaluate, and update operational changes rapidly to accommodate the increasingly dynamic airport and airspace environment.

5.3 Communications, Navigation, and Surveillance (CNS)

While there are distinct communications, navigation, and surveillance systems being developed and deployed throughout the civil aviation system, the technology underlying enhancements in these CNS systems is very closely related. There are two primary advancements that dominate the emerging technology in the CNS area:

- The use of datalink systems to exchange/display digital information; and
- The transition to satellite technologies as a primary means of generating and relaying navigation and surveillance data.

The integration of various aspects of these two technology changes is being applied in a range of situations to improve both the safety and capacity of the civil aviation system. The application of these technologies includes projects such as:

- Providing oceanic air traffic control services similar to those currently available domestically through use of satellite communications and datalink;
- The development of precision and non-precision approaches utilizing global positioning system data;
- Development of surface navigation systems and landing systems relying on GPS data and datalink communications to allow normal levels of operation in poor visibility conditions at busy airports; and
- Increasing user flexibility (free flight) and achievement of greater utilization of parallel runways through the use of GPS location data broadcast from aircraft to other aircraft and the ground Automatic Dependent Surveillance (ADS) technology.

Table 5-3 lists the major CNS programs that will impact the capacity of the civil aviation system over the next two decades. The ultimate success of CNS technology applications such as those listed in Table 5-3 is highly dependent on successful implementation of systems described under the automation and information systems headings. Without the processing, analysis, and display capabilities provided by these projects, controllers and other essential personnel will not have the tools needed to manage the information workload created by these CNS technology enhancements.

Table 5-3.

CNS Technology Enhancement Programs

Program	CIP/R,E&D Plan Number	Facility/Civil Aviation System Component(s) Affected	Program Purpose/ Expected Capacity Benefits
Voice Switching and Control System (VSCS)	C-01	En Route/Oceanic	This project will provide a voice communications system that performs the intercom, interphone, and air/ground voice connectivity and control functions necessary for air traffic control operations in an ARTCC. It will reduce leased costs and increase modularity and growth capability, and controller productivity over current communication.
Weather Message Switching Center (WMSC) Replacement	C-03	Flight Service Stations, Airport, Terminal, En Route/Oceanic	This project will replace the weather message switching center with modern technology to perform current data handling functions of the center. It will provide storage and distribution of NOTAMS. Furthermore, the WMSC functions as the primary FAA gateway to the National Weather Service telecommunications gateway.
FAA Telecommunications Satellite (FAASAT)	C-15	Flight Service Stations, Terminal, En Route/Oceanic	This provides the FAA with a leased satellite interfacility communications network, which supports the FAA strategy for cost effective interfacility communications transmissions by providing redundant alternatives to avoid single-points-of-failure through circuit diversity. It will also meet NAS service availability and message quality requirements. Economically, FAASAT supports the increased requirement for communications and data circuits needed to support the metroplex control facility and flight service station consolidation programs. It supports the weather and radar processor program and broadcast requirements.
Aeronautical Data-link	C-20	Airport, Terminal, En Route/Oceanic	Data-link communications will improve air/ground communications and contribute to system safety and capacity by improving pilot accessibility to information, relieving congested voice frequencies, and reducing the workload of pilots, specialists, and controllers.
Next-Generation Air/Ground Communications System	C-21	Flight Service Stations, Airport, Terminal, En Route/Oceanic	This program will design, implement and install a new air/ground radio communications system. It will also increase spectrum capacity in the VHF aeronautical band, replace unmaintainable VHF/UHF analog radios, and resolve radio frequency interference problems in the existing analog radio system, which will support voice and data communications within a single avionics transceiver system.

Table 5-3.

CNS Technology Enhancement Programs

Program	CIP/R,E&D Plan Number	Facility/Civil Aviation System Component(s) Affected	Program Purpose/ Expected Capacity Benefits
Instrument Landing System (ILS)	N-03	Airport	This program will aid the efficiency of NAS until global positioning landing systems can be fully implemented. ILS may include the procurement and installation of other equipment as necessary to ensure full operational capability.
Runway Visual Range (RVR)	N-08	Airport	This program establishes new generation runway visual range systems to support precision landing operations and airport capacity enhancements.
Loran-C Monitors and Transmitter Enhancements	N-11	Terminal, En Route/Oceanic	This is a supplemental radio navigation system for aviation use that provides at least single-level coverage for en route and terminal instrument flight rule navigation for the contiguous US. This program will also maximize the overall system performance of Loran-C.
Augmentations for the Global Positioning System (GPS)	N-12	Airport, Terminal, En Route/Oceanic	The GPS will make precision approach procedures available to more airport runways by significantly reducing frequency congestion problems associated with ILS. Improving the capacity of an airport's surrounding airspace, it will reduce the interdependency of proximate airports. This project will provide the necessary augmentation equipment which will enable the global positioning system to be used in the NAS as the federal aviation radionavigation system for all oceanic and domestic phases of flight. Satellite navigation presents opportunities for standardized worldwide civil aviation operations using a common navigation receiver and for significant improvements in safety, capacity, service flexibility, and aircraft operating cost. Also, satellite-based navigation systems provide the potential for new navigation and landing services not currently supported by the existing systems.
ASDE Radar	S-01	Airport	The ASDE-3 provides radar surveillance of aircraft and airport service vehicles at selected airports to ensure an effective mode of directing and moving surface traffic.
Mode S	S-02	Airport, Terminal, En Route/Oceanic	Mode S will improve the surveillance capability of the air traffic control radar beacon system (ATCRBS). It provides more accurate positional information and minimizes interference. Furthermore, it replaces aging and obsolete air traffic control beacon interrogator (ATCBI-4/5) equipment to maintain ground surveillance and increase supportability. In addition,

Table 5-3.

CNS Technology Enhancement Programs

Program	CIP/R,E&D Plan Number	Facility/Civil Aviation System Component(s) Affected	Program Purpose/ Expected Capacity Benefits
Mode S (continued)			Mode S provides the medium for a digital data-link which can be used to exchange information between aircraft and various air traffic control functions and weather data-bases.
Terminal Radar (ASR) Program	S-03	Airport, Terminal	This program provides economical radar service at airports with air traffic densities high enough to justify the service. It also upgrades the highest density airports with the most modern equipment. The project will provide for relocation and associated refurbishment of terminal radars.
Long-Range Radar Program	S-04	En Route/Oceanic	This project will provide a national radar surveillance network by installing the air route surveillance radar at existing and new sites. It will improve the current inventory of long-range radars that will extend their useful life and/or aid the transition to a beacon-only en route surveillance system.
Long-Range Radar (LRR) Radome Replacement	S-05	En Route/Oceanic	The LRR will replace existing radomes at most long-range radar facilities in the NAS, the majority of which have exceeded their normal life expectancy and are incompatible with the new Mode S monopulse antenna system. The new radome will also minimize radar signal interference.
Precision Runway Monitor (PRM)	S-08	Airport	This system reduces the allowable runway spacing for conducting independent parallel instrument approaches at closely-spaced airports. The average capacity gains expected from the PRM system would be 12-17 arrivals per hour.
Multilateration Technology Demonstrations	S02/S08	Airport	The purpose of this project is to provide a prototype demonstration of the multilateration approach to monitoring final approaches to parallel runways. The multilateration approach represents a low-cost alternative to PRM that uses multiple air traffic control radar beacon (ATCRB) transponders and Mode S to provide accurate surveillance capabilitifor monitoring final approaches to closely spaced parallel runways.
Airborne Information for Lateral Spacing (AILS)	NASA	Airport, Aircraft/Aircrew	AILS goal is to enable “airborne technology assisted approaches” to safely reduce lateral spacing requirements during IMC. It will provide crew with information on nearby traffic comparable to that available in VMC.

5.4 Weather

Weather is the single largest contributor to delay in the civil aviation system and is a major factor in aircraft safety incidents and accidents. The FAA is working in conjunction with other agencies such as NASA and the National Oceanic and Atmospheric Administration (NOAA) to improve NAS capacity though better forecasting and detection of adverse weather conditions. Programs are also underway to apply new technologies to the mitigation of the negative effects of weather such as poor visibility at airports.

Weather is the single largest contributor to delay in the civil aviation system and is a major factor in aircraft safety incidents and accidents. The FAA is working in conjunction with other agencies such as NASA and the National Oceanic and Atmospheric Administration (NOAA) to improve NAS capacity though better forecasting and detection of adverse weather conditions.

The technology enhancements under study and development in this area include automation, information system, and CNS technology applications uniquely tailored to address factors related to weather. For example, there are a number of F&E projects designed to enhance existing sensors or deploy new sensors to provide more accurate and timely weather data (e.g., Terminal Doppler Weather Radar (TDWR), Automated Weather Observation System (AWOS), Low-level Windshear Alert System (LLWAS). These surveillance and automation projects will feed data into new information systems designed to integrate a wide range of weather data into a single database where it can be analyzed using new models under development in a variety of research and development efforts (e.g., Integrated Terminal Weather System (ITWS) and Aviation Weather Analysis and Forecasting program). The output of these analytic tools will be displayed in the form of enhanced graphics on new display systems in ATC facilities and/or in the aircraft cockpit. The datalink system will be an essential element in the timely dissemination of this information to flight crews.

Table 5-4 provides a listing of the major programs that will provide technology enhancements in the weather area during the next two decades.

Table 5-4.

Weather Enhancement Programs

Program	CIP/R,E&D Plan Number	Facility/Civil Aviation System Component(s) Affected	Program Purpose/ Expected Capacity Benefits
Automated Weather Observing System (AWOS)	W-01	Flight Service Stations, Airport, En Route/Oceanic	This project's automated sensors allow for the gathering of aviation-critical weather data. Data is processed and reported to pilots via a computerized voice. The connection of AWOS with the automated weather observation system data acquisition system (ADAS) will support the closing of the National Communications Center and will make current weather observation data accessible to pilots, enhancing safety and efficiency.
Weather Radar Program	W-02	En Route/Oceanic	By establishing a weather radar network, this project provides accurate aviation weather products for en route applications. Future automated air traffic control capabilities, such as preferred routing and improved flow management, will depend on reliable weather data prior to the realization of projected fuel efficiency and personnel productivity gains.
Terminal Doppler Weather Radar (TDWR) System	W-03	Airport, Terminal	This program involves the installation of a new terminal Doppler weather radar that can detect microbursts, gust fronts, wind shifts and precipitation. It will warn aircraft in the terminal area of hazardous weather conditions and of changing wind conditions to enable the timely change of active runways.
Weather and Radar Processor (WARP)	W-04	En Route/Oceanic	The WARP will collect, process and disseminate weather information from next generation weather radars (NEXRAD) to controllers, traffic management specialists, pilots and meteorologists. By providing a mosaic product of various NEXRAD information to the Display System Replacement (DSR), the WARP will enhance the quality of weather information available to air controllers, thus, reducing accidents and air traffic delays. It also provides center weather service unit/central flow weather service unit meteorologists with automated workstations that improve their ability to analyze rapidly changing weather conditions.

Table 5-4.

Weather Enhancement Programs

Program	CIP/R,E&D Plan Number	Facility/Civil Aviation System Component(s) Affected	Program Purpose/ Expected Capacity Benefits
Low-Level Windshear Alert System (LLWAS)	W-05	Airport	The LLWAS provides local controllers and pilots with information on microbursts and windshear near airports. It will enhance the ability of existing systems by providing runway-oriented microburst/windshear alerts, increased probability of detection of microbursts, and an interface to the terminal doppler weather radar.
Integrated Terminal Weather System (ITWS)	W-07	Terminal	The ITWS will integrate relevant weather data accessible in the terminal area and from in-flight aircraft to provide air traffic personnel with timely, near-term weather information and predictions in a clear graphical and textual form.
ASR Weather Systems Processor	W-09	Terminal	This program enhances the hazardous weather detection capability of an airport surveillance radar by developing and testing a modular data processing channel for automatic detection of windshear, thunderstorm microbursts, and gust fronts. The advancement provides airports ineligible for terminal doppler weather radars with windshear warnings.
Aviation Weather Analysis and Forecasting	041-110	Aircraft/Aircrew, Flight Service, Airport, Terminal, En Route	The integration of this project with other national research programs that focus on atmospheric mesoscale analysis and prediction problems will improve the understanding of weather's effects on aviation. An additional purpose is to concentrate research efforts on developing new algorithms, numerical weather analysis and prediction models, and methods to detect the impact from weather hazards.
Aeronautical Hazards Research	042-110	Aircraft/Aircrew, Terminal, En Route	Designed to improve safety, the project will collect data and analyze systems to validate technology for detecting hazards such as mountain rotors. The research will improve the operational capability to detect, monitor and alert flightcrews to aeronautical hazards.
Low Visibility Landing and Surface Operations	NASA	Airport, Terminal	The goal is to improve the efficiency of airport surface operations for commercial aircraft operating in weather conditions to Category IIIB while maintaining a high degree of safety.

Appendix A: Aviation Statistics

It is important to note that Denver International Airport replaced Denver Stapleton International in 1995. Therefore, the data for 1993 and 1994 reflects the enplanements and operations for Denver Stapleton International.

Table A-1. Airport Operations and Enplanements, 1993, 1994, and 1995[1]

City-Airport	Airport ID	Rank	Enplanements FY93	Enplanements FY94	Enplanements FY95	Operations FY93	Operations FY94	Operations FY95
Chicago O'Hare Int'l Airport	ORD	1	30,085,425	30,606,235	31,255,738	851,865	883,480	892,330
Hartsfield Atlanta Int'l Airport	ATL	2	22,336,481	26,472,972	27,350,320	658,414	699,400	747,105
Dallas-Fort Worth Int'l Airport	DFW	3	25,182,625	26,267,502	26,612,579	789,183	831,135	873,510
Los Angeles Int'l Airport	LAX	4	22,377,277	23,848,357	25,851,031	681,845	687,627	716,293
San Francisco Int'l Airport	SFO	5	14,827,283	15,973,975	16,700,975	423,404	430,380	436,907
Miami Int'l Airport	MIA	6	13,661,225	14,379,431	16,242,081	527,545	550,194	576,609
Denver Int'l Airport	DEN	7	15,046,704	15,744,474	14,818,822	552,238	546,305	487,225
New York John F. Kennedy Int'l Airport	JFK	8	13,048,381	13,659,611	14,782,367	351,205	352,494	345,263
Detroit Metropolitan Airport	DTW	9	11,410,123	12,691,906	13,810,517	460,009	479,738	498,887
Phoenix Sky Harbor Int'l Airport	PHX	10	11,247,976	12,347,562	13,472,480	520,403	507,698	522,634
Newark Int'l Airport	EWR	11	12,199,131	13,544,066	13,072,250	431,944	441,997	428,703
Las Vegas McCarran Int'l Airport	LAS	12	10,035,719	11,913,954	12,764,544	439,393	488,347	508,077
Lambert St. Louis Int'l Airport	STL	13	9,667,061	11,124,230	12,688,589	441,142	466,639	516,021
Minneapolis-St. Paul Int'l Airport	MSP	14	10,856,313	11,358,679	12,247,015	442,341	454,441	466,916
Boston Logan Int'l Airport	BOS	15	11,118,037	11,716,314	11,889,020	495,347	478,660	478,253
Houston Intercontinental Airport	IAH	16	9,351,601	10,139,079	11,420,071	352,340	352,385	375,246
Seattle-Tacoma Int'l Airport	SEA	17	8,653,666	9,945,559	10,947,345	339,968	345,052	382,100
Honolulu Int'l Airport	HNL	18	10,137,658	10,480,767	10,909,298	365,195	357,116	376,224
Orlando Int'l Airport	MCO	19	9,957,138	10,251,933	10,556,973	327,199	344,213	343,609
Charlotte/Douglas Int'l Airport	CLT	20	8,444,325	10,042,865	10,482,958	446,315	471,128	474,338
New York LaGuardia Airport	LGA	21	9,409,713	9,956,711	10,240,938	335,071	335,539	346,869
Greater Pittsburgh Int'l Airport	PIT	22	9,017,674	9,763,045	9,934,985	419,581	435,433	452,900
Philadelphia Int'l Airport	PHL	23	7,864,850	8,325,571	8,719,275	390,736	402,845	409,148
Salt Lake City Int'l Airport	SLC	24	7,067,806	8,138,609	8,594,490	324,595	343,807	349,699
Washington National Airport	DCA	25	7,562,011	7,549,169	7,459,210	316,762	316,790	316,404
Greater Cincinnati Int'l Airport	CVG	26	5,967,103	6,679,025	7,170,498	306,811	333,832	358,203
San Diego Int'l Lindberg Field	SAN	27	5,792,921	6,248,662	6,596,498	209,267	215,215	228,740
Baltimore-Washington Int'l Airport	BWI	28	4,372,994	6,047,432	6,541,031	261,674	286,392	296,932
Washington Dulles Int'l Airport	IAD	29	5,180,124	5,490,799	5,694,267	277,483	296,201	311,279
Tampa Int'l Airport	TPA	30	4,645,391	5,756,785	5,531,128	240,425	263,541	261,617
Portland Int'l Airport	PDX	31	3,944,523	4,742,410	5,419,125	280,263	277,000	301,785
Cleveland Hopkins Int'l Airport	CLE	32	4,289,995	5,028,369	5,278,909	247,502	260,485	268,097
Kansas City Int'l Airport	MCI	33	3,843,492	4,354,351	4,691,799	184,848	198,274	207,518
Metropolitan Oakland Int'l Airport	OAK	34	3,499,905	3,840,519	4,691,068	439,214	470,901	502,952
San Juan Int'l Airport	SJU	35	4,431,716	4,588,481	4,643,034	180,567	174,598	183,082
Fort Lauderdale Int'l Airport	FLL	36	4,081,258	4,937,251	4,587,770	217,786	233,044	238,108
Chicago Midway Airport	MDW	37	2,688,342	4,040,900	4,348,380	189,755	254,570	268,575
San Jose Int'l Airport	SJC	38	3,277,798	3,962,812	4,327,508	312,405	298,220	270,519
Memphis Int'l Airport	MEM	39	3,786,795	3,908,960	4,223,864	337,608	345,534	356,294
New Orleans Int'l Airport	MSY	40	3,343,714	3,883,655	4,147,081	141,384	167,375	177,383
Nashville Int'l Airport	BNA	41	4,657,484	4,240,353	3,983,741	318,886	295,558	278,957
Houston William P. Hobby Airport	HOU	42	4,070,069	3,920,000	3,921,273	239,634	236,683	245,603

1. At the top 100 airports, ranked by 1995 enplanements.

Table A-1. Airport Operations and Enplanements, 1993, 1994, and 1995[1]

	Airport		Enplanements			Operations		
City-Airport	ID	Rank	FY93	FY94	FY95	FY93	FY94	FY95
Santa Ana John Wayne Airport	SNA	43	2,878,493	3,255,004	3,522,755	494,378	509,220	493,391
Dallas-Love Field	DAL	44	3,116,746	3,378,468	3,416,394	212,854	217,331	208,768
Sacramento Metropolitan Airport	SMF	45	2,580,739	2,828,848	3,307,202	169,272	149,053	177,010
Raleigh-Durham Int'l Airport	RDU	46	4,850,848	4,616,106	3,234,420	294,066	283,713	214,011
Ontario Int'l Airport	ONT	47	3,039,014	3,199,499	3,234,259	152,914	158,635	158,302
Indianapolis Int'l Airport	IND	48	2,972,210	3,068,733	3,101,724	238,789	237,937	245,541
San Antonio Int'l Airport	SAT	49	2,792,057	2,964,827	3,096,670	219,305	238,277	238,315
Albuquerque Int'l Airport	ABQ	50	2,730,538	2,996,622	3,076,532	209,567	220,914	199,114
Port Columbus Int'l Airport	CMH	51	2,449,811	2,769,749	2,786,503	217,049	223,633	204,100
Kahului Airport	OGG	52	2,456,187	2,573,507	2,732,610	173,002	176,209	178,602
Palm Beach Int'l Airport	PBI	53	2,434,178	2,723,145	2,710,286	230,903	216,480	205,104
Austin Robert Mueller Airport	AUS	54	2,263,264	2,462,680	2,652,578	188,026	192,040	201,409
Reno Cannon Int'l Airport	RNO	55	2,176,373	2,465,577	2,649,673	162,441	161,190	151,603
Milwaukee Int'l Airport	MKE	56	2,192,185	2,444,663	2,490,301	198,529	213,602	209,939
Bradley Int'l Airport	BDL	57	2,274,623	2,318,262	2,482,024	166,889	163,180	176,382
Burbank-Glendale-Pasadena Airport	BUR	58	2,063,436	2,371,258	2,471,158	207,460	194,264	184,366
Anchorage Int'l Airport	ANC	59	1,796,727	1,963,820	2,023,536	218,279	215,641	217,768
Fort Myers Regional Airport	RSW	60	1,725,235	1,897,157	1,971,981	66,004	64,849	67,026
El Paso Int'l Airport	ELP	61	1,757,415	1,822,024	1,863,388	151,284	157,984	151,905
Greensboro Int'l Airport	GSO	62	925,478	1,782,183	1,843,343	126,446	157,401	173,259
Jacksonville Int'l Airport	JAX	63	1,324,942	1,886,673	1,819,003	129,683	142,821	142,786
Louisville Standiford Field	SDF	64	1,120,776	1,547,786	1,786,129	155,941	179,921	178,646
Tucson Int'l Airport	TUS	65	1,252,411	1,570,527	1,735,564	228,877	249,729	238,024
Oklahoma City World Airport	OKC	66	1,517,419	1,650,479	1,674,814	142,492	146,759	149,275
Greater Buffalo Int'l Airport	BUF	67	1,553,248	1,799,588	1,621,140	142,136	145,221	153,646
Tulsa Int'l Airport	TUL	68	1,452,380	1,589,503	1,570,020	188,009	198,332	186,512
Guam Int'l	GUM	69	1,143,563	1,227,840	1,495,835	68,912	68,912	59,928
Omaha Eppley Airfield	OMA	70	1,046,679	1,171,493	1,463,845	143,739	154,154	160,039
Spokane Int'l Airport	GEG	71	1,080,799	1,297,601	1,454,000	122,350	122,615	119,701
Norfolk Int'l Airport	ORF	72	1,244,921	1,682,504	1,410,057	134,564	141,861	135,793
Little Rock Adams Field	LIT	73	1,091,806	1,204,442	1,266,989	171,399	173,126	169,312
Greater Rochester Int'l Airport	ROC	74	1,167,895	1,271,298	1,230,589	188,072	189,372	190,053
Birmingham Airport	BHM	75	1,012,878	1,089,094	1,229,581	168,074	161,638	165,295
Dayton Int'l Airport	DAY	76	1,033,543	1,243,861	1,173,454	132,234	154,481	151,248
Lihue Airport	LIH	77	768,822	1,084,800	1,145,858	57,686	92,542	94,439
Kailua-Kona Keahole	KOA	78	1,117,491	1,106,614	1,126,777	60,393	66,821	72,057
Colorado Springs Municipal Airport	COS	79	737,878	793,078	1,125,042	246,732	239,885	206,192
Providence Green State Airport	PVD	80	1,124,761	1,195,652	1,120,707	125,442	123,195	133,679
Richmond Int'l Airport	RIC	81	985,320	1,084,400	1,082,367	154,925	153,589	153,119
Boise Air Terminal	BOI	82	724,298	916,382	1,062,790	155,166	163,306	166,499
Albany County Airport	ALB	83	1,038,637	1,092,580	1,051,394	160,587	158,658	150,986
Syracuse Hancock Int'l Airport	SYR	84	1,095,651	1,057,116	1,018,467	180,936	158,677	153,066

1. At the top 100 airports, ranked by 1995 enplanements.

Table A-1. Airport Operations and Enplanements, 1993, 1994, and 1995[1]

City-Airport	Airport ID	Rank	Enplanements FY93	Enplanements FY94	Enplanements FY95	Operations FY93	Operations FY94	Operations FY95
Grand Rapids Int'l Airport	GRR	85	708,351	774,202	791,254	150,313	154,264	151,742
Sarasota Bradenton Airport	SRQ	86	871,643	856,930	785,003	152,722	147,115	145,886
Charleston AFB Int'l Airport	CHS	87	630,125	858,878	745,408	114,427	151,674	137,517
Des Moines Int'l Airport	DSM	88	663,332	690,012	732,085	128,797	133,954	137,043
Hilo Int'l Airport	ITO	89	664,337	702,798	717,226	91,903	90,802	81,497
Greer Greenville-Spartanburg Airport	GSP	90	574,273	725,118	702,115	56,855	62,526	58,978
Knoxville McGhee-Tyson Airport	TYS	91	642,803	654,663	664,446	130,368	128,032	136,507
Harrisburg Int'l Airport	MDT	92	671,806	684,575	657,586	86,427	82,405	83,447
St. Thomas, Virgin Islands	STT	93	670,123	659,849	633,872	105,217	109,958	101,451
Wichita Mid-Continent Airport	ICT	94	592,805	600,067	604,482	174,527	167,757	177,982
Columbia Metropolitan Airport	CAE	95	491,445	562,562	595,782	103,202	108,410	106,544
Lubbock Int'l Airport	LBB	96	596,488	658,421	586,445	103,112	104,968	101,944
Islip Long Island Mac Arthur Airport	ISP	97	554,559	601,352	574,699	195,198	189,663	188,314
Savannah Int'l Airport	SAV	98	482,712	559,508	567,534	104,681	97,509	95,060
Pensacola Regional Airport	PNS	99	431,163	556,847	567,249	125,547	123,462	119,795
Portland Int'l Jetport	PWM	100	585,250	584,603	561,395	126,353	114,162	120,234

Totals:
- 1993 Enplanements 476,382,717
- 1994 Enplanements 521,109,168
- 1995 Enplanements 543,439,185
- 1993 Operations 25,375,007
- 1994 Operations 26,114,095
- 1995 Operations 26,407,065

1. At the top 100 airports, ranked by 1995 enplanements.

Table A-2. Airport Enplanements, 1995 and Forecast 2010[2]

City-Airport	Airport ID	Rank	Enplanements FY95	FY2010	% Growth
Chicago O'Hare Int'l Airport	ORD	1	31,255,738	50,133,000	60.4
Hartsfield Atlanta Int'l Airport	ATL	2	27,350,320	46,416,000	69.7
Dallas-Fort Worth Int'l Airport	DFW	3	26,612,579	46,553,000	74.9
Los Angeles Int'l Airport	LAX	4	25,851,031	45,189,000	74.8
San Francisco Int'l Airport	SFO	5	16,700,975	28,791,000	72.4
Miami Int'l Airport	MIA	6	16,242,081	34,932,000	115.1
Denver Int'l Airport	DEN	7	14,818,822	22,751,000	53.5
New York John F. Kennedy Int'l Airport	JFK	8	14,782,367	21,139,000	43.0
Detroit Metropolitan Airport	DTW	9	13,810,517	24,220,000	75.4
Phoenix Sky Harbor Int'l Airport	PHX	10	13,472,480	25,408,000	88.6
Newark Int'l Airport	EWR	11	13,072,250	21,378,000	63.5
Las Vegas McCarran Int'l Airport	LAS	12	12,764,544	21,605,000	69.3
Lambert St. Louis Int'l Airport	STL	13	12,688,589	20,991,000	65.4
Minneapolis-St. Paul Int'l Airport	MSP	14	12,247,015	21,772,000	77.8
Boston Logan Int'l Airport	BOS	15	11,889,020	16,590,000	39.5
Houston Intercontinental Airport	IAH	16	11,420,071	20,799,000	82.1
Seattle-Tacoma Int'l Airport	SEA	17	10,947,345	18,947,000	73.1
Honolulu Int'l Airport	HNL	18	10,909,298	16,663,000	52.7
Orlando Int'l Airport	MCO	19	10,556,973	21,524,000	103.9
Charlotte/Douglas Int'l Airport	CLT	20	10,482,958	17,517,000	67.1
New York LaGuardia Airport	LGA	21	10,240,938	14,208,000	38.7
Greater Pittsburgh Int'l Airport	PIT	22	9,934,985	15,403,000	55.0
Philadelphia Int'l Airport	PHL	23	8,719,275	14,245,000	63.4
Salt Lake City Int'l Airport	SLC	24	8,594,490	15,280,000	77.8
Washington National Airport	DCA	25	7,459,210	9,830,000	31.8
Greater Cincinnati Int'l Airport	CVG	26	7,170,498	13,353,000	86.2
San Diego Int'l Lindberg Field	SAN	27	6,596,498	11,272,000	70.9
Baltimore-Washington Int'l Airport	BWI	28	6,541,031	10,819,000	65.4
Washington Dulles Int'l Airport	IAD	29	5,694,267	11,049,000	94.0
Tampa Int'l Airport	TPA	30	5,531,128	9,801,000	77.2
Portland Int'l Airport	PDX	31	5,419,125	10,210,000	88.4
Cleveland Hopkins Int'l Airport	CLE	32	5,278,909	9,270,000	75.6
Kansas City Int'l Airport	MCI	33	4,691,799	8,400,000	79.0
Metropolitan Oakland Int'l Airport	OAK	34	4,691,068	8,728,000	86.1
San Juan Int'l Airport	SJU	35	4,643,034	6,825,000	47.0
Fort Lauderdale Int'l Airport	FLL	36	4,587,770	7,962,000	73.5
Chicago Midway Airport	MDW	37	4,348,380	6,946,000	59.7
San Jose Int'l Airport	SJC	38	4,327,508	9,533,000	120.3
Memphis Int'l Airport	MEM	39	4,223,864	6,522,000	54.4
New Orleans Int'l Airport	MSY	40	4,147,081	5,193,000	25.2
Nashville Int'l Airport	BNA	41	3,983,741	6,747,000	69.4
Houston William P. Hobby Airport	HOU	42	3,921,273	5,617,000	43.2

2. At the top 100 airports, ranked by 1995 enplanements.

Table A-2. Airport Enplanements, 1995 and Forecast 2010[2]

City-Airport	Airport ID	Rank	Enplanements FY95	Enplanements FY2010	% Growth
Santa Ana John Wayne Airport	SNA	43	3,522,755	6,675,000	89.5
Dallas-Love Field	DAL	44	3,416,394	5,020,000	46.9
Sacramento Metropolitan Airport	SMF	45	3,307,202	6,875,000	107.9
Raleigh-Durham Int'l Airport	RDU	46	3,234,420	5,613,000	73.5
Ontario Int'l Airport	ONT	47	3,234,259	5,130,000	58.6
Indianapolis Int'l Airport	IND	48	3,101,724	5,228,000	68.6
San Antonio Int'l Airport	SAT	49	3,096,670	5,114,000	65.1
Albuquerque Int'l Airport	ABQ	50	3,076,532	5,334,000	73.4
Port Columbus Int'l Airport	CMH	51	2,786,503	4,154,000	49.1
Kahului Airport	OGG	52	2,732,610	3,902,000	42.8
Palm Beach Int'l Airport	PBI	53	2,710,286	3,880,000	43.2
Austin Municipal Airport	AUS	54	2,652,578	4,957,000	86.9
Reno Cannon Int'l Airport	RNO	55	2,649,673	5,646,000	113.1
Milwaukee Int'l Airport	MKE	56	2,490,301	3,699,000	48.5
Bradley Int'l Airport	BDL	57	2,482,024	3,537,000	42.5
Burbank-Glendale-Pasadena Airport	BUR	58	2,471,158	4,877,000	97.4
Anchorage Int'l Airport	ANC	59	2,023,536	2,895,000	43.1
Fort Myers Regional Airport	RSW	60	1,971,981	3,871,000	96.3
El Paso Int'l Airport	ELP	61	1,863,388	2,850,000	52.9
Greensboro Int'l Airport	GSO	62	1,843,343	3,208,000	74.0
Jacksonville Int'l Airport	JAX	63	1,819,003	3,121,000	71.6
Louisville Standiford Field	SDF	64	1,786,129	2,807,000	57.2
Tucson Int'l Airport	TUS	65	1,735,564	3,011,000	73.5
Oklahoma City World Airport	OKC	66	1,674,814	2,319,000	38.5
Greater Buffalo Int'l Airport	BUF	67	1,621,140	1,992,000	22.9
Tulsa Int'l Airport	TUL	68	1,570,020	2,377,000	51.4
Guam Int'l	GUM	69	1,495,835	3,049,000	103.8
Omaha Eppley Airfield	OMA	70	1,463,845	2,830,000	93.3
Spokane Int'l Airport	GEG	71	1,454,000	2,660,000	82.9
Norfolk Int'l Airport	ORF	72	1,410,057	2,270,000	61.0
Little Rock Adams Field	LIT	73	1,266,989	2,174,000	71.6
Greater Rochester Int'l Airport	ROC	74	1,230,589	2,208,000	79.4
Birmingham Airport	BHM	75	1,229,581	1,930,000	57.0
Dayton Int'l Airport	DAY	76	1,173,454	2,042,000	74.0
Lihue Airport	LIH	77	1,145,858	1,944,000	69.7
Kailua-Kona Keahole	KOA	78	1,126,777	1,814,000	61.0
Colorado Springs Municipal Airport	COS	79	1,125,042	2,270,000	101.8
Providence Green State Airport	PVD	80	1,120,707	2,057,000	83.5
Richmond Int'l Airport	RIC	81	1,082,367	1,990,000	83.9
Boise Air Terminal	BOI	82	1,062,790	1,734,000	63.2
Albany County Airport	ALB	83	1,051,394	1,775,000	68.8

2. At the top 100 airports, ranked by 1995 enplanements.

Table A-2. Airport Enplanements, 1995 and Forecast 2010[2]

City-Airport	Airport ID	Rank	Enplanements FY95	Enplanements FY2010	% Growth
Syracuse Hancock Int'l Airport	SYR	84	1,018,467	1,240,000	21.8
Grand Rapids Int'l Airport	GRR	85	791,254	1,369,000	73.0
Sarasota Bradenton Airport	SRQ	86	785,003	1,022,000	30.2
Charleston AFB Int'l Airport	CHS	87	745,408	1,104,000	48.1
Des Moines Int'l Airport	DSM	88	732,085	1,418,000	93.7
Hilo Int'l Airport	ITO	89	717,226	1,117,000	55.7
Greer Greenville-Spartanburg Airport	GSP	90	702,115	1,074,000	53.0
Knoxville McGhee-Tyson Airport	TYS	91	664,446	868,000	30.6
Harrisburg Int'l Airport	MDT	92	657,586	978,000	48.7
St. Thomas, Virgin Islands	STT	93	633,872	811,000	27.9
Wichita Mid-Continent Airport	ICT	94	604,482	1,097,000	81.5
Columbia Metropolitan Airport	CAE	95	595,782	1,045,000	75.4
Lubbock Int'l Airport	LBB	96	586,445	863,000	47.2
Islip Long Island Mac Arthur Airport	ISP	97	574,699	1,100,000	91.4
Savannah Int'l Airport	SAV	98	567,534	1,007,000	77.4
Pensacola Regional Airport	PNS	99	567,249	914,000	61.1
Portland Int'l Jetport	PWM	100	561,395	748,000	33.2

Totals:
1995 Enplanements 543,439,185
2010 Enplanements 919,145,000
Average forecast growth at the top 100 airports for the 15 year period 69.1

2. At the top 100 airports, ranked by 1995 enplanements.

Table A-3. Total Airport Operations, 1995 and Forecast 2010[3]

City-Airport	Airport ID	Rank	Operations FY95	Operations FY2010	% Growth
Chicago O'Hare Int'l Airport	ORD	1	892,330	1,168,000	30.9
Dallas-Fort Worth Int'l Airport	DFW	2	873,510	1,221,000	39.8
Hartsfield Atlanta Int'l Airport	ATL	3	747,105	1,056,000	41.3
Los Angeles Int'l Airport	LAX	4	716,293	987,000	37.8
Miami Int'l Airport	MIA	5	576,609	930,000	61.3
Phoenix Sky Harbor Int'l Airport	PHX	6	522,634	736,000	40.8
Lambert St. Louis Int'l Airport	STL	7	516,021	645,000	25.0
Las Vegas McCarran Int'l Airport	LAS	8	508,077	682,000	34.2
Metropolitan Oakland Int'l Airport	OAK	9	502,952	573,000	13.9
Detroit Metropolitan Airport	DTW	10	498,887	675,000	35.3
Santa Ana John Wayne Airport	SNA	11	493,391	611,000	23.8
Denver Int'l Airport	DEN	12	487,225	598,000	22.7
Boston Logan Int'l Airport	BOS	13	478,253	538,000	12.5
Charlotte/Douglas Int'l Airport	CLT	14	474,338	616,000	29.9
Minneapolis-St. Paul Int'l Airport	MSP	15	466,916	622,000	33.2
Greater Pittsburgh Int'l Airport	PIT	16	452,900	538,000	18.8
San Francisco Int'l Airport	SFO	17	436,907	576,000	31.8
Newark Int'l Airport	EWR	18	428,703	525,000	22.5
Philadelphia Int'l Airport	PHL	19	409,148	464,000	13.4
Seattle-Tacoma Int'l Airport	SEA	20	382,100	528,000	38.2
Honolulu Int'l Airport	HNL	21	376,224	493,000	31.0
Houston Intercontinental Airport	IAH	22	375,246	577,000	53.8
Greater Cincinnati Int'l Airport	CVG	23	358,203	529,000	47.7
Memphis Int'l Airport	MEM	24	356,294	531,000	49.0
Salt Lake City Int'l Airport	SLC	25	349,699	499,000	42.7
New York LaGuardia Airport	LGA	26	346,869	374,000	7.8
New York John F. Kennedy Int'l Airport	JFK	27	345,263	404,000	17.0
Orlando Int'l Airport	MCO	28	343,609	532,000	54.8
Washington National Airport	DCA	29	316,404	321,000	1.5
Washington Dulles Int'l Airport	IAD	30	311,279	418,000	34.3
Portland Int'l Airport	PDX	31	301,785	405,000	34.2
Baltimore-Washington Int'l Airport	BWI	32	296,932	378,000	27.3
Nashville Int'l Airport	BNA	33	278,957	355,000	27.3
San Jose Int'l Airport	SJC	34	270,519	307,000	13.5
Chicago Midway Airport	MDW	35	268,575	329,000	22.5
Cleveland Hopkins Int'l Airport	CLE	36	268,097	394,000	47.0
Tampa Int'l Airport	TPA	37	261,617	384,000	46.8
Houston William P. Hobby Airport	HOU	38	245,603	295,000	20.1
Indianapolis Int'l Airport	IND	39	245,541	333,000	35.6
San Antonio Int'l Airport	SAT	40	238,315	302,000	26.7
Fort Lauderdale Int'l Airport	FLL	41	238,108	286,000	20.1
Tucson Int'l Airport	TUS	42	238,024	247,000	3.8

3. At the top 100 airports, ranked by 1995 operations.

Table A-3. Total Airport Operations, 1995 and Forecast 2010[3]

City-Airport	Airport ID	Rank	Operations FY95	FY2010	% Growth
San Diego Int'l Lindberg Field	SAN	43	228,740	307,000	34.2
Anchorage Int'l Airport	ANC	44	217,768	252,000	15.7
Raleigh-Durham Int'l Airport	RDU	45	214,011	270,000	26.2
Milwaukee Int'l Airport	MKE	46	209,939	276,000	31.5
Dallas-Love Field	DAL	47	208,768	221,000	5.9
Kansas City Int'l Airport	MCI	48	207,518	296,000	42.6
Colorado Springs Municipal Airport	COS	49	206,192	255,000	23.7
Palm Beach Int'l Airport	PBI	50	205,104	227,000	10.7
Port Columbus Int'l Airport	CMH	51	204,100	229,000	12.2
Austin Municipal Airport	AUS	52	201,409	261,000	29.6
Albuquerque Int'l Airport	ABQ	53	199,114	247,000	24.0
Greater Rochester Int'l Airport	ROC	54	190,053	204,000	7.3
Islip Long Island Mac Arthur Airport	ISP	55	188,314	179,000	-4.9
Tulsa Int'l Airport	TUL	56	186,512	219,000	17.4
Burbank-Glendale-Pasadena Airport	BUR	57	184,366	275,000	49.2
San Juan Int'l Airport	SJU	58	183,082	210,000	14.7
Louisville Standiford Field	SDF	59	178,646	224,000	25.4
Kahului Airport	OGG	60	178,602	195,000	9.2
Wichita Mid-Continent Airport	ICT	61	177,982	213,000	19.7
New Orleans Int'l Airport	MSY	62	177,383	192,000	8.2
Sacramento Metropolitan Airport	SMF	63	177,010	282,000	59.3
Bradley Int'l Airport	BDL	64	176,382	204,000	15.7
Greensboro Int'l Airport	GSO	65	173,259	223,000	28.7
Little Rock Adams Field	LIT	66	169,312	184,000	8.7
Boise Air Terminal	BOI	67	166,499	196,000	17.7
Birmingham Airport	BHM	68	165,295	194,000	17.4
Omaha Eppley Airfield	OMA	69	160,039	200,000	25.0
Ontario Int'l Airport	ONT	70	158,302	200,000	26.3
Greater Buffalo Int'l Airport	BUF	71	153,646	183,000	19.1
Richmond Int'l Airport	RIC	72	153,119	179,000	16.9
Syracuse Hancock Int'l Airport	SYR	73	153,066	166,000	8.4
El Paso Int'l Airport	ELP	74	151,905	180,000	18.5
Grand Rapids Int'l Airport	GRR	75	151,742	174,000	14.7
Reno Cannon Int'l Airport	RNO	76	151,603	245,000	61.6
Dayton Int'l Airport	DAY	77	151,248	181,000	19.7
Albany County Airport	ALB	78	150,986	169,000	11.9
Oklahoma City World Airport	OKC	79	149,275	167,000	11.9
Sarasota Bradenton Airport	SRQ	80	145,886	168,000	15.2
Jacksonville Int'l Airport	JAX	81	142,786	172,000	20.5
Charleston AFB Int'l Airport	CHS	82	137,517	138,000	0.4
Des Moines Int'l Airport	DSM	83	137,043	165,000	20.4
Knoxville McGhee-Tyson Airport	TYS	84	136,507	157,000	15.0

3. At the top 100 airports, ranked by 1995 operations.

Table A-3. Total Airport Operations, 1995 and Forecast 2010[3]

City-Airport	Airport ID	Rank	Operations FY95	Operations FY2010	% Growth
Norfolk Int'l Airport	ORF	85	135,793	167,000	23.0
Providence Green State Airport	PVD	86	133,679	161,000	20.4
Portland Int'l Jetport	PWM	87	120,234	141,000	17.3
Pensacola Regional Airport	PNS	88	119,795	124,000	3.5
Spokane Int'l Airport	GEG	89	119,701	155,000	29.5
Columbia Metropolitan Airport	CAE	90	106,544	107,000	0.4
Lubbock Int'l Airport	LBB	91	101,944	107,000	5.0
St. Thomas, Virgin Islands	STT	92	101,451	105,000	3.5
Savannah Int'l Airport	SAV	93	95,060	103,000	8.4
Lihue Airport	LIH	94	94,439	142,000	50.4
Harrisburg Int'l Airport	MDT	95	83,447	88,000	5.5
Hilo Int'l Airport	ITO	96	81,497	95,000	16.6
Kailua-Kona Keahole	KOA	97	72,057	97,000	34.6
Fort Myers Regional Airport	RSW	98	67,026	113,000	68.6
Guam Int'l	GUM	99	59,928	74,000	23.5
Greer Greenville-Spartanburg Airport	GSP	100	58,978	66,000	11.9

Totals: 1995 Operations 26,407,065
2010 Operations 33,706,000
Average forecast growth at the top 100 airports for the 15 year period 27.6

3. At the top 100 airports, ranked by 1995 operations.

Table A-4. Growth in Enplanements From 1994 to 1995[4]

City-Airport	Airport ID	Rank	Enplanements FY94	Enplanements FY95	% Growth
Colorado Springs Municipal Airport	COS	1	793,078	1,125,042	41.9
Omaha Eppley Airfield	OMA	2	1,171,493	1,463,845	25.0
Metropolitan Oakland Int'l Airport	OAK	3	3,840,519	4,691,068	22.1
Guam Int'l	GUM	4	1,227,840	1,495,835	21.8
Sacramento Metropolitan Airport	SMF	5	2,828,848	3,307,202	16.9
Boise Air Terminal	BOI	6	916,382	1,062,790	16.0
Louisville Standiford Field	SDF	7	1,547,786	1,786,129	15.4
Portland Int'l Airport	PDX	8	4,742,410	5,419,125	14.3
Lambert St. Louis Int'l Airport	STL	9	11,124,230	12,688,589	14.1
Miami Int'l Airport	MIA	10	14,379,431	16,242,081	13.0
Birmingham Airport	BHM	11	1,089,094	1,229,581	12.9
Houston Intercontinental Airport	IAH	12	10,139,079	11,420,071	12.6
Spokane Int'l Airport	GEG	13	1,297,601	1,454,000	12.1
Tucson Int'l Airport	TUS	14	1,570,527	1,735,564	10.5
Seattle-Tacoma Int'l Airport	SEA	15	9,945,559	10,947,345	10.1
San Jose Int'l Airport	SJC	16	3,962,812	4,327,508	9.2
Phoenix Sky Harbor Int'l Airport	PHX	17	12,347,562	13,472,480	9.1
Detroit Metropolitan Airport	DTW	18	12,691,906	13,810,517	8.8
Los Angeles Int'l Airport	LAX	19	23,848,357	25,851,031	8.4
Santa Ana John Wayne Airport	SNA	20	3,255,004	3,522,755	8.2
New York John F. Kennedy Int'l Airport	JFK	21	13,659,611	14,782,367	8.2
Baltimore-Washington Int'l Airport	BWI	22	6,047,432	6,541,031	8.2
Memphis Int'l Airport	MEM	23	3,908,960	4,223,864	8.1
Minneapolis-St. Paul Int'l Airport	MSP	24	11,358,679	12,247,015	7.8
Kansas City Int'l Airport	MCI	25	4,354,351	4,691,799	7.7
Austin Municipal Airport	AUS	26	2,462,680	2,652,578	7.7
Chicago Midway Airport	MDW	27	4,040,900	4,348,380	7.6
Reno Cannon Int'l Airport	RNO	28	2,465,577	2,649,673	7.5
Greater Cincinnati Int'l Airport	CVG	29	6,679,025	7,170,498	7.4
Las Vegas McCarran Int'l Airport	LAS	30	11,913,954	12,764,544	7.1
Bradley Int'l Airport	BDL	31	2,318,262	2,482,024	7.1
New Orleans Int'l Airport	MSY	32	3,883,655	4,147,081	6.8
Kahului Airport	OGG	33	2,573,507	2,732,610	6.2
Des Moines Int'l Airport	DSM	34	690,012	732,085	6.1
Columbia Metropolitan Airport	CAE	35	562,562	595,782	5.9
Lihue Airport	LIH	36	1,084,800	1,145,858	5.6
Salt Lake City Int'l Airport	SLC	37	8,138,609	8,594,490	5.6
San Diego Int'l Lindberg Field	SAN	38	6,248,662	6,596,498	5.6
Little Rock Adams Field	LIT	39	1,204,442	1,266,989	5.2
Cleveland Hopkins Int'l Airport	CLE	40	5,028,369	5,278,909	5.0
Philadelphia Int'l Airport	PHL	41	8,325,571	8,719,275	4.7
San Francisco Int'l Airport	SFO	42	15,973,975	16,700,975	4.6

4. At the top 100 airports, ranked by growth in total enplanments.

Table A-4. Growth in Enplanements From 1994 to 1995[4]

City-Airport	Airport ID	Rank	Enplanements FY94	FY95	% Growth
San Antonio Int'l Airport	SAT	43	2,964,827	3,096,670	4.4
Charlotte/Douglas Int'l Airport	CLT	44	10,042,865	10,482,958	4.4
Burbank-Glendale-Pasadena Airport	BUR	45	2,371,258	2,471,158	4.2
Honolulu Int'l Airport	HNL	46	10,480,767	10,909,298	4.1
Fort Myers Regional Airport	RSW	47	1,897,157	1,971,981	3.9
Washington Dulles Int'l Airport	IAD	48	5,490,799	5,694,267	3.7
Greensboro Int'l Airport	GSO	49	1,782,183	1,843,343	3.4
Hartsfield Atlanta Int'l Airport	ATL	50	26,472,972	27,350,320	3.3
Anchorage Int'l Airport	ANC	51	1,963,820	2,023,536	3.0
Orlando Int'l Airport	MCO	52	10,251,933	10,556,973	3.0
New York LaGuardia Airport	LGA	53	9,956,711	10,240,938	2.9
Albuquerque Int'l Airport	ABQ	54	2,996,622	3,076,532	2.7
El Paso Int'l Airport	ELP	55	1,822,024	1,863,388	2.3
Grand Rapids Int'l Airport	GRR	56	774,202	791,254	2.2
Chicago O'Hare Int'l Airport	ORD	57	30,606,235	31,255,738	2.1
Hilo Int'l Airport	ITO	58	702,798	717,226	2.1
Pensacola Regional Airport	PNS	59	556,847	567,249	1.9
Milwaukee Int'l Airport	MKE	60	2,444,663	2,490,301	1.9
Kailua-Kona Keahole	KOA	61	1,106,614	1,126,777	1.8
Greater Pittsburgh Int'l Airport	PIT	62	9,763,045	9,934,985	1.8
Knoxville McGhee-Tyson Airport	TYS	63	654,663	664,446	1.5
Oklahoma City World Airport	OKC	64	1,650,479	1,674,814	1.5
Boston Logan Int'l Airport	BOS	65	11,716,314	11,889,020	1.5
Savannah Int'l Airport	SAV	66	559,508	567,534	1.4
Dallas-Fort Worth Int'l Airport	DFW	67	26,267,502	26,612,579	1.3
San Juan Int'l Airport	SJU	68	4,588,481	4,643,034	1.2
Dallas-Love Field	DAL	69	3,378,468	3,416,394	1.1
Ontario Int'l Airport	ONT	70	3,199,499	3,234,259	1.1
Indianapolis Int'l Airport	IND	71	3,068,733	3,101,724	1.1
Wichita Mid-Continent Airport	ICT	72	600,067	604,482	0.7
Port Columbus Int'l Airport	CMH	73	2,769,749	2,786,503	0.6
Houston William P. Hobby Airport	HOU	74	3,920,000	3,921,273	0.0
Richmond Int'l Airport	RIC	75	1,084,400	1,082,367	-0.2
Palm Beach Int'l Airport	PBI	76	2,723,145	2,710,286	-0.5
Washington National Airport	DCA	77	7,549,169	7,459,210	-1.2
Tulsa Int'l Airport	TUL	78	1,589,503	1,570,020	-1.2
Greer Greenville-Spartanburg Airport	GSP	79	725,118	702,115	-3.2
Greater Rochester Int'l Airport	ROC	80	1,271,298	1,230,589	-3.2
Newark Int'l Airport	EWR	81	13,544,066	13,072,250	-3.5
Jacksonville Int'l Airport	JAX	82	1,886,673	1,819,003	-3.6
Syracuse Hancock Int'l Airport	SYR	83	1,057,116	1,018,467	-3.7
Albany County Airport	ALB	84	1,092,580	1,051,394	-3.8

4. At the top 100 airports, ranked by growth in total enplanments.

Table A-4. Growth in Enplanements From 1994 to 1995[4]

City-Airport	Airport ID	Rank	Enplanements FY94	Enplanements FY95	% Growth
Tampa Int'l Airport	TPA	85	5,756,785	5,531,128	-3.9
St. Thomas, Virgin Islands	STT	86	659,849	633,872	-3.9
Harrisburg Int'l Airport	MDT	87	684,575	657,586	-3.9
Portland Int'l Jetport	PWM	88	584,603	561,395	-4.0
Islip Long Island Mac Arthur Airport	ISP	89	601,352	574,699	-4.4
Dayton Int'l Airport	DAY	90	1,243,861	1,173,454	-5.7
Denver Int'l Airport	DEN	91	15,744,474	14,818,822	-5.9
Nashville Int'l Airport	BNA	92	4,240,353	3,983,741	-6.1
Providence Green State Airport	PVD	93	1,195,652	1,120,707	-6.3
Fort Lauderdale Int'l Airport	FLL	94	4,937,251	4,587,770	-7.1
Sarasota Bradenton Airport	SRQ	95	856,930	785,003	-8.4
Greater Buffalo Int'l Airport	BUF	96	1,799,588	1,621,140	-9.9
Lubbock Int'l Airport	LBB	97	658,421	586,445	-10.9
Charleston AFB Int'l Airport	CHS	98	858,878	745,408	-13.2
Norfolk Int'l Airport	ORF	99	1,682,504	1,410,057	-16.2
Raleigh-Durham Int'l Airport	RDU	100	4,616,106	3,234,420	-29.9

Totals: 1994 Enplanements 521,109,168
1995 Enplanements 543,439,185
Average forecast growth at the top 100 airports .... -29.9

4. At the top 100 airports, ranked by growth in total enplanments.

Table A-5. Growth in Operations From 1994 to 1995[5]

City-Airport	Airport ID	Rank	Operations FY94	FY95	% Growth
Sacramento Metropolitan Airport	SMF	1	149,053	177,010	18.8
Seattle-Tacoma Int'l Airport	SEA	2	345,052	382,100	10.7
Lambert St. Louis Int'l Airport	STL	3	466,639	516,021	10.6
Greensboro Int'l Airport	GSO	4	157,401	173,259	10.1
Portland Int'l Airport	PDX	5	277,000	301,785	8.9
Providence Green State Airport	PVD	6	123,195	133,679	8.5
Bradley Int'l Airport	BDL	7	163,180	176,382	8.1
Kailua-Kona Keahole	KOA	8	66,821	72,057	7.8
Greater Cincinnati Int'l Airport	CVG	9	333,832	358,203	7.3
Hartsfield Atlanta Int'l Airport	ATL	10	699,400	747,105	6.8
Metropolitan Oakland Int'l Airport	OAK	11	470,901	502,952	6.8
Knoxville McGhee-Tyson Airport	TYS	12	128,032	136,507	6.6
Houston Intercontinental Airport	IAH	13	352,385	375,246	6.5
San Diego Int'l Lindberg Field	SAN	14	215,215	228,740	6.3
Wichita Mid-Continent Airport	ICT	15	167,757	177,982	6.1
New Orleans Int'l Airport	MSY	16	167,375	177,383	6.0
Greater Buffalo Int'l Airport	BUF	17	145,221	153,646	5.8
Chicago Midway Airport	MDW	18	254,570	268,575	5.5
Honolulu Int'l Airport	HNL	19	357,116	376,224	5.4
Portland Int'l Jetport	PWM	20	114,162	120,234	5.3
Dallas-Fort Worth Int'l Airport	DFW	21	831,135	873,510	5.1
Washington Dulles Int'l Airport	IAD	22	296,201	311,279	5.1
Austin Municipal Airport	AUS	23	192,040	201,409	4.9
San Juan Int'l Airport	SJU	24	174,598	183,082	4.9
Miami Int'l Airport	MIA	25	550,194	576,609	4.8
Kansas City Int'l Airport	MCI	26	198,274	207,518	4.7
Los Angeles Int'l Airport	LAX	27	687,627	716,293	4.2
Las Vegas McCarran Int'l Airport	LAS	28	488,347	508,077	4.0
Greater Pittsburgh Int'l Airport	PIT	29	435,433	452,900	4.0
Detroit Metropolitan Airport	DTW	30	479,738	498,887	4.0
Omaha Eppley Airfield	OMA	31	154,154	160,039	3.8
Houston William P. Hobby Airport	HOU	32	236,683	245,603	3.8
Baltimore-Washington Int'l Airport	BWI	33	286,392	296,932	3.7
New York LaGuardia Airport	LGA	34	335,539	346,869	3.4
Fort Myers Regional Airport	RSW	35	64,849	67,026	3.4
Indianapolis Int'l Airport	IND	36	237,937	245,541	3.2
Memphis Int'l Airport	MEM	37	345,534	356,294	3.1
Phoenix Sky Harbor Int'l Airport	PHX	38	507,698	522,634	2.9
Cleveland Hopkins Int'l Airport	CLE	39	260,485	268,097	2.9
Minneapolis-St. Paul Int'l Airport	MSP	40	454,441	466,916	2.7
Des Moines Int'l Airport	DSM	41	133,954	137,043	2.3
Birmingham Airport	BHM	42	161,638	165,295	2.3

5. At the top 100 airports, ranked by growth in total operations.

Table A-5. Growth in Operations From 1994 to 1995[5]

City-Airport	Airport ID	Rank	Operations FY94	FY95	% Growth
Fort Lauderdale Int'l Airport	FLL	43	233,044	238,108	2.2
Lihue Airport	LIH	44	92,542	94,439	2.0
Boise Air Terminal	BOI	45	163,306	166,499	2.0
Oklahoma City World Airport	OKC	46	146,759	149,275	1.7
Salt Lake City Int'l Airport	SLC	47	343,807	349,699	1.7
Philadelphia Int'l Airport	PHL	48	402,845	409,148	1.6
San Francisco Int'l Airport	SFO	49	430,380	436,907	1.5
Kahului Airport	OGG	50	176,209	178,602	1.4
Harrisburg Int'l Airport	MDT	51	82,405	83,447	1.3
Chicago O'Hare Int'l Airport	ORD	52	883,480	892,330	1.0
Anchorage Int'l Airport	ANC	53	215,641	217,768	1.0
Charlotte/Douglas Int'l Airport	CLT	54	471,128	474,338	0.7
Greater Rochester Int'l Airport	ROC	55	189,372	190,053	0.4
San Antonio Int'l Airport	SAT	56	238,277	238,315	0.0
Jacksonville Int'l Airport	JAX	57	142,821	142,786	-0.0
Boston Logan Int'l Airport	BOS	58	478,660	478,253	-0.1
Washington National Airport	DCA	59	316,790	316,404	-0.1
Orlando Int'l Airport	MCO	60	344,213	343,609	-0.2
Ontario Int'l Airport	ONT	61	158,635	158,302	-0.2
Richmond Int'l Airport	RIC	62	153,589	153,119	-0.3
Louisville Standiford Field	SDF	63	179,921	178,646	-0.7
Islip Long Island Mac Arthur Airport	ISP	64	189,663	188,314	-0.7
Tampa Int'l Airport	TPA	65	263,541	261,617	-0.7
Sarasota Bradenton Airport	SRQ	66	147,115	145,886	-0.8
Grand Rapids Int'l Airport	GRR	67	154,264	151,742	-1.6
Milwaukee Int'l Airport	MKE	68	213,602	209,939	-1.7
Columbia Metropolitan Airport	CAE	69	108,410	106,544	-1.7
New York John F. Kennedy Int'l Airport	JFK	70	352,494	345,263	-2.1
Dayton Int'l Airport	DAY	71	154,481	151,248	-2.1
Little Rock Adams Field	LIT	72	173,126	169,312	-2.2
Spokane Int'l Airport	GEG	73	122,615	119,701	-2.4
Savannah Int'l Airport	SAV	74	97,509	95,060	-2.5
Lubbock Int'l Airport	LBB	75	104,968	101,944	-2.9
Pensacola Regional Airport	PNS	76	123,462	119,795	-3.0
Newark Int'l Airport	EWR	77	441,997	428,703	-3.0
Santa Ana John Wayne Airport	SNA	78	509,220	493,391	-3.1
Syracuse Hancock Int'l Airport	SYR	79	158,677	153,066	-3.5
El Paso Int'l Airport	ELP	80	157,984	151,905	-3.8
Dallas-Love Field	DAL	81	217,331	208,768	-3.9
Norfolk Int'l Airport	ORF	82	141,861	135,793	-4.3
Tucson Int'l Airport	TUS	83	249,729	238,024	-4.7
Albany County Airport	ALB	84	158,658	150,986	-4.8

5. At the top 100 airports, ranked by growth in total operations.

Table A-5. Growth in Operations From 1994 to 1995[5]

City-Airport	Airport ID	Rank	Operations FY94	FY95	% Growth
Burbank-Glendale-Pasadena Airport	BUR	85	194,264	184,366	-5.1
Palm Beach Int'l Airport	PBI	86	216,480	205,104	-5.3
Nashville Int'l Airport	BNA	87	295,558	278,957	-5.6
Greer Greenville-Spartanburg Airport	GSP	88	62,526	58,978	-5.7
Reno Cannon Int'l Airport	RNO	89	161,190	151,603	-5.9
Tulsa Int'l Airport	TUL	90	198,332	186,512	-6.0
St. Thomas, Virgin Islands	STT	91	109,958	101,451	-7.7
Port Columbus Int'l Airport	CMH	92	223,633	204,100	-8.7
San Jose Int'l Airport	SJC	93	298,220	270,519	-9.3
Charleston AFB Int'l Airport	CHS	94	151,674	137,517	-9.3
Albuquerque Int'l Airport	ABQ	95	220,914	199,114	-9.9
Hilo Int'l Airport	ITO	96	90,802	81,497	-10.2
Denver Int'l Airport	DEN	97	546,305	487,225	-10.8
Guam Int'l	GUM	98	68,912	59,928	-13.0
Colorado Springs Municipal Airport	COS	99	239,885	206,192	-14.0
Raleigh-Durham Int'l Airport	RDU	100	283,713	214,011	-24.6

Totals: 1994 Operations 26,114,095
1995 Operations 26,407,065
Average forecast growth at the top 100 airports 1.1

5. At the top 100 airports, ranked by growth in total operations.

Table A-6. Growth in Operations and Enplanements[6]

City-Airport	Airport ID	% Growth in Enplanements FY94-FY95	% Growth in Enplanements FY95-FY2010	% Growth in Operations FY94-FY95	% Growth in Operations FY95-FY2010
Albuquerque Int'l Airport	ABQ	2.7	73.4	-9.9	24.0
Albany County Airport	ALB	-3.8	68.8	-4.8	11.9
Anchorage Int'l Airport	ANC	3.0	43.1	1.0	15.7
Hartsfield Atlanta Int'l Airport	ATL	3.3	69.7	6.8	41.3
Austin Municipal Airport	AUS	7.7	86.9	4.9	29.6
Bradley Int'l Airport	BDL	7.1	42.5	8.1	15.7
Birmingham Airport	BHM	12.9	57.0	2.3	17.4
Nashville Int'l Airport	BNA	-6.1	69.4	-5.6	27.3
Boise Air Terminal	BOI	16.0	63.2	2.0	17.7
Boston Logan Int'l Airport	BOS	1.5	39.5	-0.1	12.5
Greater Buffalo Int'l Airport	BUF	-9.9	22.9	5.8	19.1
Burbank-Glendale-Pasadena Airport	BUR	4.2	97.4	-5.1	49.2
Baltimore-Washington Int'l Airport	BWI	8.2	65.4	3.7	27.3
Columbia Metropolitan Airport	CAE	5.9	75.4	-1.7	0.4
Charleston AFB Int'l Airport	CHS	-13.2	48.1	-9.3	0.4
Cleveland Hopkins Int'l Airport	CLE	5.0	75.6	2.9	47.0
Charlotte/Douglas Int'l Airport	CLT	4.4	67.1	0.7	29.9
Port Columbus Int'l Airport	CMH	0.6	49.1	-8.7	12.2
Colorado Springs Municipal Airport	COS	41.9	101.8	-14.0	23.7
Greater Cincinnati Int'l Airport	CVG	7.4	86.2	7.3	47.7
Dallas-Love Field	DAL	1.1	46.9	-3.9	5.9
Dayton Int'l Airport	DAY	-5.7	74.0	-2.1	19.7
Washington National Airport	DCA	-1.2	31.8	-0.1	1.5
Denver Int'l Airport	DEN	-5.9	53.5	-10.8	22.7
Dallas-Fort Worth Int'l Airport	DFW	1.3	74.9	5.1	39.8
Des Moines Int'l Airport	DSM	6.1	93.7	2.3	20.4
Detroit Metropolitan Airport	DTW	8.8	75.4	4.0	35.3
El Paso Int'l Airport	ELP	2.3	52.9	-3.8	18.5
Newark Int'l Airport	EWR	-3.5	63.5	-3.0	22.5
Fort Lauderdale Int'l Airport	FLL	-7.1	73.5	2.2	20.1
Spokane Int'l Airport	GEG	12.1	82.9	-2.4	29.5
Grand Rapids Int'l Airport	GRR	2.2	73.0	-1.6	14.7
Greensboro Int'l Airport	GSO	3.4	74.0	10.1	28.7
Greer Greenville-Spartanburg Airport	GSP	-3.2	53.0	-5.7	11.9
Guam Int'l	GUM	21.8	103.8	-13.0	23.5
Honolulu Int'l Airport	HNL	4.1	52.7	5.4	31.0
Houston William P. Hobby Airport	HOU	0.0	43.2	3.8	20.1
Washington Dulles Int'l Airport	IAD	3.7	94.0	5.1	34.3
Houston Intercontinental Airport	IAH	12.6	82.1	6.5	53.8
Wichita Mid-Continent Airport	ICT	0.7	81.5	6.1	19.7
Indianapolis Int'l Airport	IND	1.1	68.6	3.2	35.6
Islip Long Island Mac Arthur Airport	ISP	-4.4	91.4	-0.7	-4.9

6. At the top 100 airports, listed in alphabetical order by Airport Identifier.

Table A-6. Growth in Operations and Enplanements[6]

City-Airport	Airport ID	% Growth in Enplanements FY94-FY95	% Growth in Enplanements FY95-FY2010	% Growth in Operations FY94-FY95	% Growth in Operations FY95-FY2010
Hilo Int'l Airport	ITO	2.1	55.7	-10.2	16.6
Jacksonville Int'l Airport	JAX	-3.6	71.6	-0.0	20.5
New York John F. Kennedy Int'l Airport	JFK	8.2	43.0	-2.1	17.0
Kailua-Kona Keahole	KOA	1.8	61.0	7.8	34.6
Las Vegas McCarran Int'l Airport	LAS	7.1	69.3	4.0	34.2
Los Angeles Int'l Airport	LAX	8.4	74.8	4.2	37.8
Lubbock Int'l Airport	LBB	-10.9	47.2	-2.9	5.0
New York LaGuardia Airport	LGA	2.9	38.7	3.4	7.8
Lihue Airport	LIH	5.6	69.7	2.0	50.4
Little Rock Adams Field	LIT	5.2	71.6	-2.2	8.7
Kansas City Int'l Airport	MCI	7.7	79.0	4.7	42.6
Orlando Int'l Airport	MCO	3.0	103.9	-0.2	54.8
Harrisburg Int'l Airport	MDT	-3.9	48.7	1.3	5.5
Chicago Midway Airport	MDW	7.6	59.7	5.5	22.5
Memphis Int'l Airport	MEM	8.1	54.4	3.1	49.0
Miami Int'l Airport	MIA	13.0	115.1	4.8	61.3
Milwaukee Int'l Airport	MKE	1.9	48.5	-1.7	31.5
Minneapolis-St. Paul Int'l Airport	MSP	7.8	77.8	2.7	33.2
New Orleans Int'l Airport	MSY	6.8	25.2	6.0	8.2
Metropolitan Oakland Int'l Airport	OAK	22.1	86.1	6.8	13.9
Kahului Airport	OGG	6.2	42.8	1.4	9.2
Oklahoma City World Airport	OKC	1.5	38.5	1.7	11.9
Omaha Eppley Airfield	OMA	25.0	93.3	3.8	25.0
Ontario Int'l Airport	ONT	1.1	58.6	-0.2	26.3
Chicago O'Hare Int'l Airport	ORD	2.1	60.4	1.0	30.9
Norfolk Int'l Airport	ORF	-16.2	61.0	-4.3	23.0
Palm Beach Int'l Airport	PBI	-0.5	43.2	-5.3	10.7
Portland Int'l Airport	PDX	14.3	88.4	8.9	34.2
Philadelphia Int'l Airport	PHL	4.7	63.4	1.6	13.4
Phoenix Sky Harbor Int'l Airport	PHX	9.1	88.6	2.9	40.8
Greater Pittsburgh Int'l Airport	PIT	1.8	55.0	4.0	18.8
Pensacola Regional Airport	PNS	1.9	61.1	-3.0	3.5
Providence Green State Airport	PVD	-6.3	83.5	8.5	20.4
Portland Int'l Jetport	PWM	-4.0	33.2	5.3	17.3
Raleigh-Durham Int'l Airport	RDU	-29.9	73.5	-24.6	26.2
Richmond Int'l Airport	RIC	-0.2	83.9	-0.3	16.9
Reno Cannon Int'l Airport	RNO	7.5	113.1	-5.9	61.6
Greater Rochester Int'l Airport	ROC	-3.2	79.4	0.4	7.3
Fort Myers Regional Airport	RSW	3.9	96.3	3.4	68.6
San Diego Int'l Lindberg Field	SAN	5.6	70.9	6.3	34.2
San Antonio Int'l Airport	SAT	4.4	65.1	0.0	26.7
Savannah Int'l Airport	SAV	1.4	77.4	-2.5	8.4

6. At the top 100 airports, listed in alphabetical order by Airport Identifier.

Table A-6. Growth in Operations and Enplanements[6]

City-Airport	Airport ID	% Growth in Enplanements FY94-FY95	% Growth in Enplanements FY95-FY2010	% Growth in Operations FY94-FY95	% Growth in Operations FY95-FY2010
Louisville Standiford Field	SDF	15.4	57.2	-0.7	25.4
Seattle-Tacoma Int'l Airport	SEA	10.1	73.1	10.7	38.2
San Francisco Int'l Airport	SFO	4.6	72.4	1.5	31.8
San Jose Int'l Airport	SJC	9.2	120.3	-9.3	13.5
San Juan Int'l Airport	SJU	1.2	47.0	4.9	14.7
Salt Lake City Int'l Airport	SLC	5.6	77.8	1.7	42.7
Sacramento Metropolitan Airport	SMF	16.9	107.9	18.8	59.3
Santa Ana John Wayne Airport	SNA	8.2	89.5	-3.1	23.8
Sarasota Bradenton Airport	SRQ	-8.4	30.2	-0.8	15.2
Lambert St. Louis Int'l Airport	STL	14.1	65.4	10.6	25.0
St. Thomas, Virgin Islands	STT	-3.9	27.9	-7.7	3.5
Syracuse Hancock Int'l Airport	SYR	-3.7	21.8	-3.5	8.4
Tampa Int'l Airport	TPA	-3.9	77.2	-0.7	46.8
Tulsa Int'l Airport	TUL	-1.2	51.4	-6.0	17.4
Tucson Int'l Airport	TUS	10.5	73.5	-4.7	3.8
Knoxville McGhee-Tyson Airport	TYS	1.5	30.6	6.6	15.0

Totals: Average growth at the top 100 airports .... 1.5 .... 1.1
Average forecast growth at the top 100 airports for the 15 year period ...... 69.1 .... 27.6

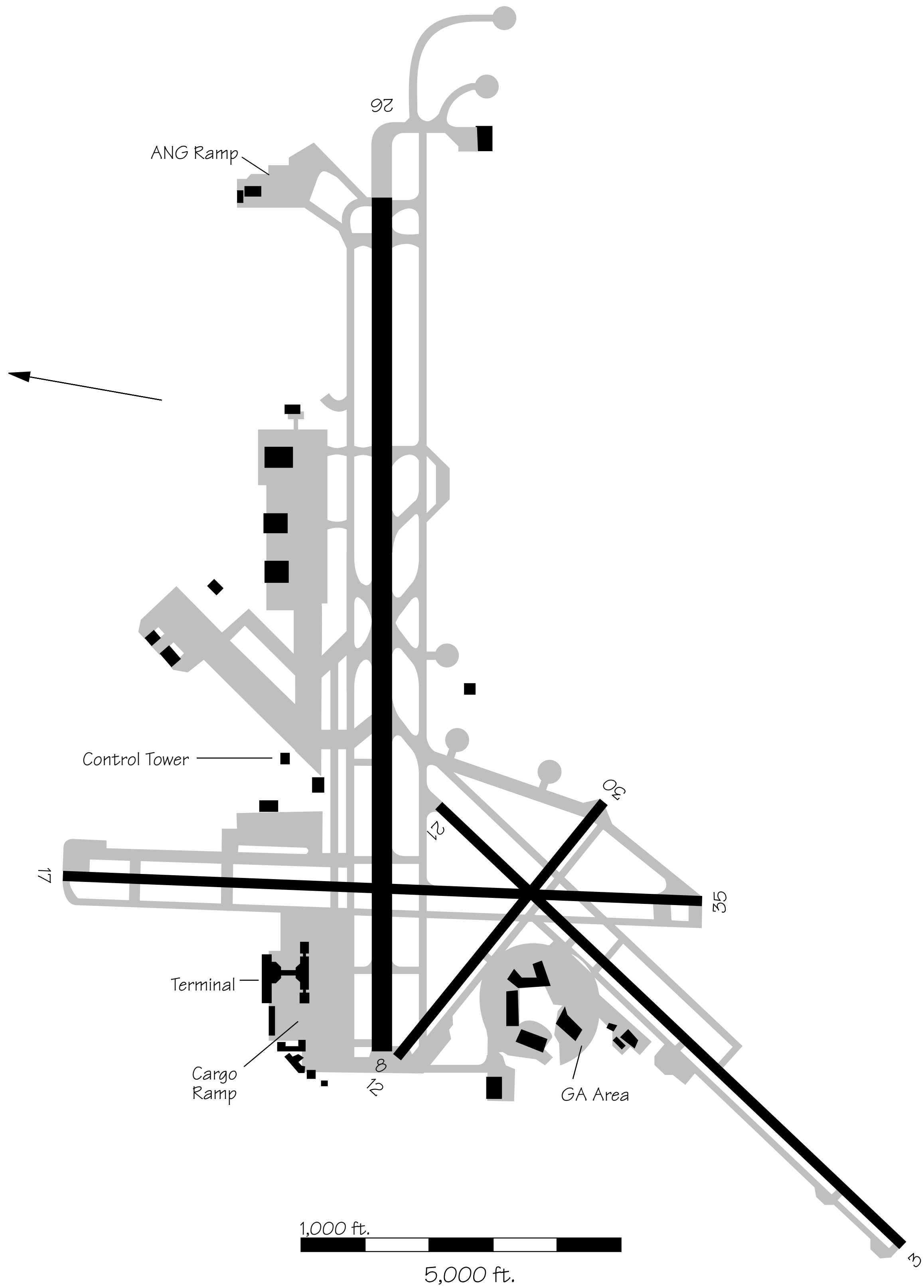
6. At the top 100 airports, listed in alphabetical order by Airport Identifier.

Appendix B: The Top 100 Airports

This appendix contains current airport diagrams for the top 100 airports[1]. For those airports that are considering or have plans for the construction of new runways or extensions to existing runways, the diagrams show the proposed runway and runway extension projects indicated in blue. These diagrams are for illustration only, and should not be used in any way for airport planning purposes. Accompanying the diagrams is a brief narrative of construction projects being planned or considered.

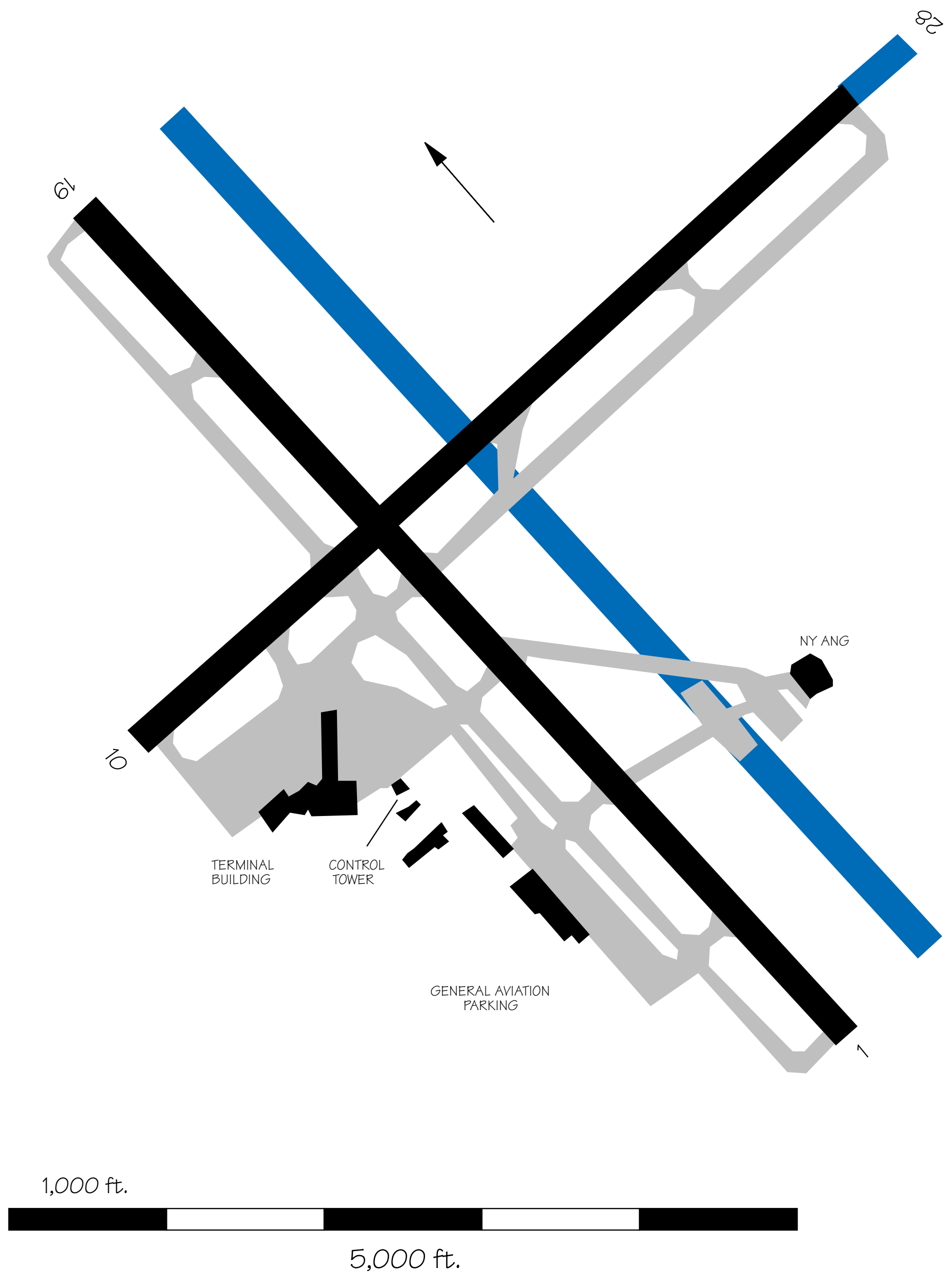
1. Based on 1995 passenger enplanements (see Appendix A, Table A-1).

ABQ — Albuquerque International Airport

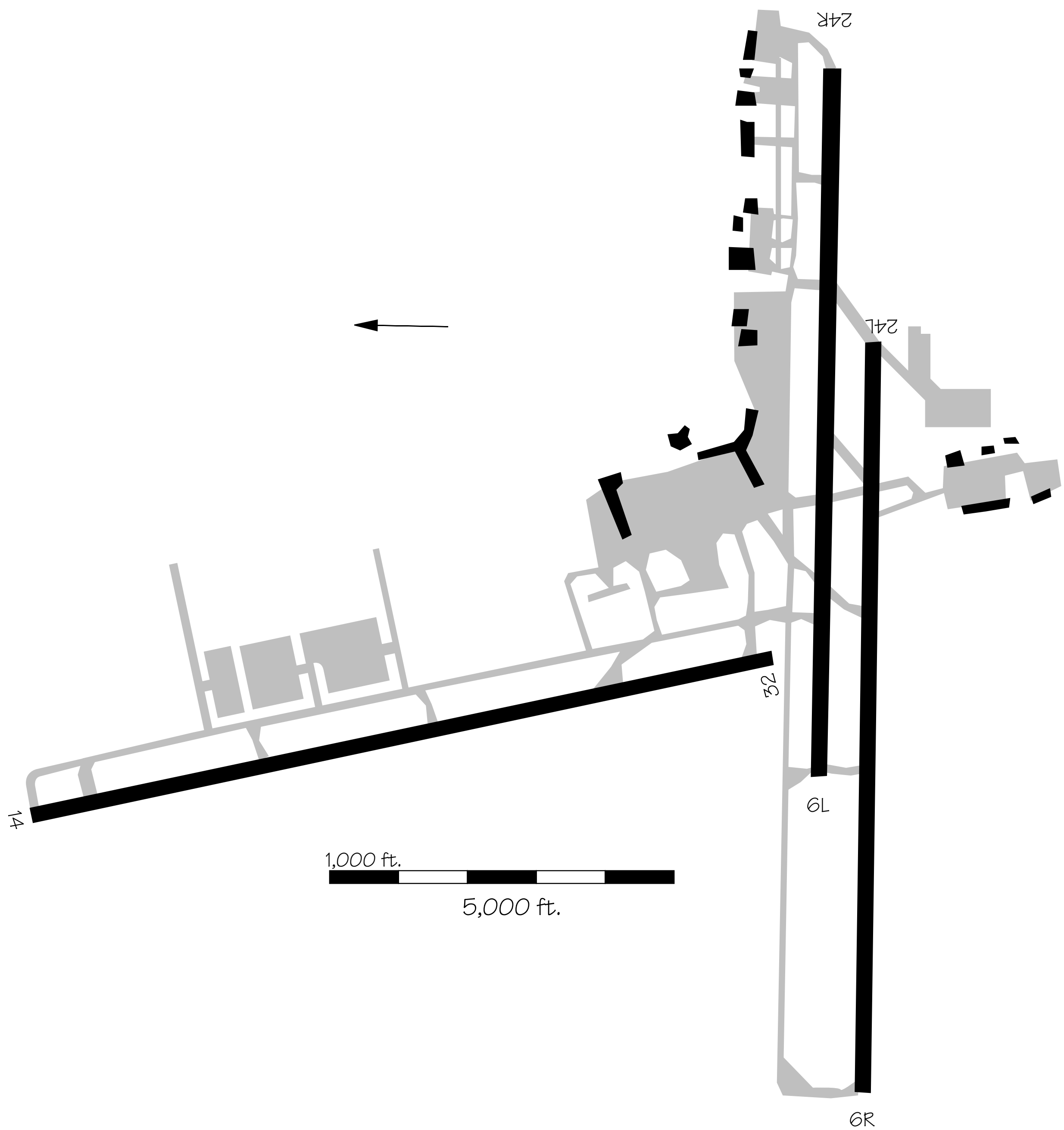


ALB — Albany County Airport

Construction of an extension to Runway 10/28 is planned. The estimated cost of construction is $5.8 million. A new parallel Runway 1R/19L is also planned. The estimated cost is $7.5 million.

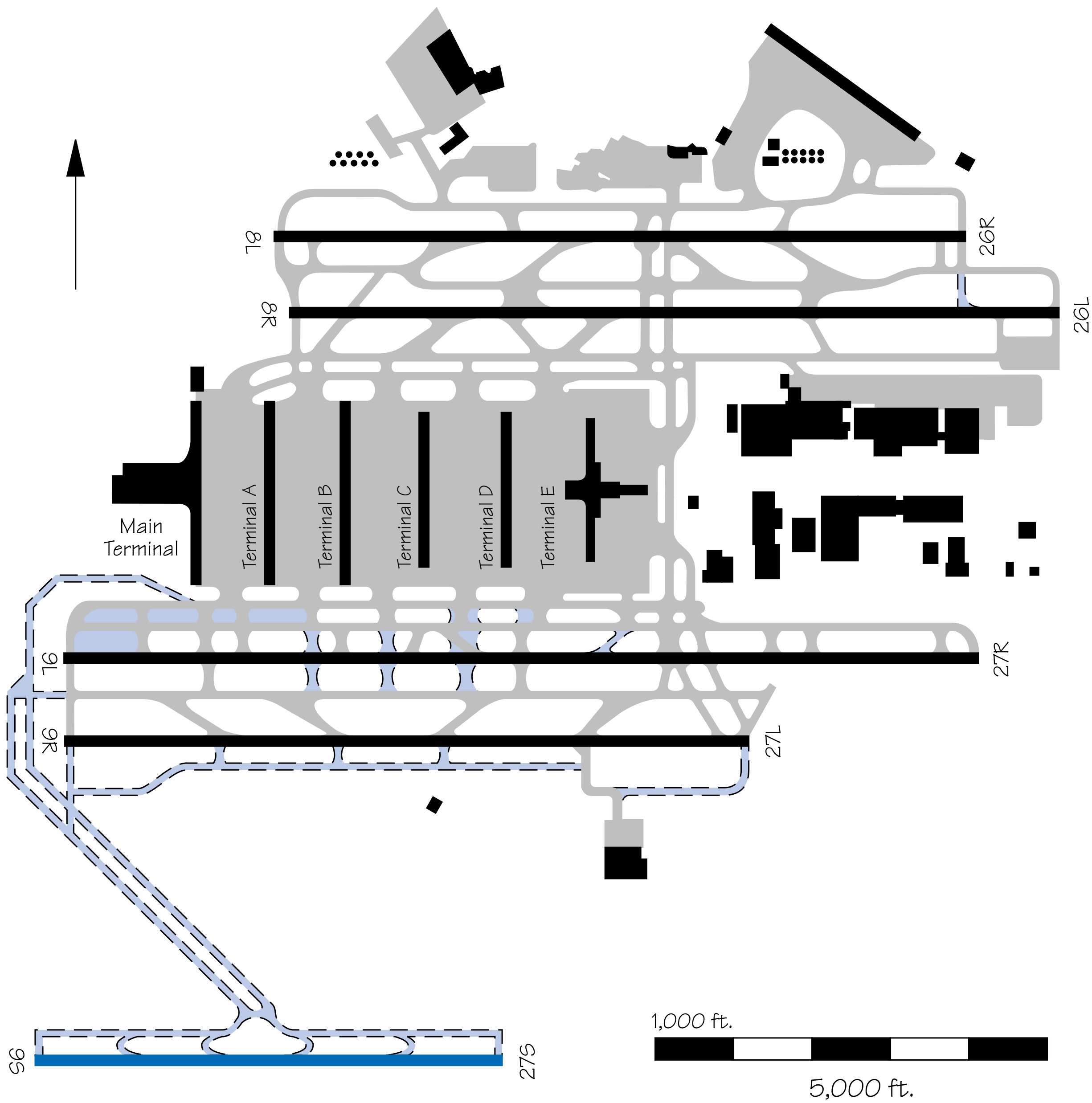


ANK — Anchorage International Airport

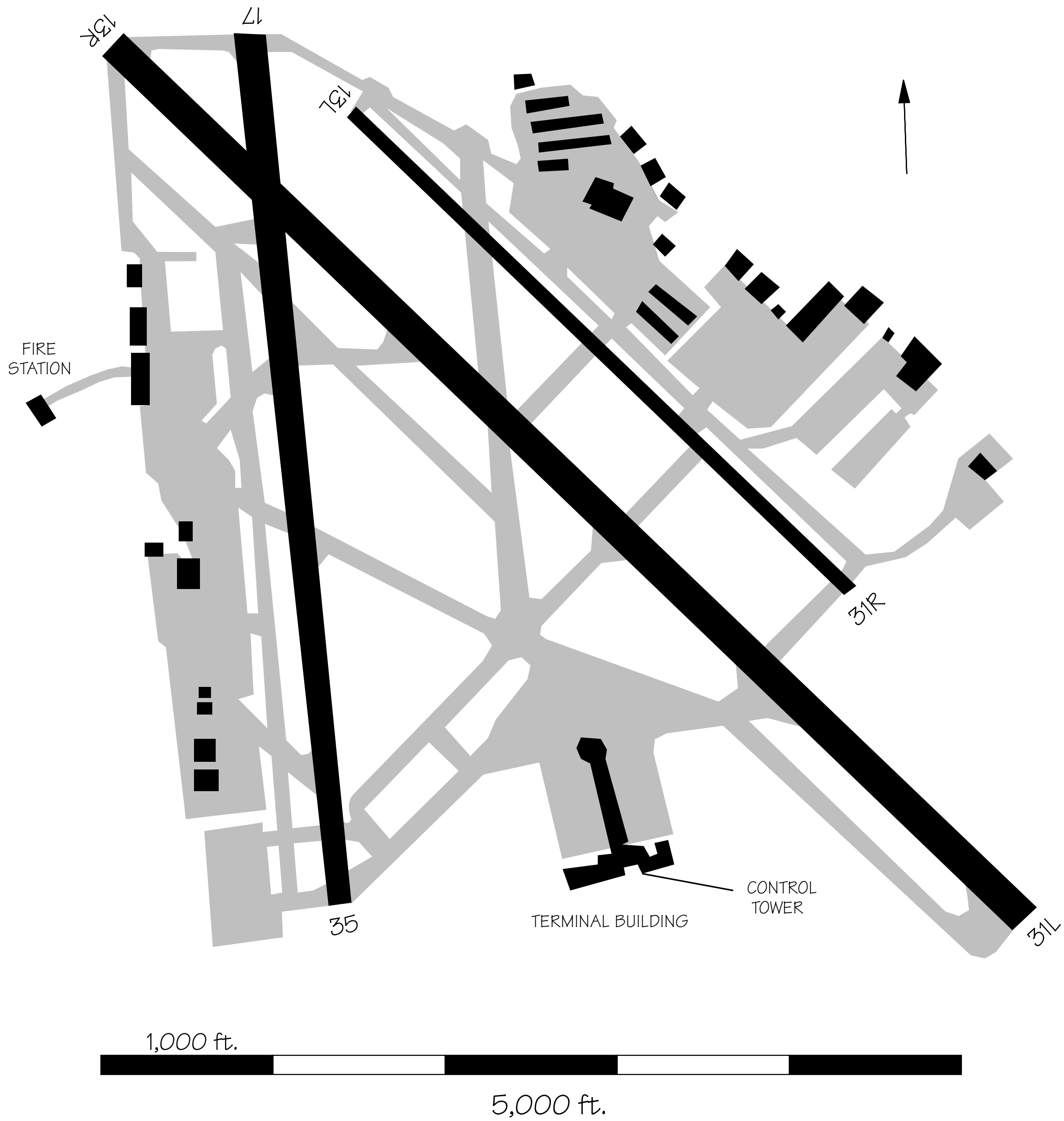


ATL — Hartsfield Atlanta International Airport

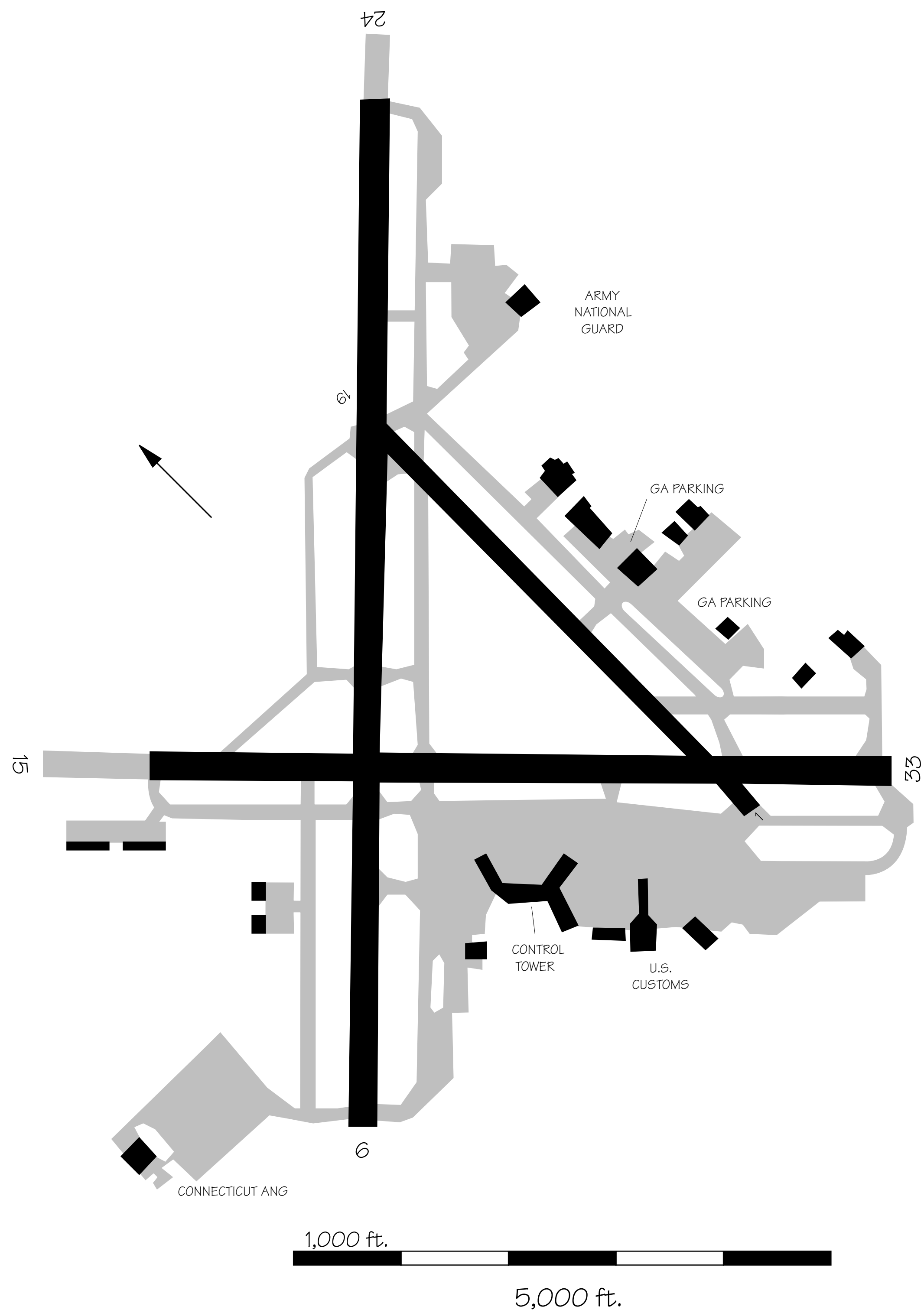
A fifth parallel commuter runway, 6,000 feet long and approximately 4,200 feet south of Runway 9R/27L, is being planned. The runway will permit triple independent IFR approaches using the PRM. The total estimated cost is $418 million. The estimated operational date is 2000.



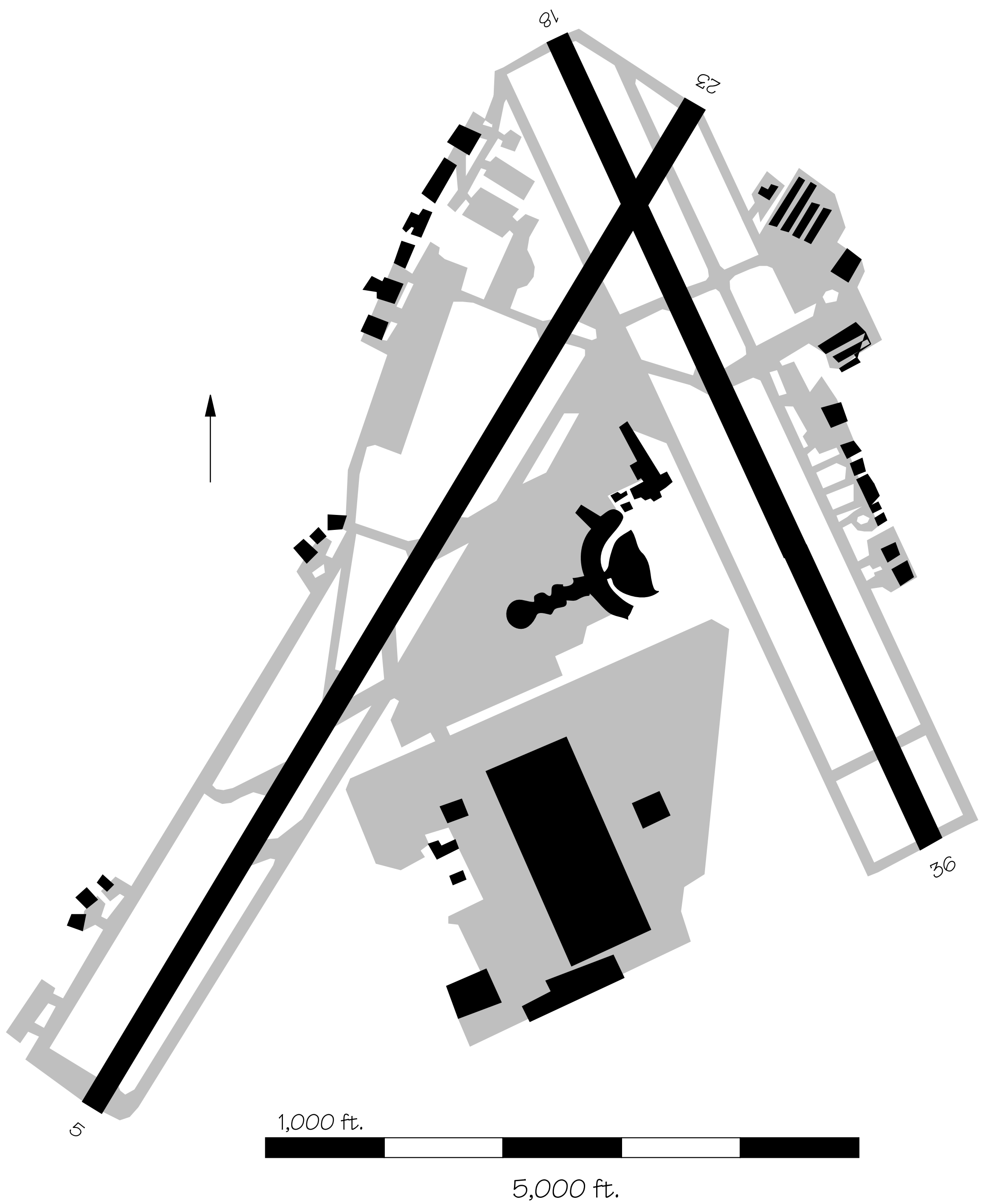
AUS — Austin Robert Mueller Airport



BDL — Bradley International Airport

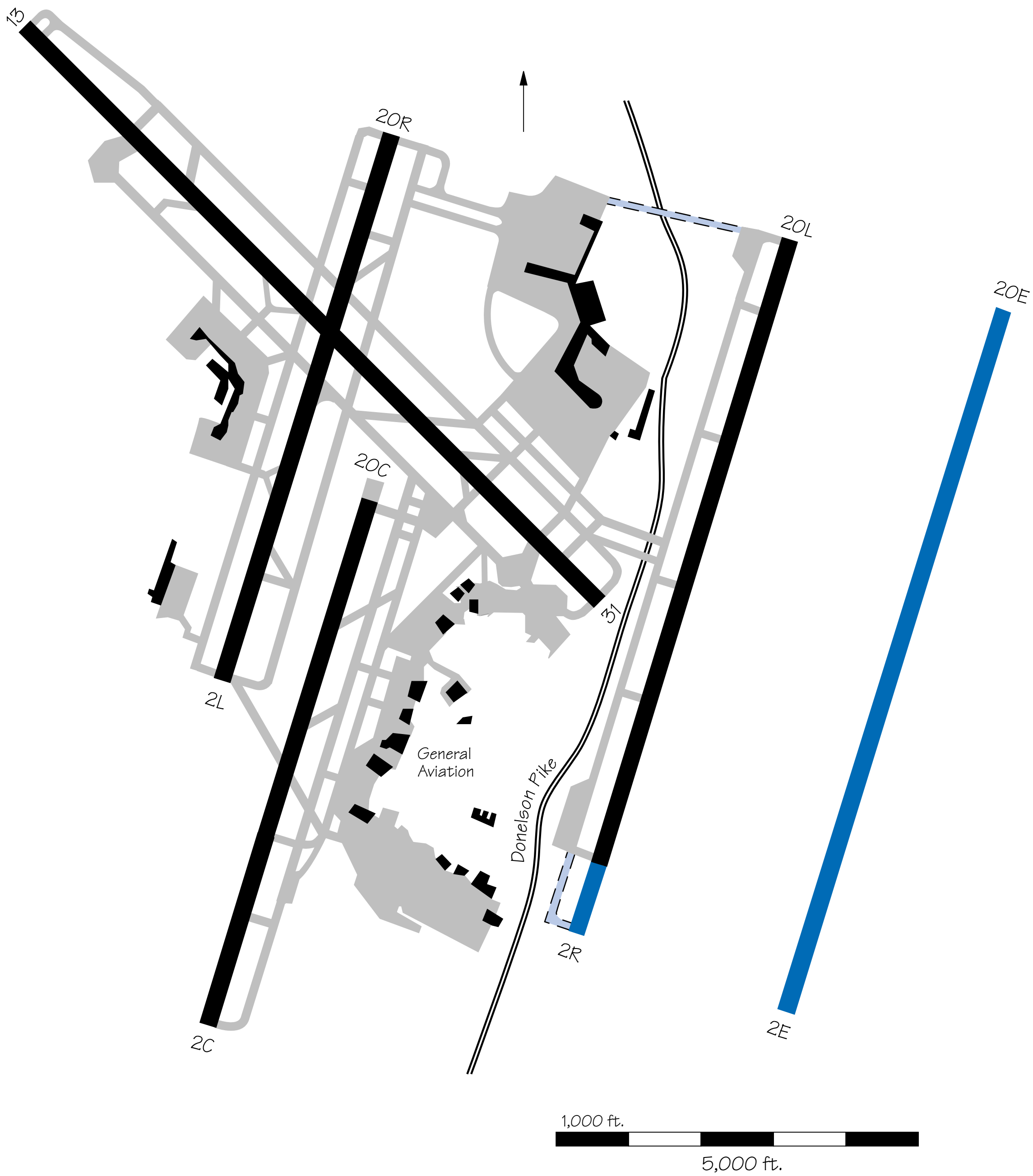


BHM — Birmingham Airport



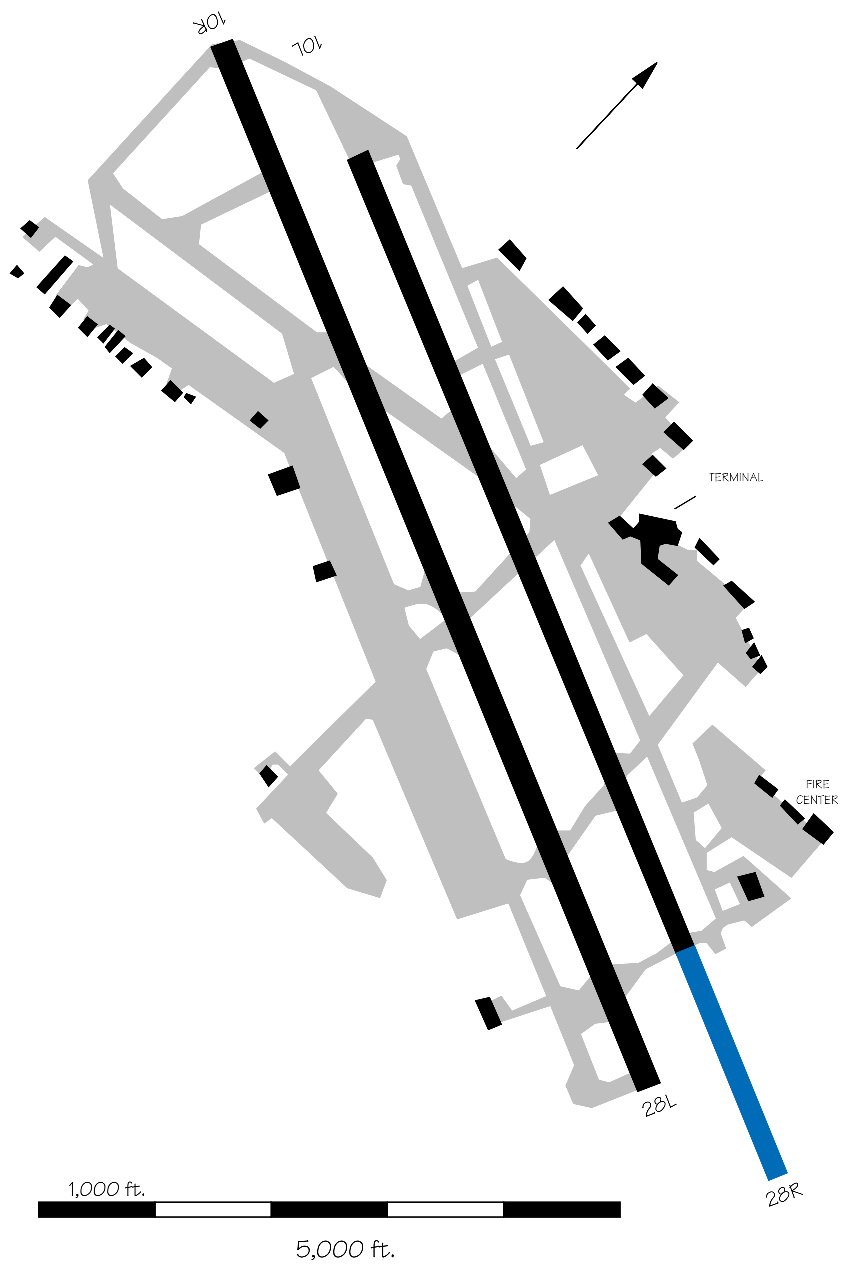
BNA — Nashville International Airport

A new Runway 2E/20E is planned for the future between 1,500 and 3,500 feet from Runway 2R/20L. In addition, an extension to Runway 2R/20L is planned.



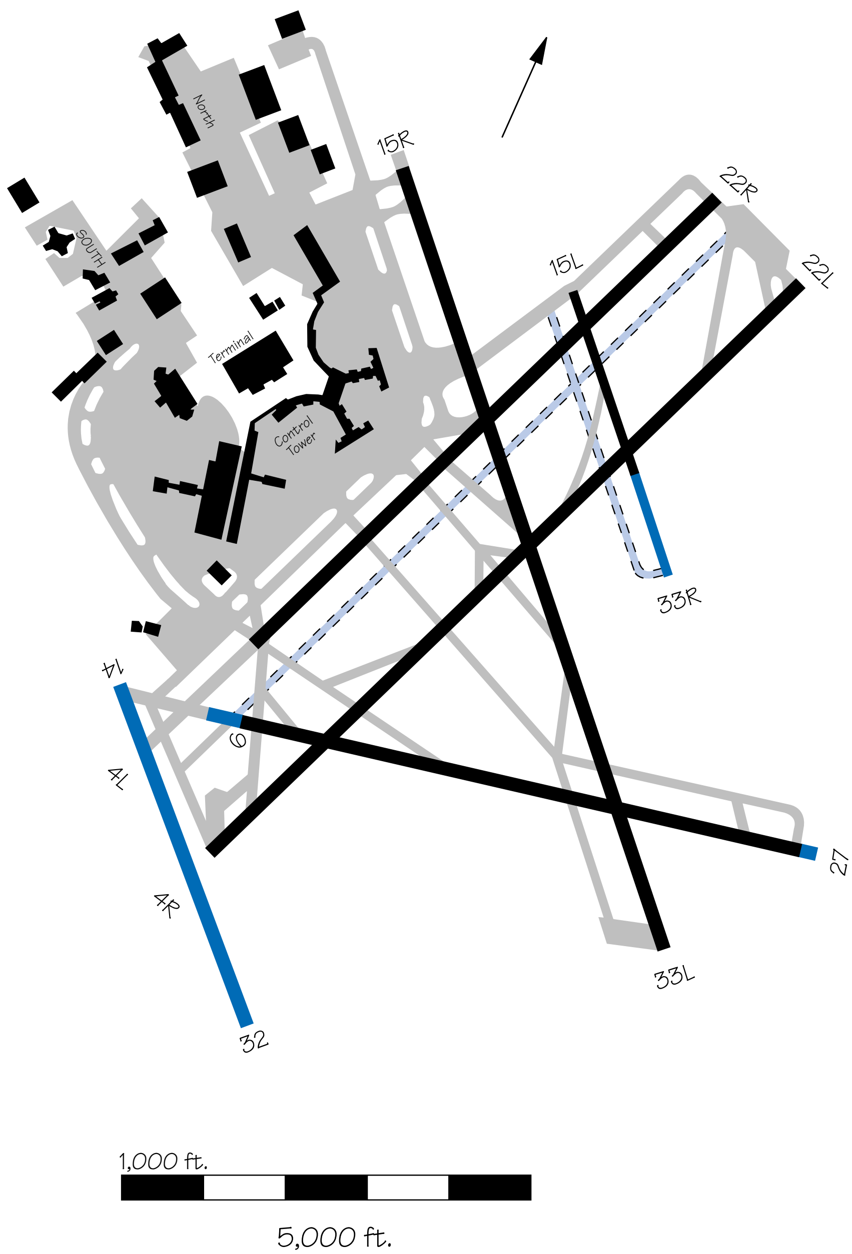
BOI — Boise Air Terminal

A 2,600 foot extension to the east end of Runway 10L/28R is planned. It is expected to be operational in 1998, at a cost of $8 million.



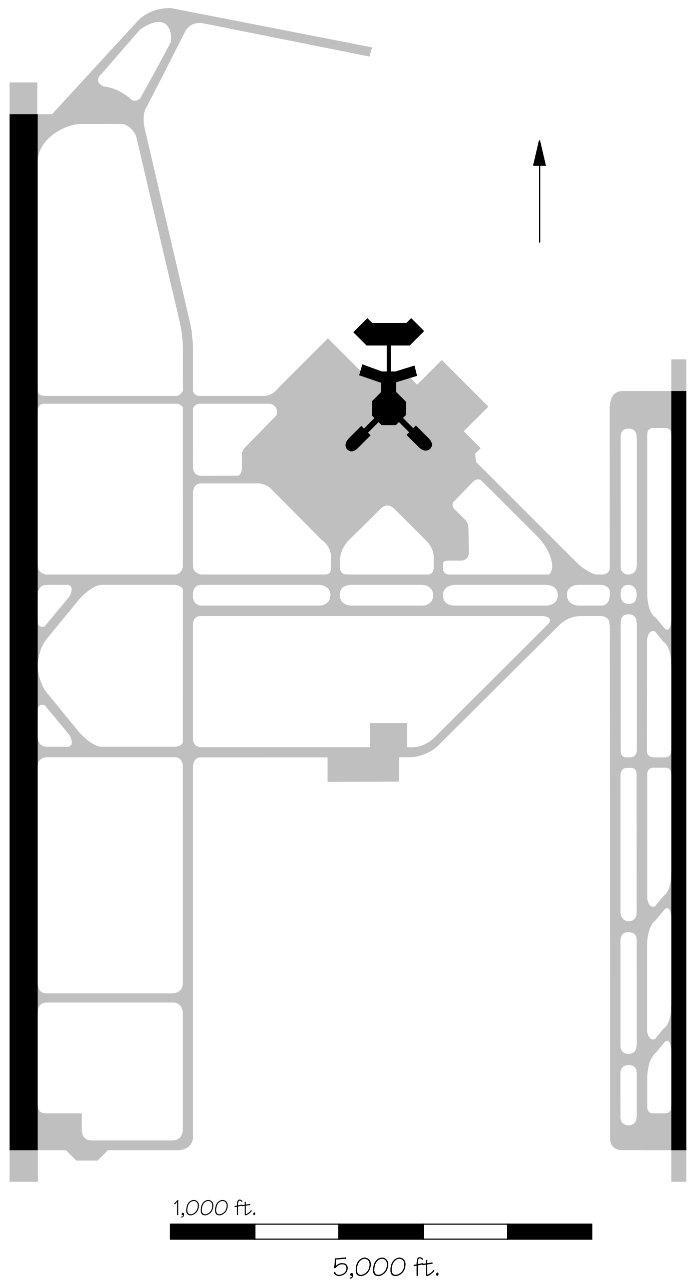
BOS — Boston Logan International Airport

A new uni-directional commuter runway (Runway 14/32) 4,300 feet from Runway 15R/33L, an extension of Runway 15L/33R to 3,500 feet, and a 400-foot extension of Runway 9 are being studied. An Environmental Impact Study is currently in progress for the new runway.



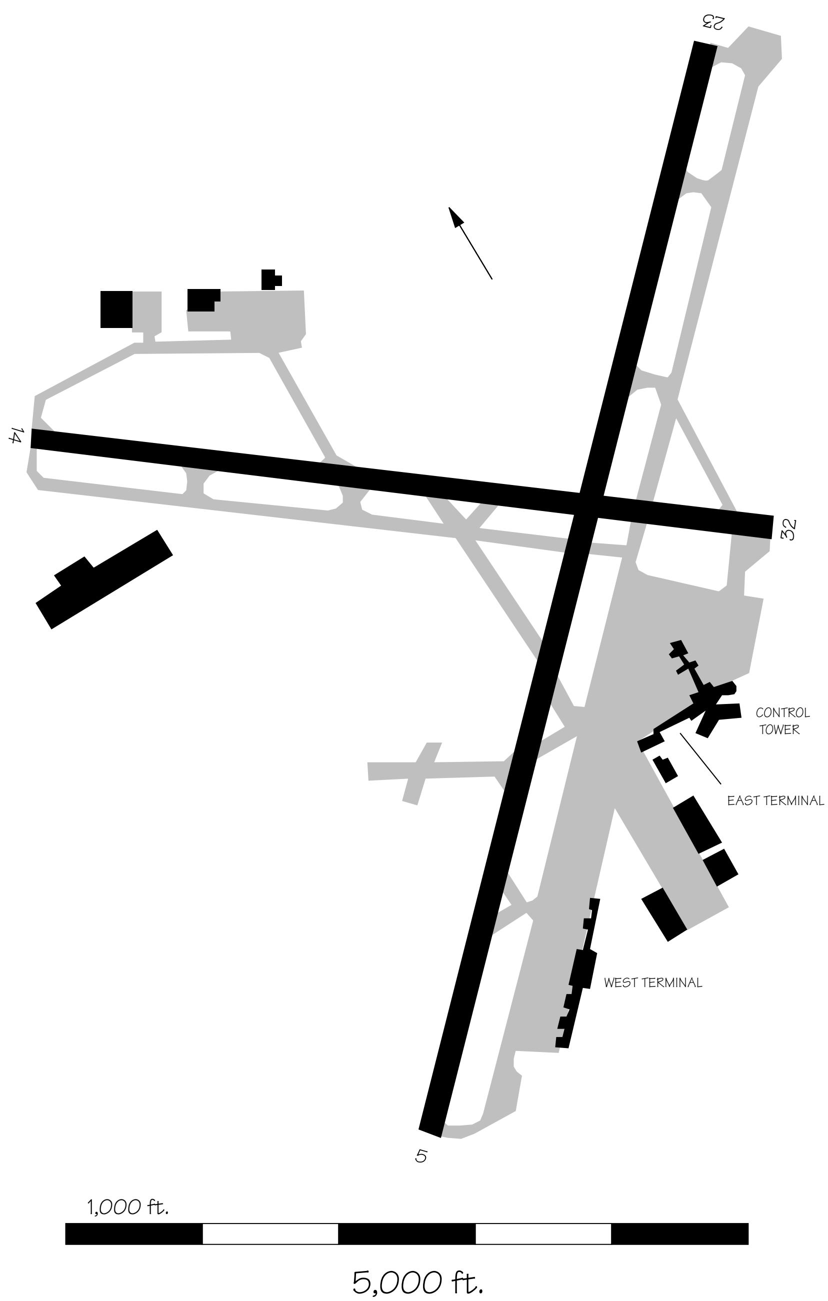
BSM — Bergstrom AFB (new Austin)

The community has approved the sale of revenue bonds for the development of a new airport. The present Robert Mueller Airport cannot be expanded. Bergstrom Air Force Base (AFB) was transferred to the city on October 1, 1993, and the city is now planning to construct a new parallel runway and relocate all commercial activity there in 1998. The total estimated project cost is $520 million. The city has an Airport Master Plan under development. Environmental studies are in progress by the Air Force and the city. Since Robert Mueller Airport will close upon completion of the new airport, no capacity enhancements are planned at Mueller. Some of the construction projects include a new Runway 17L/35R and associated taxiways, new midfield cross taxiways, a new air cargo apron, and renovation of Runway 17R/35L to bring it up to FAA CAT III standards.

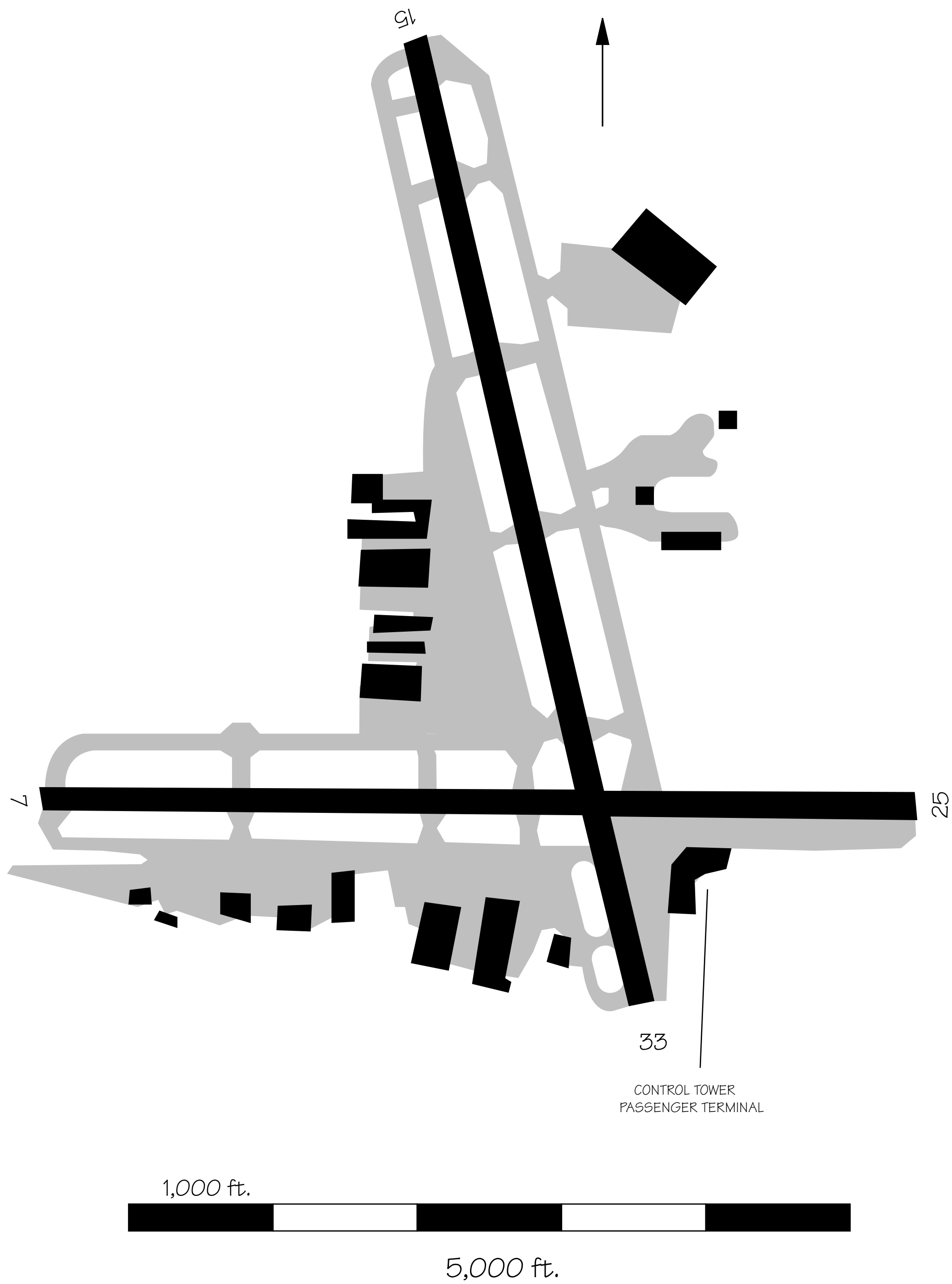


Bergstrom Air Force Base Conversion
Opening Day Layout Plan
as of 1-31-95

BUF — Greater Buffalo International Airport

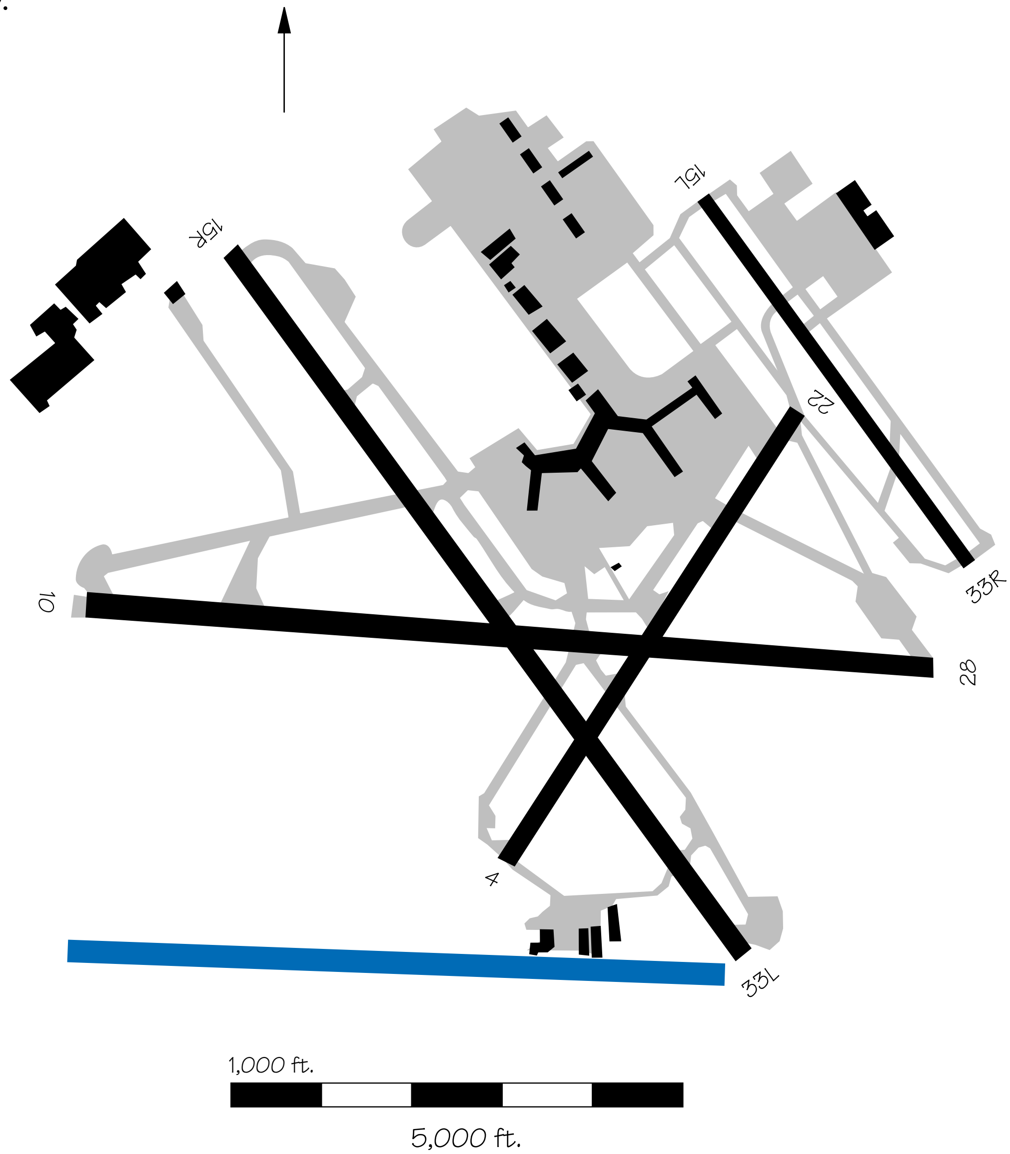


BUR — Burbank-Glendale-Pasadena Airport

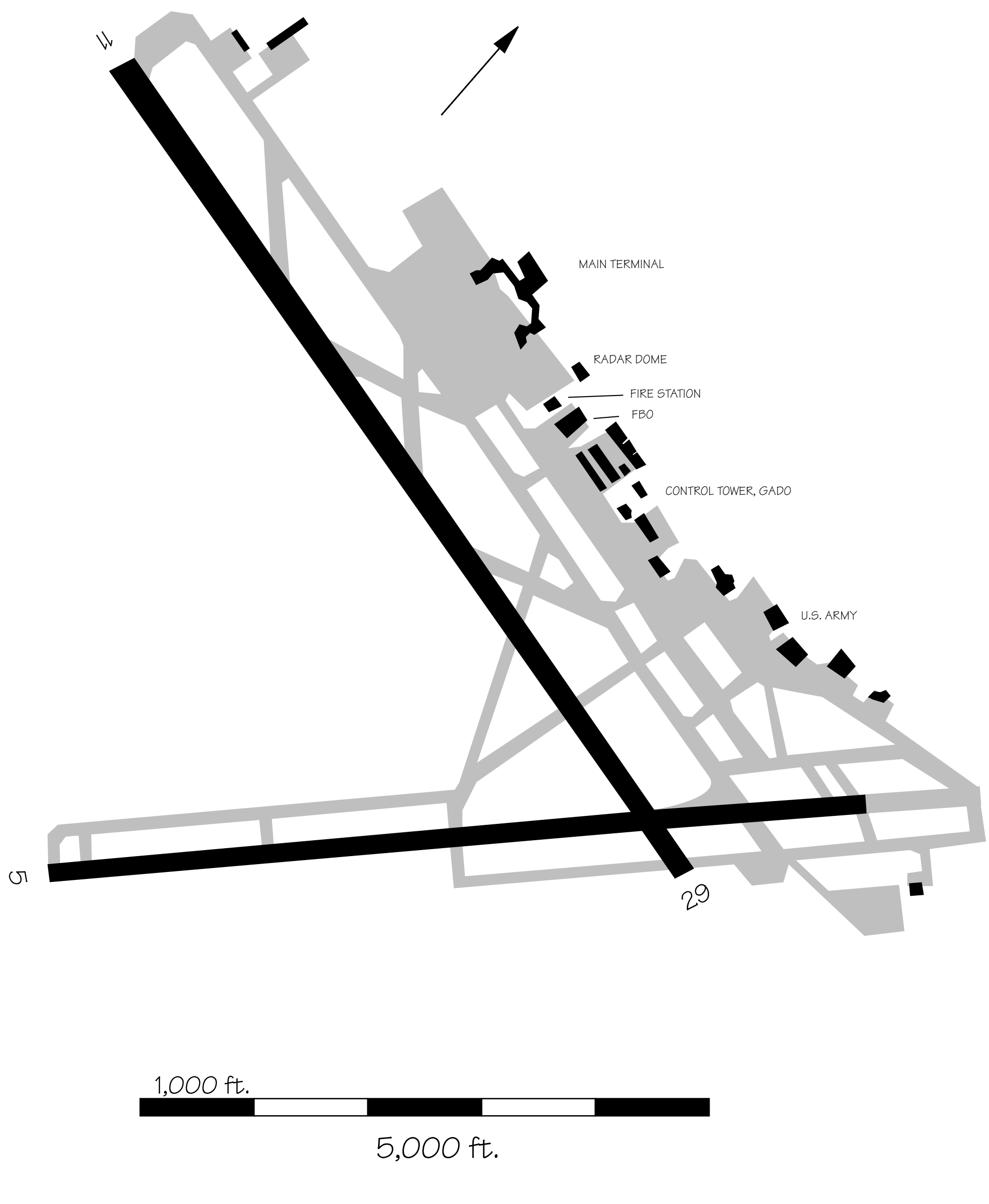


BWI — Baltimore-Washington International Airport

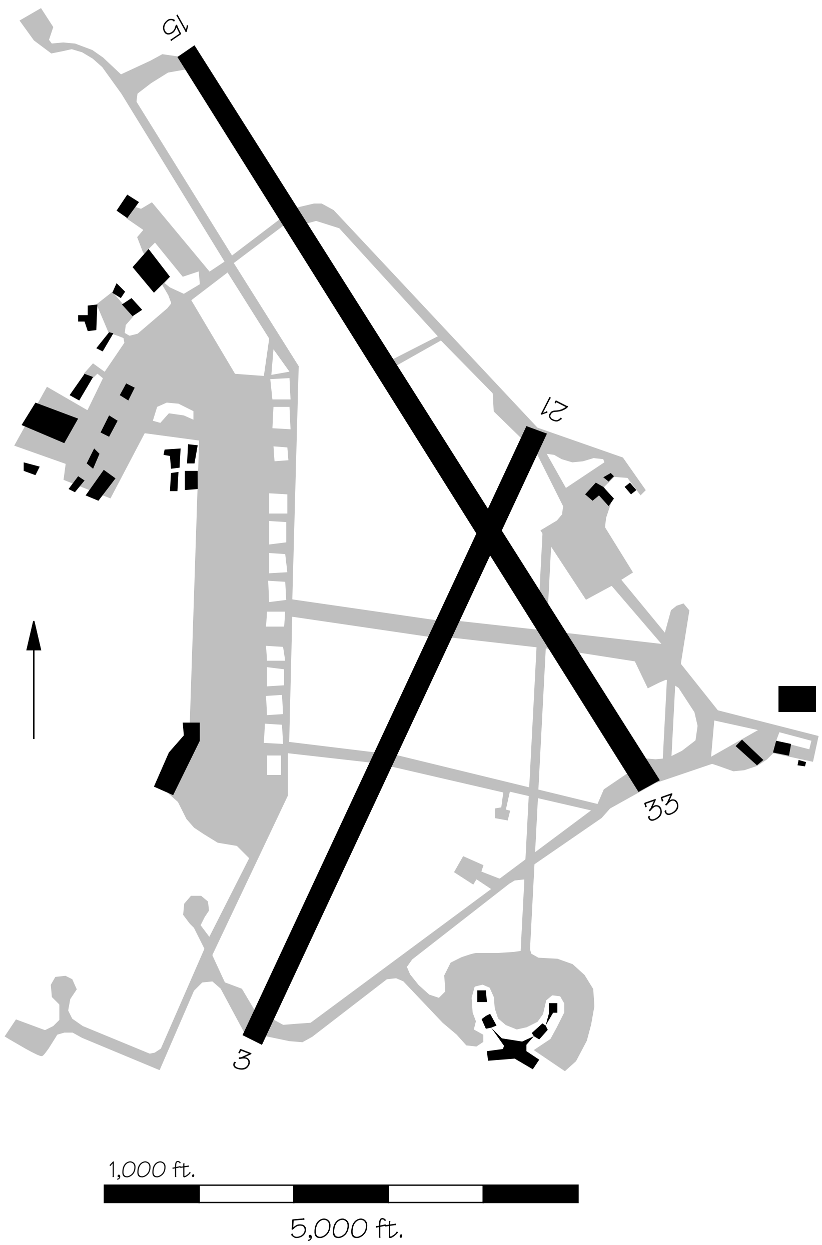
A new 7,800-foot runway, Runway 10R/28L, is planned to be constructed by 2003, 3,500 feet south of Runway 10/28. When Runway 10R/28L is constructed, Runway 4/22 will be converted to a taxiway.



CAE — Columbia Metropolitan Airport

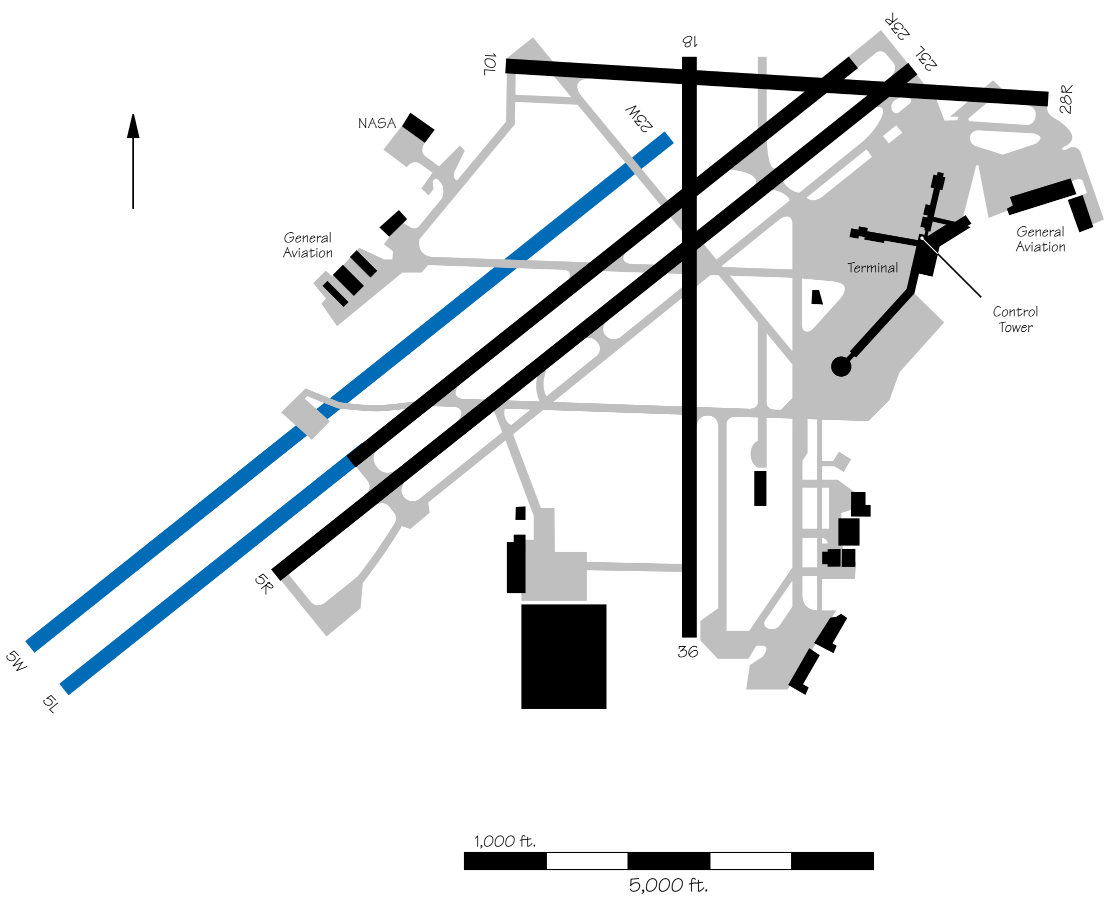


CHS — Charleston AFB International Airport



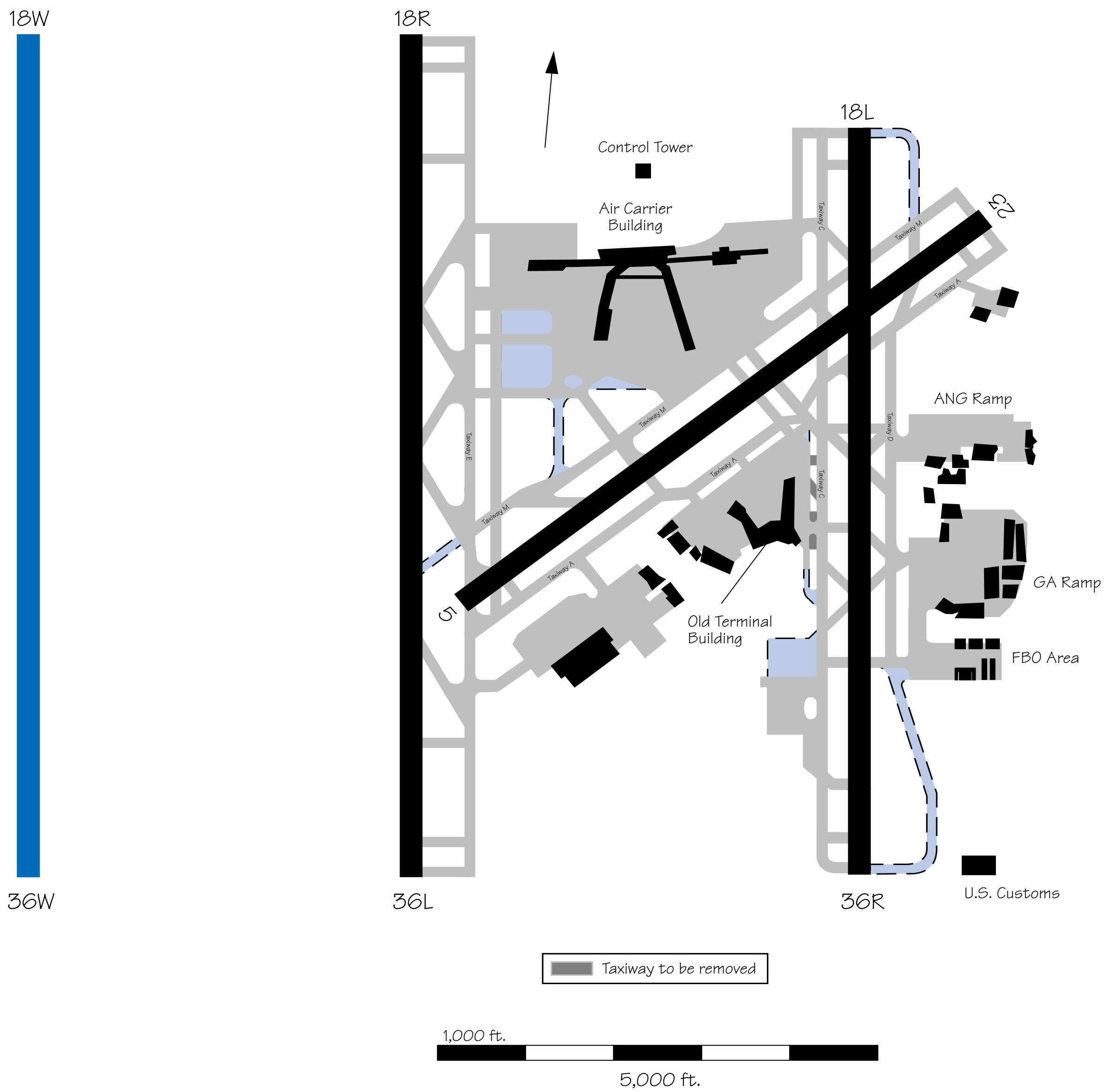
CLE — Cleveland Hopkins International Airport

A Master Plan Update is currently being coordinated. The preliminary Airport Layout Plan shows construction of a new Runway 5W/23W that would be 10,950 feet long and 150 feet wide. Construction is expected to be completed in 2000 at a cost of $180 million. Also included in the development plan is an extension of the existing Runway 5L/23R from 7,095 feet to 12,480 feet at an estimated cost of $40 million and conversion of the existing Runway 5R/23L to a parallel taxiway at a cost of $3 million. All of this work is scheduled for completion in 2005.



CLT — Charlotte/Douglas International Airport

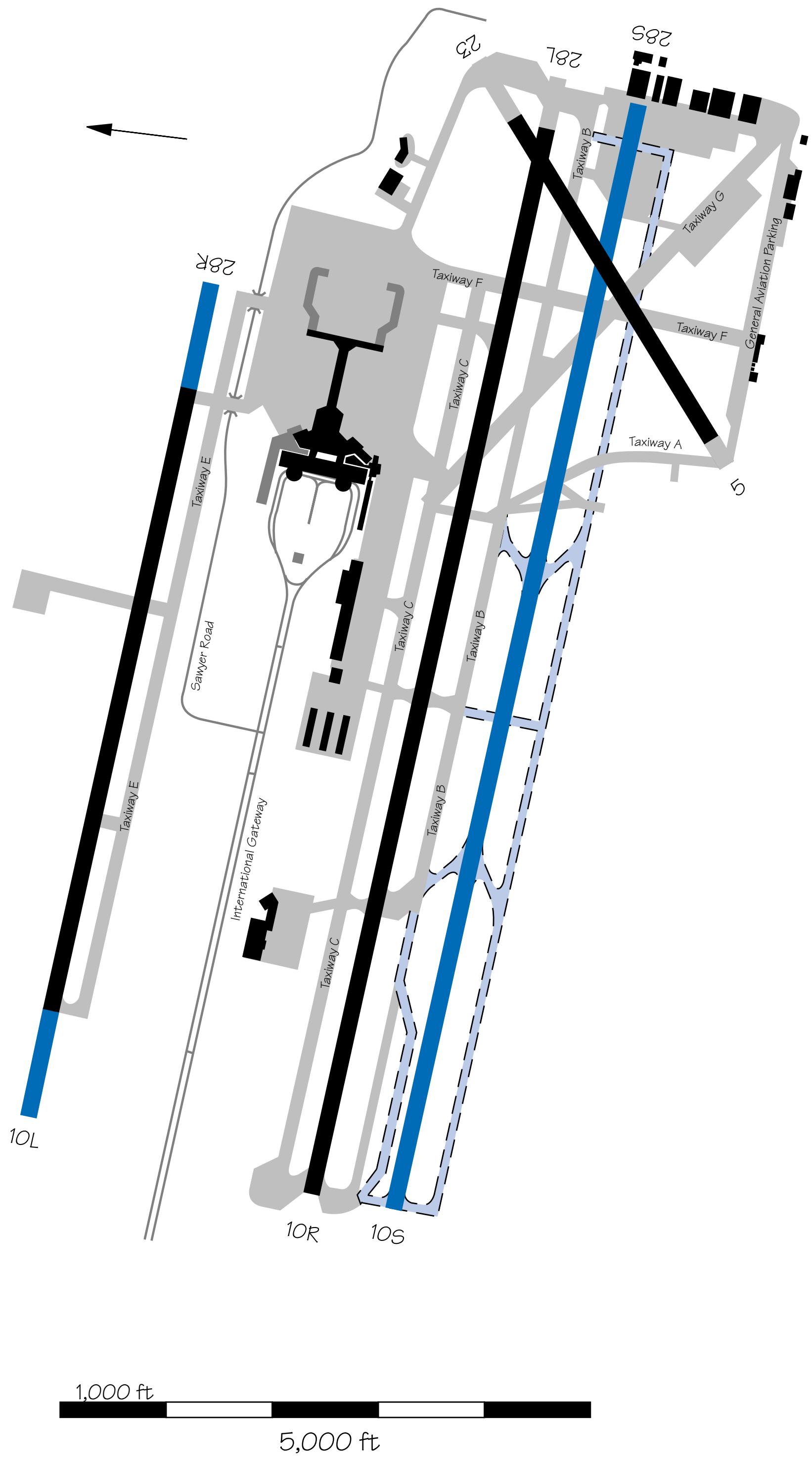
Plans to open a third parallel 8,000-foot runway west of Runway 18R/36L that would permit triple IFR approaches (dependent or independent, based on final separation) is being considered. An Environmental Impact Study is underway. While construction has not begun, it is estimated to be completed in 2000, with an estimated cost of $122 million.



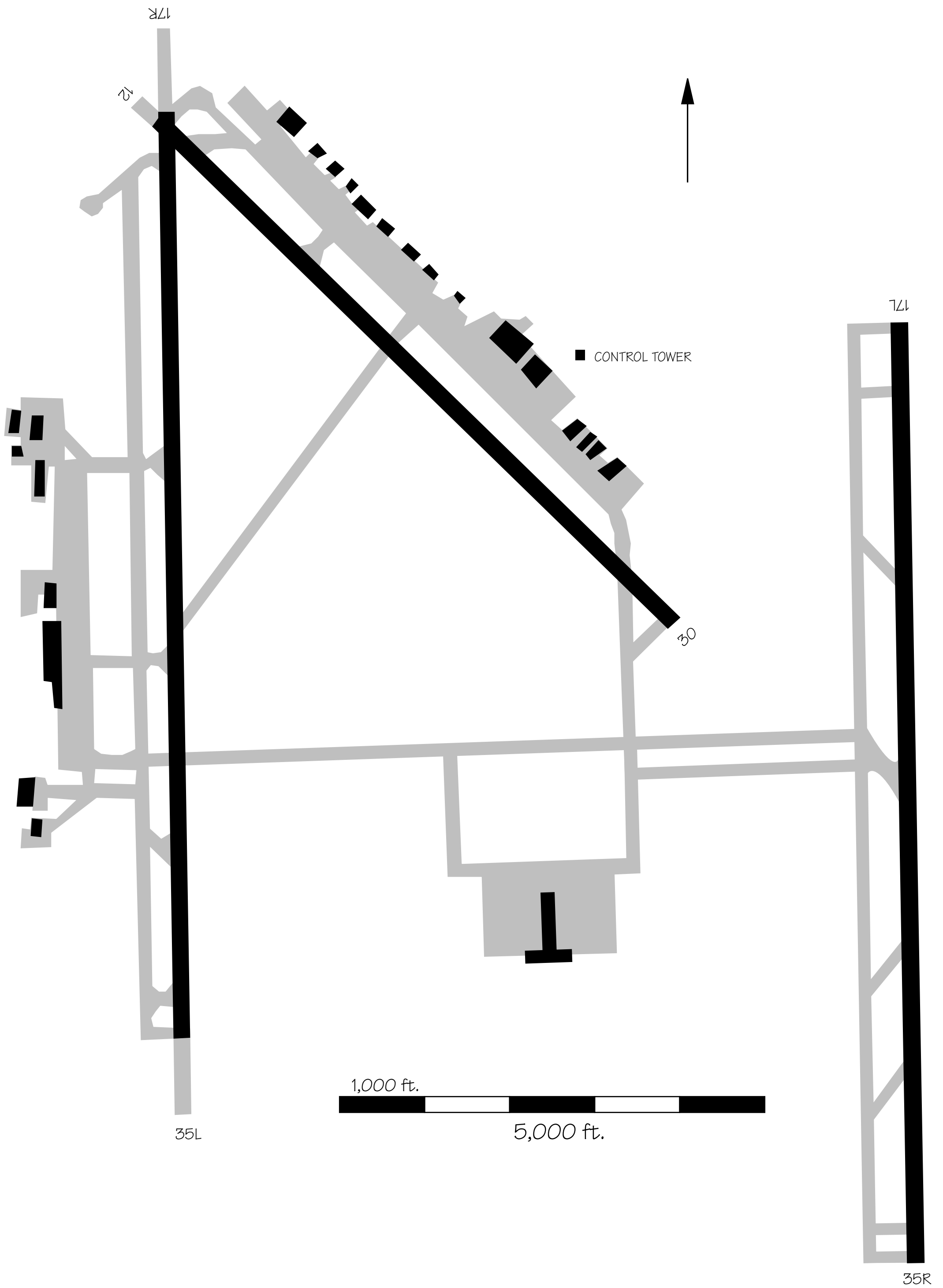
CMH — Port Columbus International Airport

The Airport Layout Plan has been coordinated to show a third parallel Runway 10S/28S constructed 800 feet south of the existing Runway 10R/28L. This runway will be 10,250 feet long and 150 feet wide, with two high speed exits, a 90 degree exit at the center, and a 90 degree bypass taxiway at each end. This would provide a 3,650 foot separation between the proposed Runway 10S/28S and the existing Runway 10L/28R. With the installation of the Precision Runway Monitor (PRM), the existing Runway 10L/28R and the proposed Runway 10S/28S could be used for arrival air traffic. Runway 10R/28L would be used as the departure runway. A 1,000 foot extension to Runwya 28R was completed in late 1996.

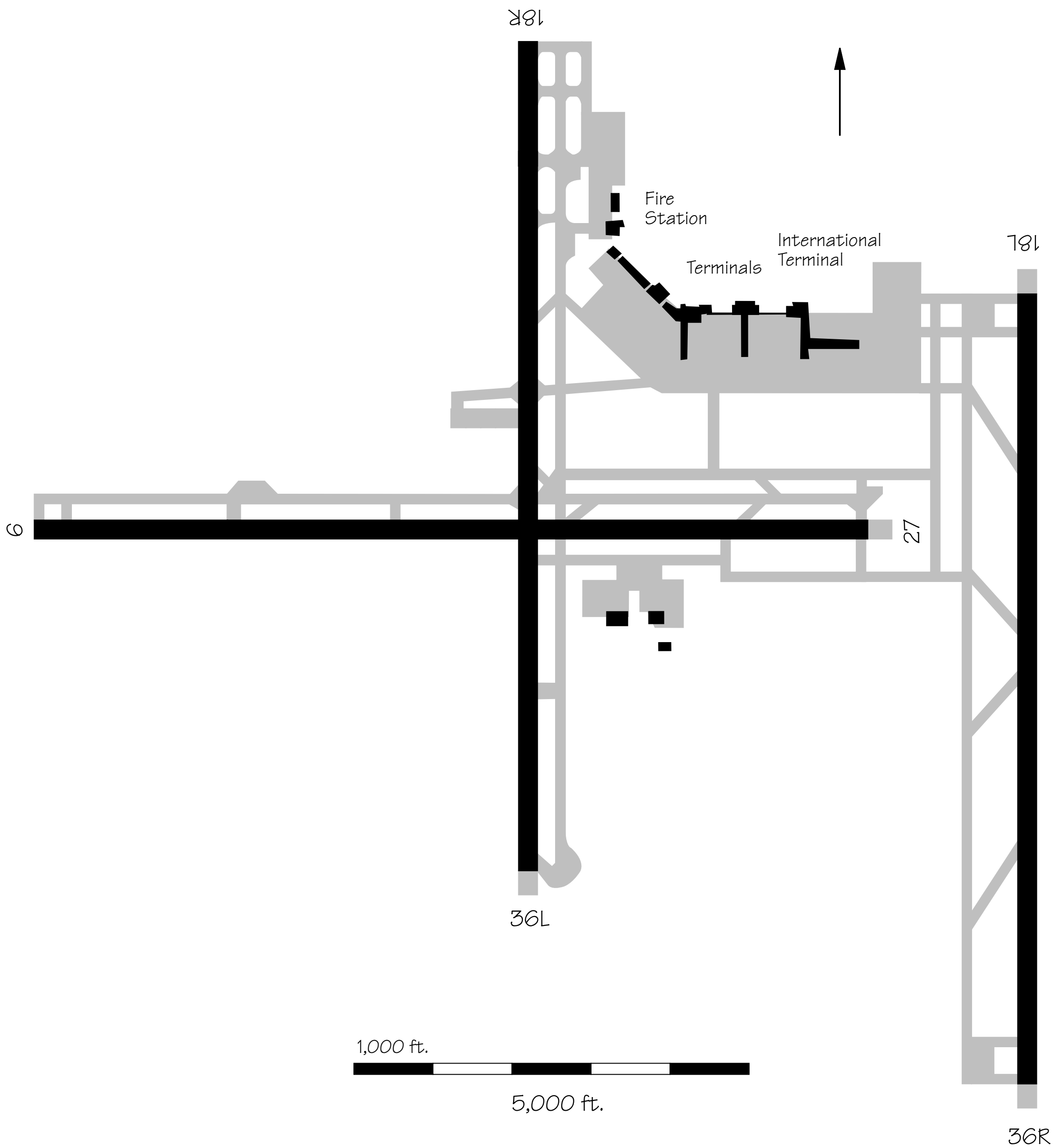
The existing Runway 10L is being extended 1,000 feet and will be completed in 1997. Upon completion, Runway 10L/28R will be 8,000 feet long and 150 feet wide.



COS — Colorado Springs Municipal Airport

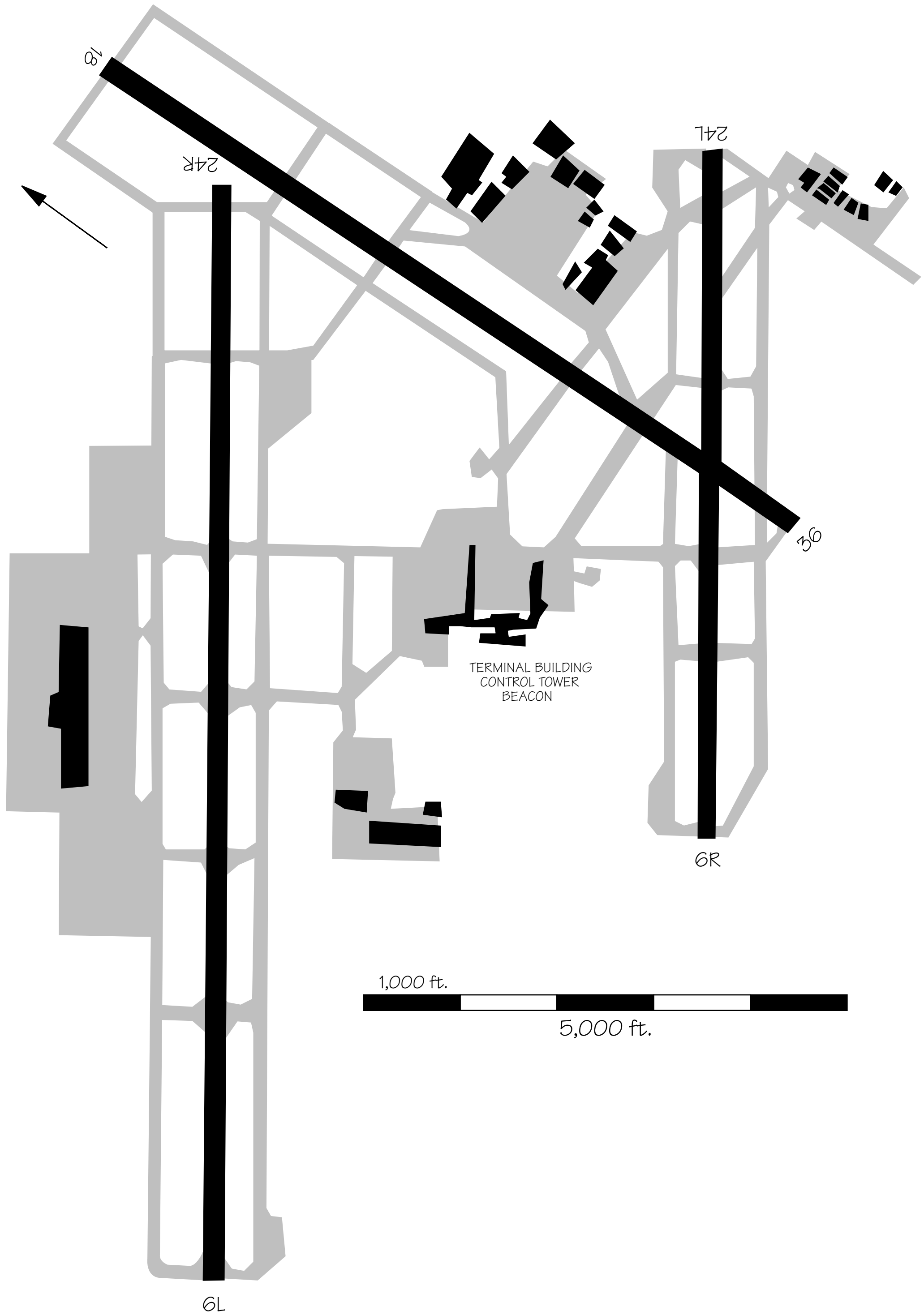


CVG — Greater Cincinnati International Airport

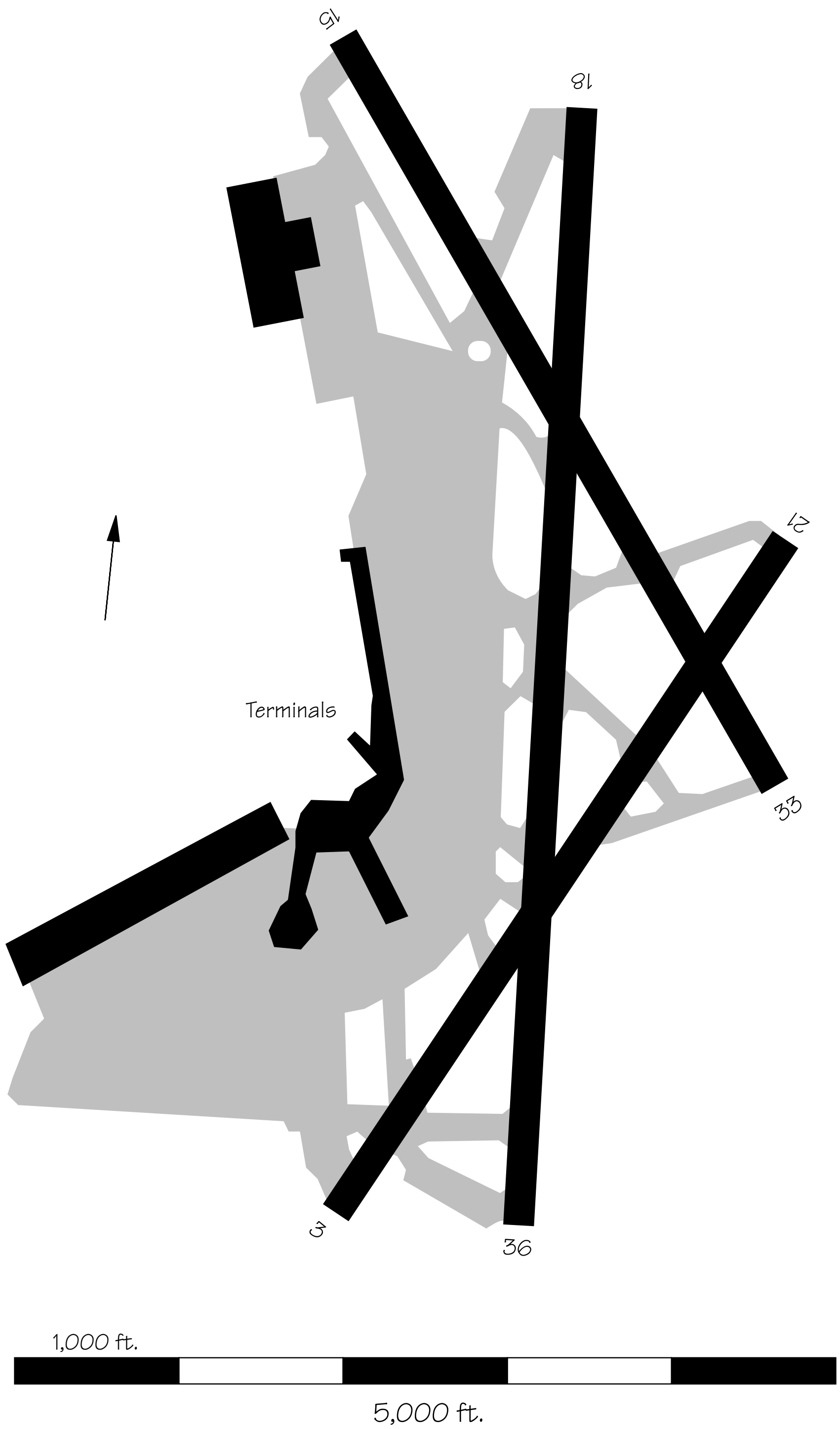


DAL — Dallas-Love Field

DAY — Dayton International Airport

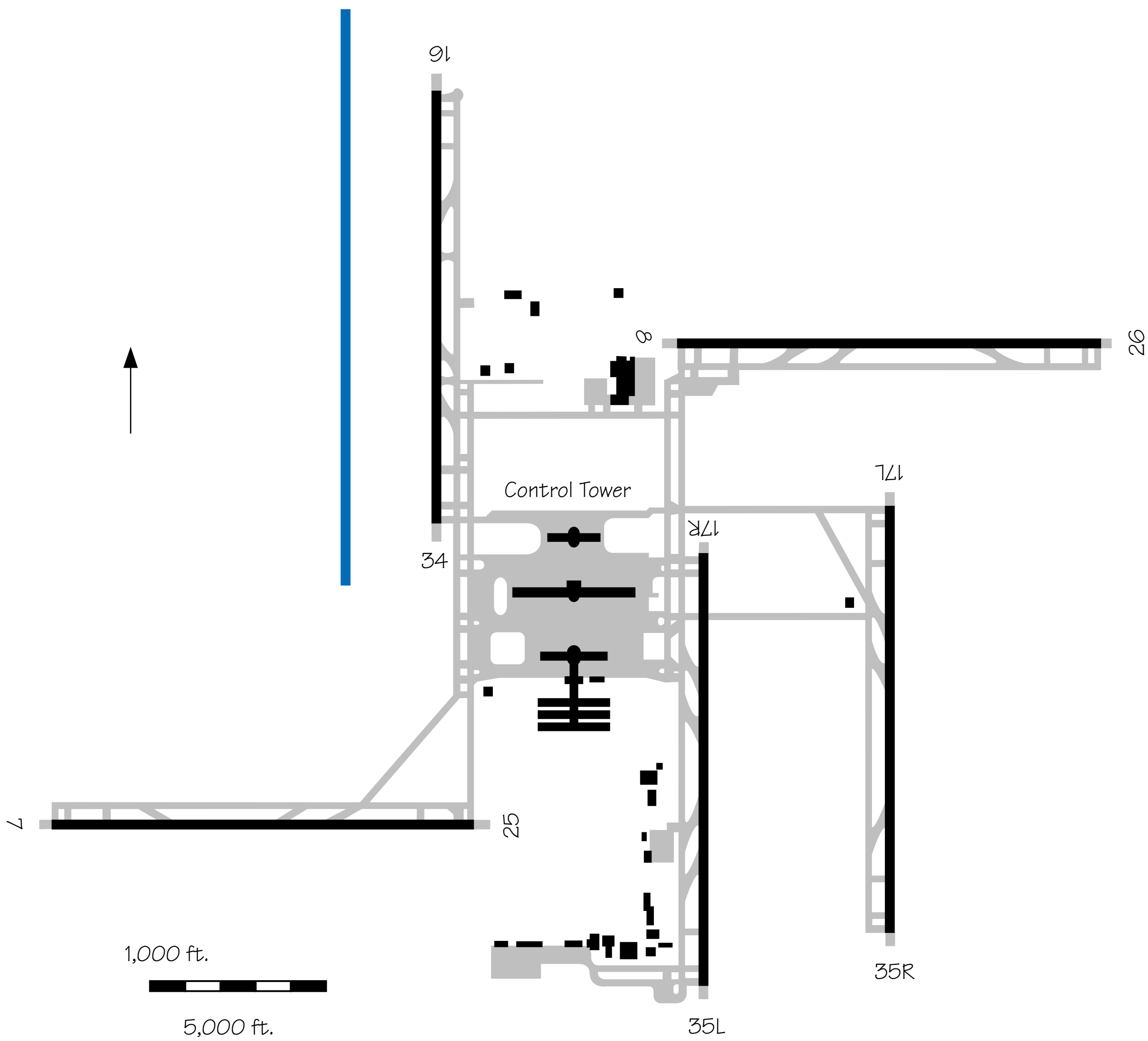


DCA — Washington National Airport



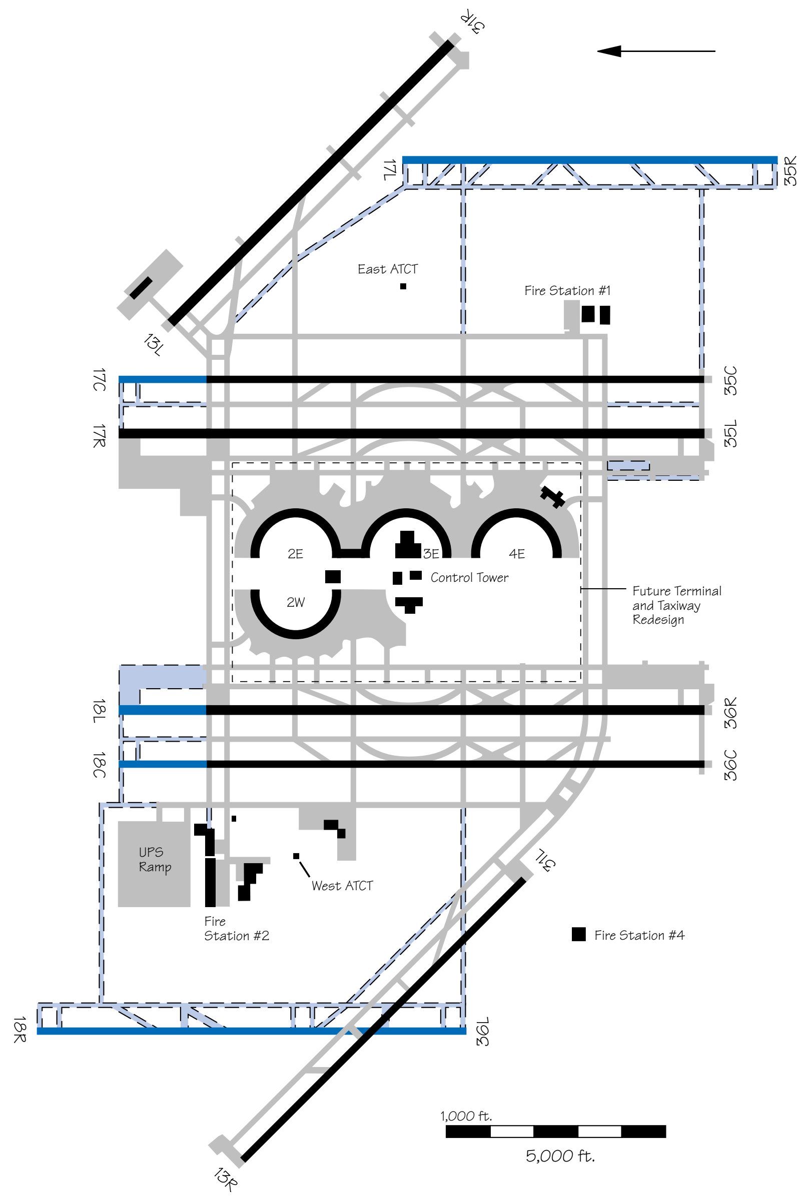
DEN — Denver International Airport

Runway 16R/34L is the last of the six original runways to be built at the new airport. It will be separated 2,600 feet from Runway 16L/34R, and be 16,000 feet in length. The runway is expected to be completed in 2000, at an estimated cost of $75 million.



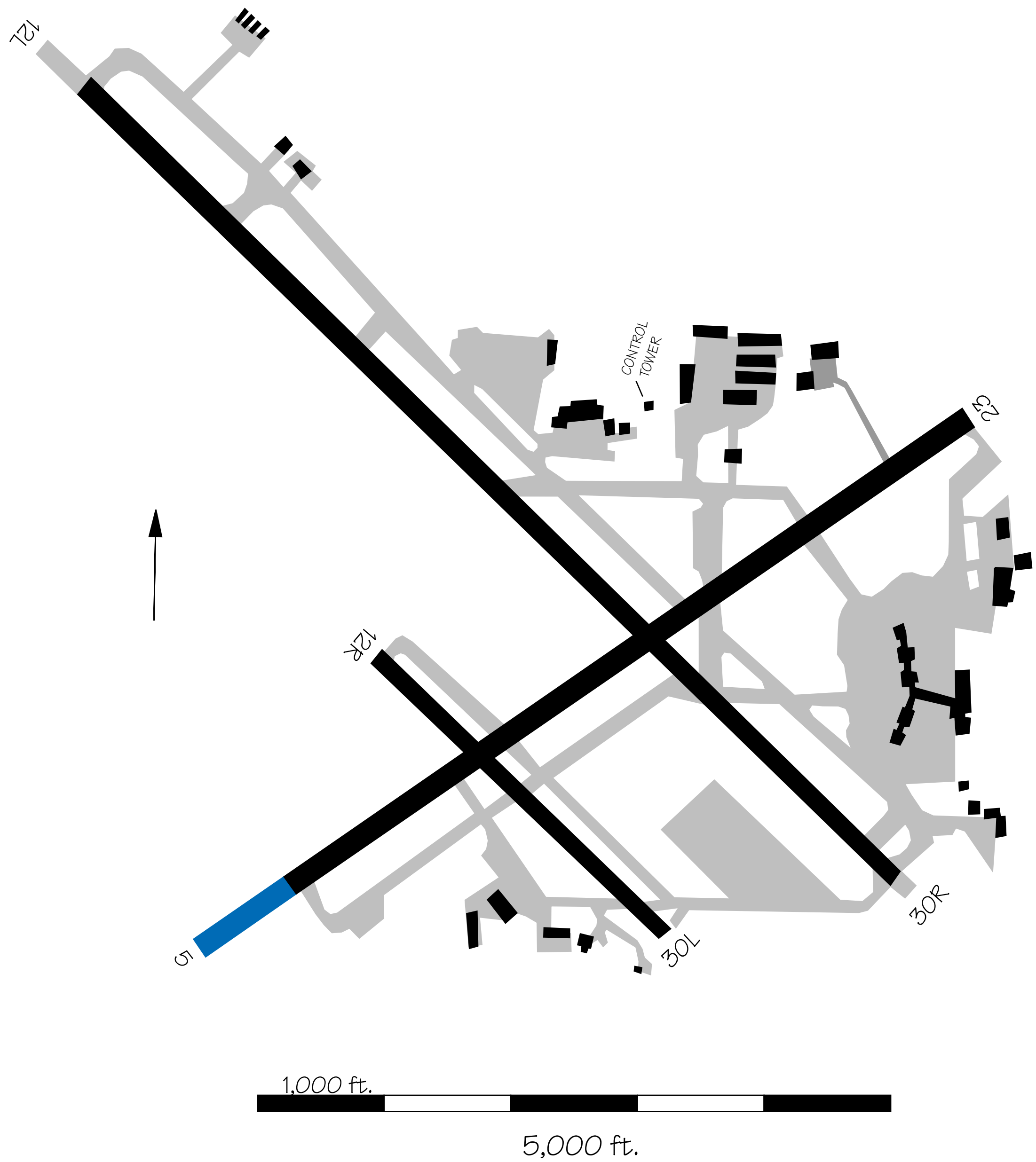
DFW — Dallas-Fort Worth International Airport

Proposed 2,000-foot extensions to all of the north/south parallel runways will provide an overall length of 13,400 feet for each. Environmental assessments for the extension to Runway 17C/35C, Runway 18L/36R, and Runway 18R/36L are expected to begin in 1997.The estimated cost of each extension is $25 million. The extension of Runway 17R/35L has been completed and was operational September 16, 1993. The construction of Runway 17L/35R was completed and was operational on October 1, 1996. The runway is 8,500 feet in length. It is 5,000 feet east of and parallel to Runway 17C/35C (previously 17L/35R). The total cost of the runway was approximately $300 million and allows DFW to accomodate triple simultaneous precision instrument approaches for the first time. Construction on the west runway, Runway 18R/36L, will begin when warranted by aviation demand. It could be available as early as 2001. The estimated cost is $100 million. It will be located 5,800 feet west of Runway 18R/36L (to be renamed 18C/36C). Runway 18R/36L may be constructed in phases, with the first phase a 6,000 foot runway located north of Runway 13R/31L. The second phase extension to 9,760 feet would intersect and continue south of Runway 13R/31L. The addition of Runway 18R/36L will allow DFW to accomodate quadruple simultaneous precision instrument approaches.



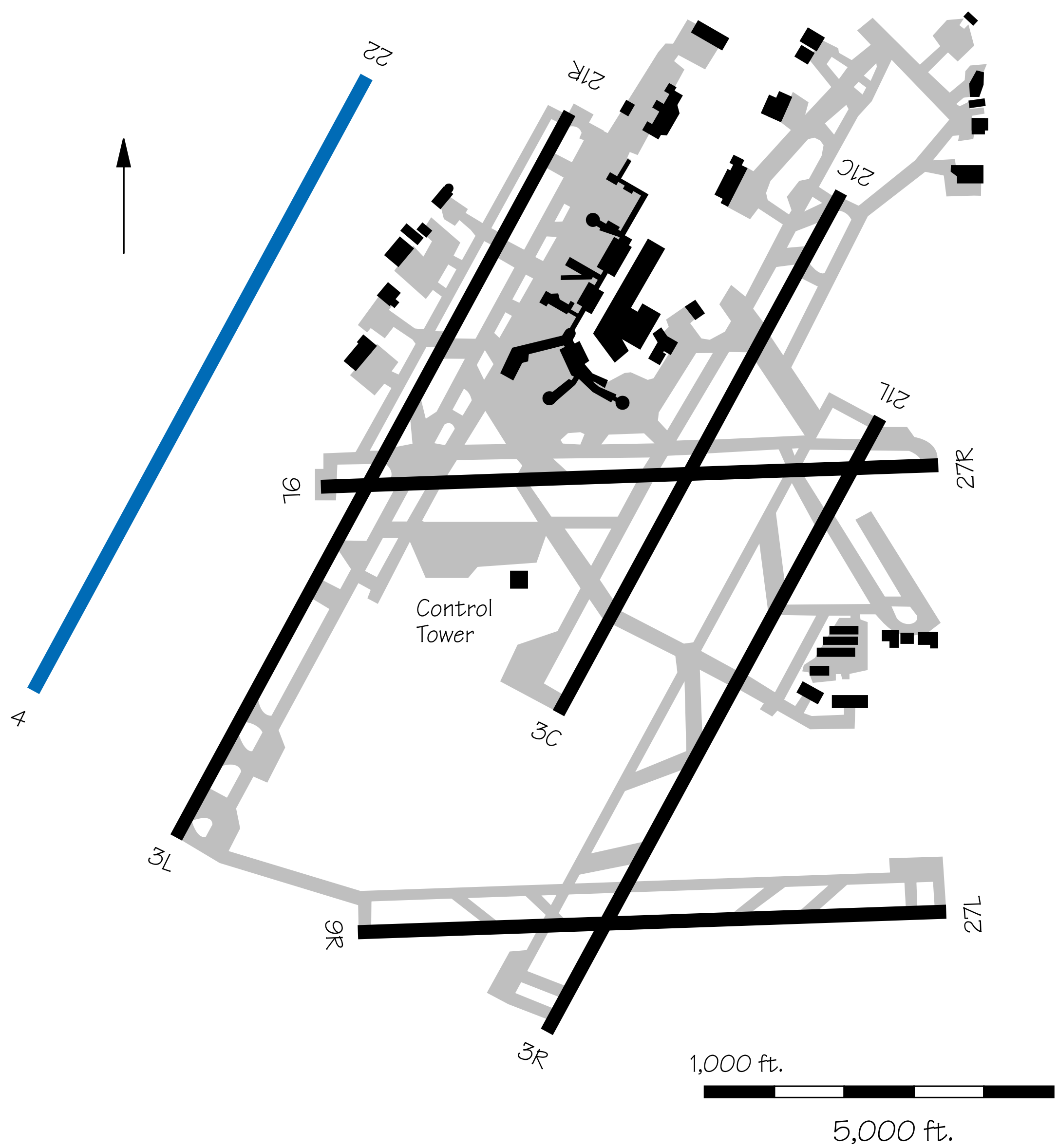
DSM — Des Moines International Airport

An Environmental Impact Study was recently completed on a southwest extension of Runway 5/23. Construction is planned to begin in 1997, and is expected to be completed in 2001. Cost for construction is estimated at $28 million, with an estimated additional $20 million for road relocation.



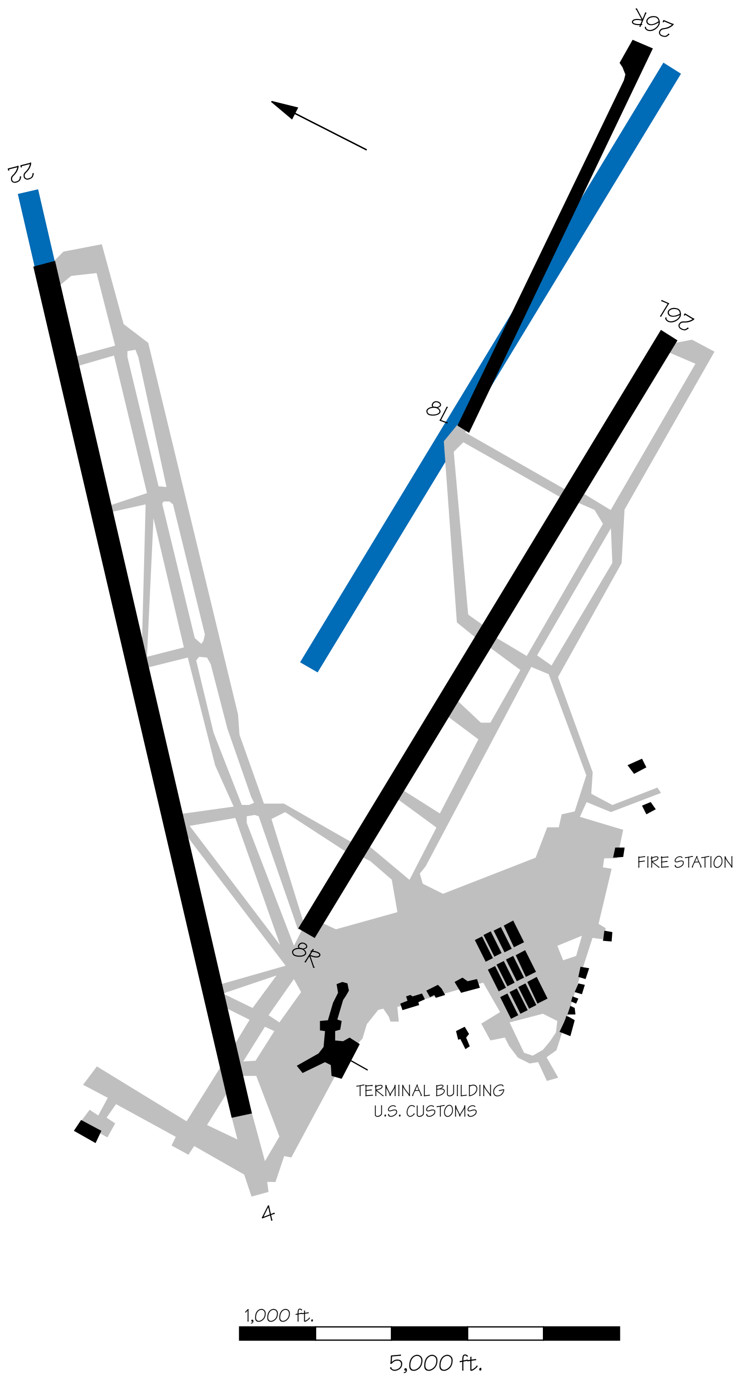
DTW — Detroit Metropolitan Wayne County Airport

A fourth north-south parallel, Runway 4/22 is planned. Construction is expected to begin in 1999 and should be completed in 2001. The estimated cost of construction is $116.5 million. This runway could potentially permit triple IFR arrivals with one dependent and one independent pairing. An environmental assessment was submitted in September 1989, and a record of decision was issued in March 1990. Land acquisition is currently in progress.



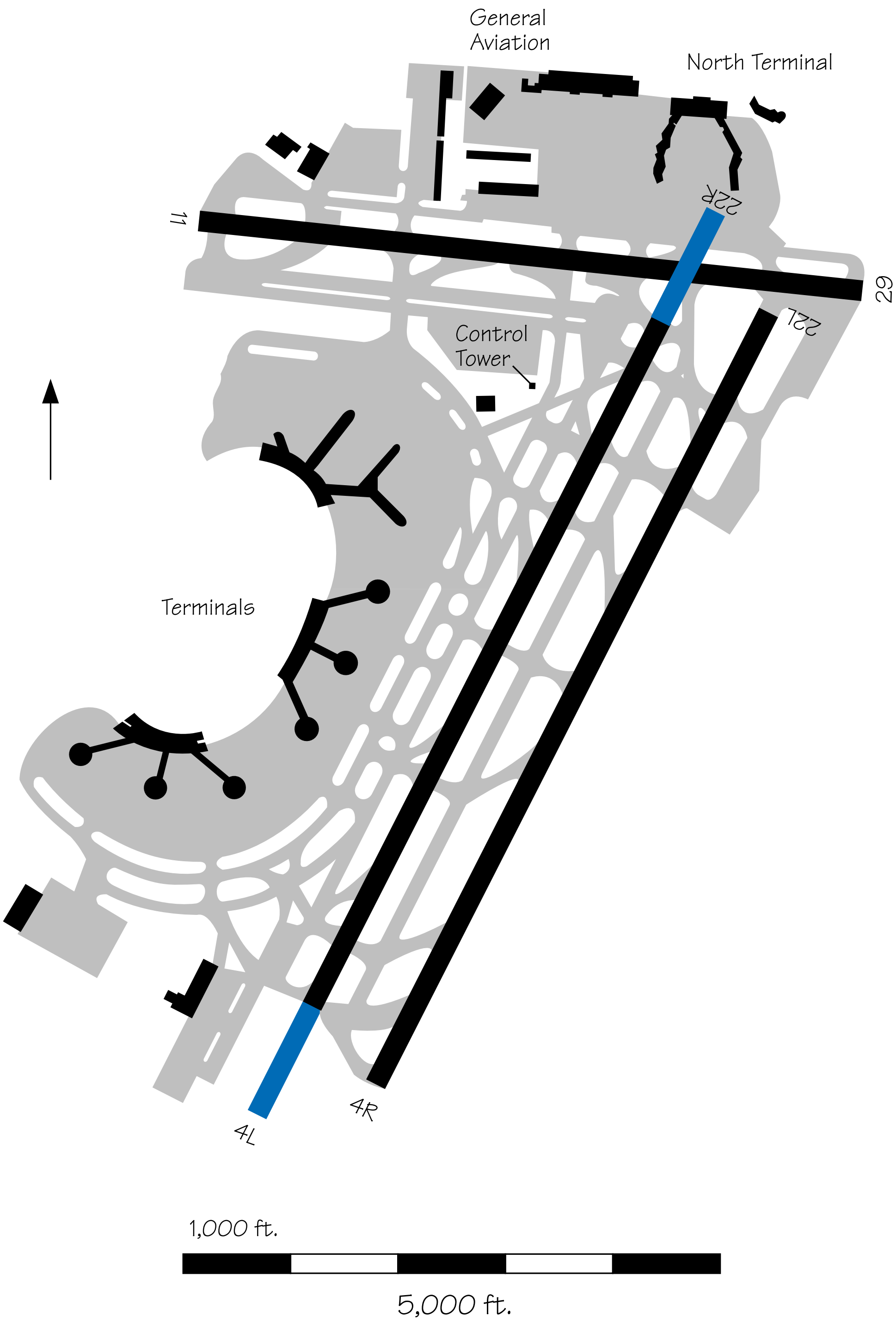
ELP — El Paso International Airport

A new parallel Runway 8L/26R is shown on the current Airport Layout Plan for the year 2010 plus time frame. Estimated cost would be $20-30 million. In addition, a 1,000 ft. extension to Runway 22 is included in the currently approved Passenger Facility Charge for the year 2000. Estimated cost would be $8 million.



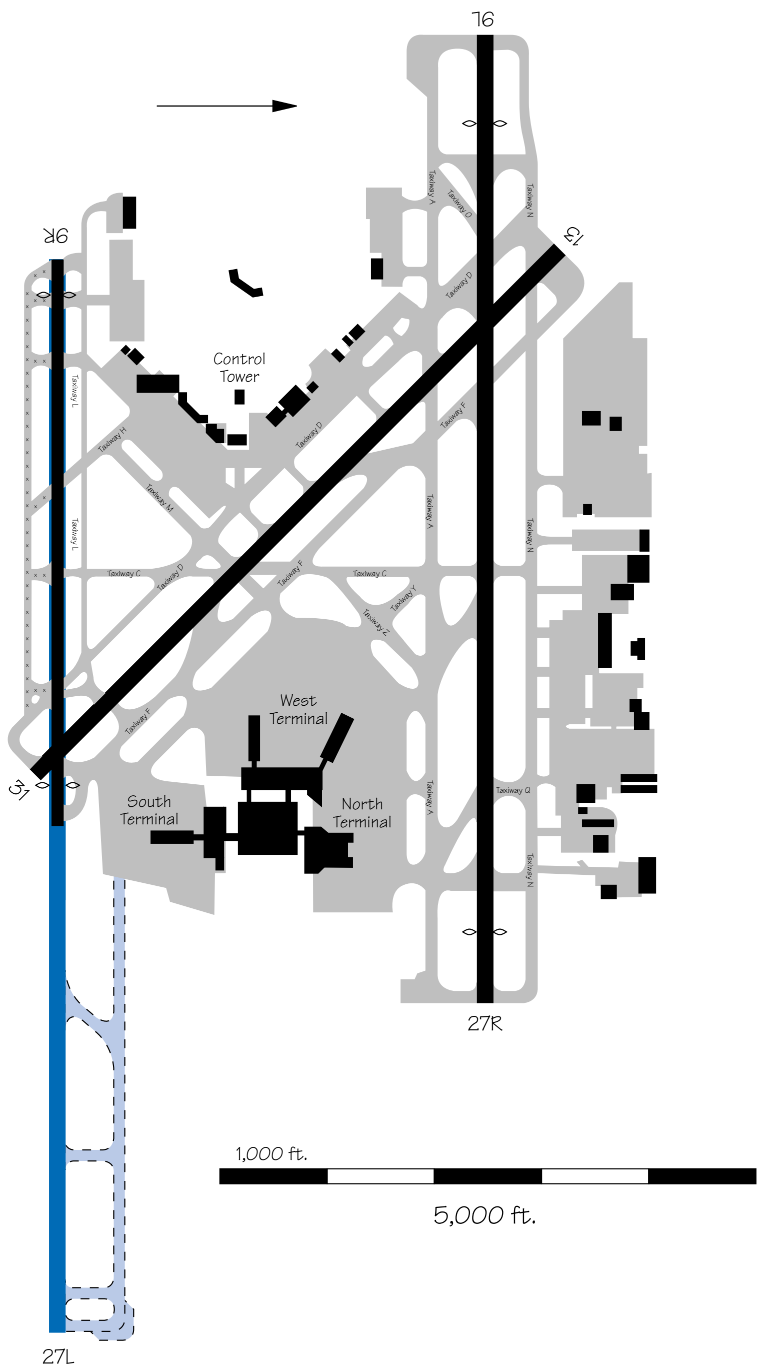
EWR — Newark International Airport

An extension to Runway 4L/22R is in the preliminary planning stage. The estimated operational date is 2000.



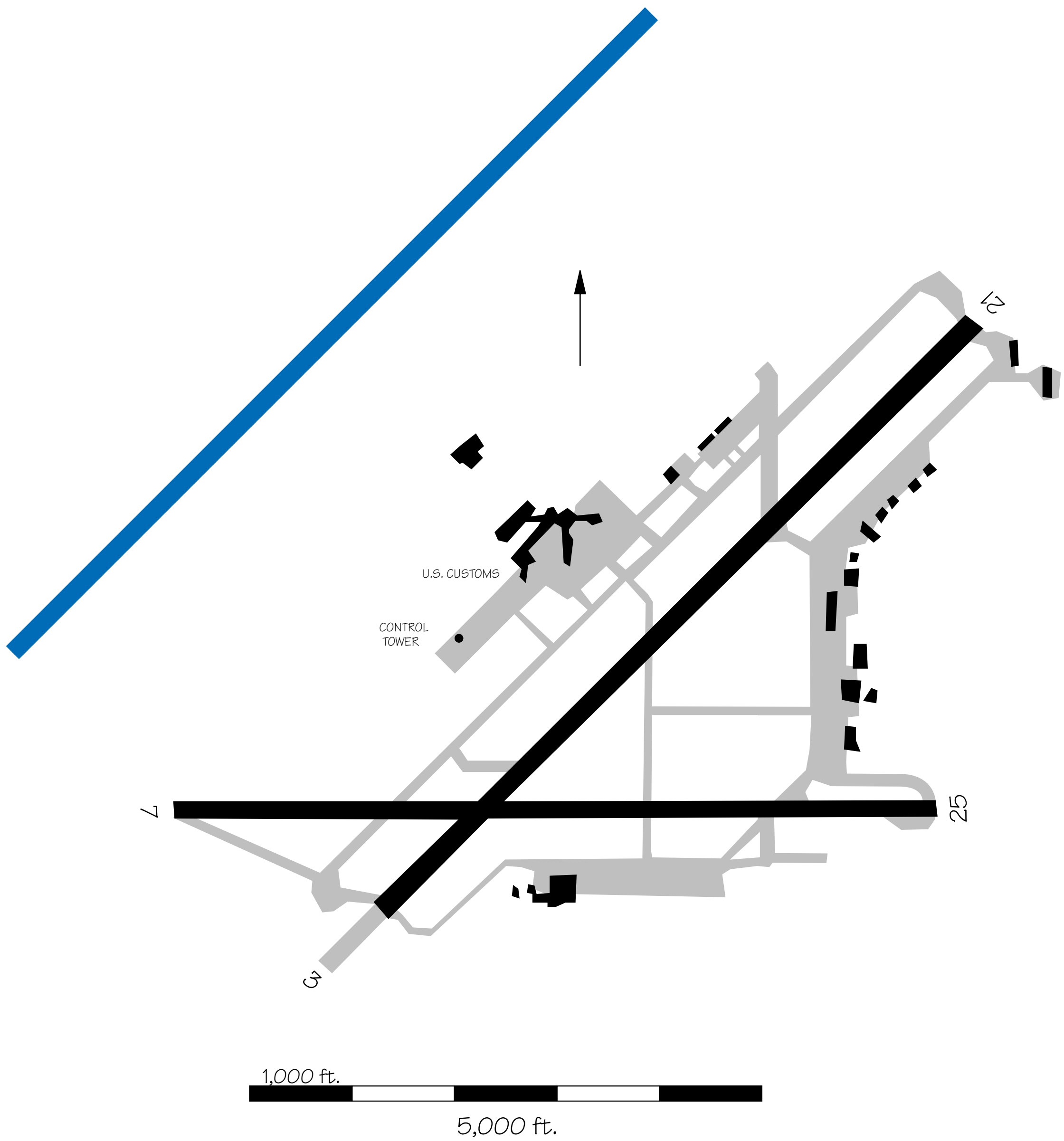
FLL — Fort Lauderdale-Hollywood International Airport

An extension of the short parallel Runway 9R/27L to 10,000 feet long by 150 feet wide is planned to provide the airport with a second parallel air carrier runway. Construction is expected to begin in 2000. The estimated cost of construction is $270 million. The anticipated operational date is 2002. An EIS is underway and expected to be completed in 1998.



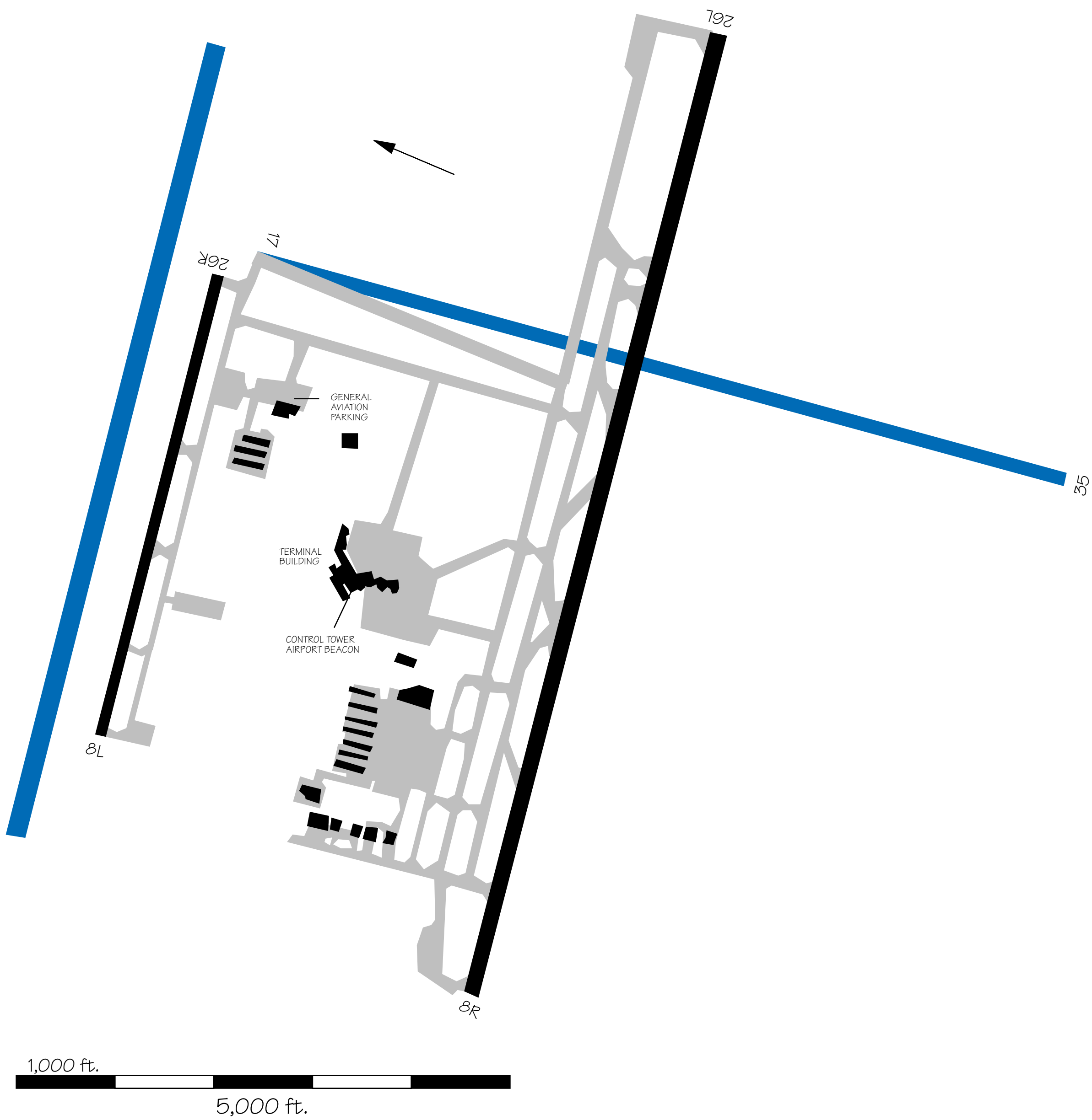
GEG — Spokane International Airport

Future projects include the construction of a new parallel Runway 3L/21R. The new runway will be 8,800 feet long by 150 feet wide and will be separated from Runway 3R/21L by 4,300 feet. This would enable independent parallel operations, doubling hourly IFR arrival capacity. The estimated cost of construction of the new runway is approximately $11 million. Construction could be started as early as 1999.



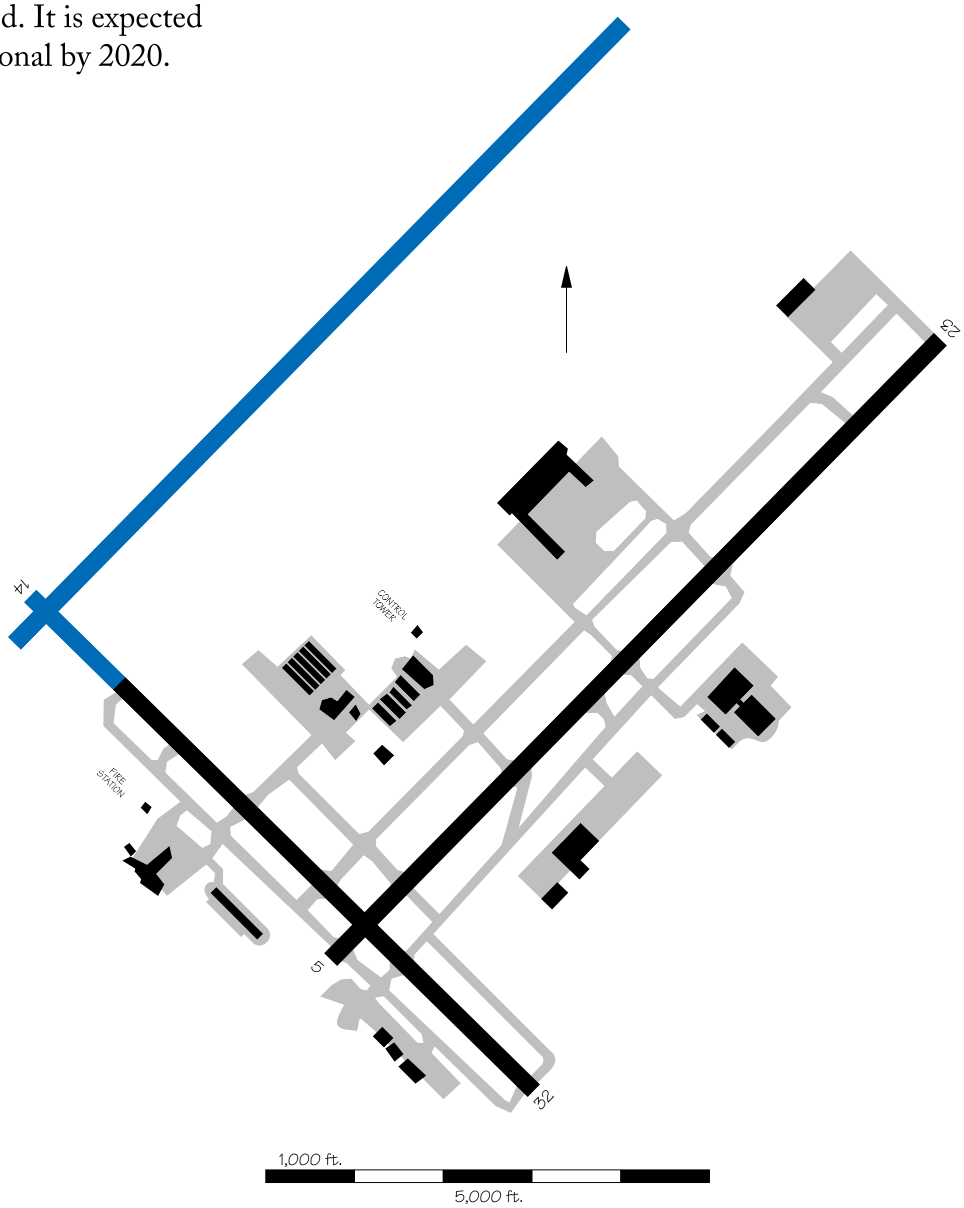
GRR — Grand Rapids Kent County International Airport

An extension to 8,500 feet and realignment for the cross-wind Runway 18/36 (17/35) is under construction. Estimated cost is $58 million. The runway will provide wind coverage, noise relief, and reduce winter weather related delays by providing a second air carrier runway. Construction is expected to be complete in 1997. A new 7,000 foot parallel Runway 8L/26R is planned for future development. The current 8L/26R would be converted into a taxiway at that time.



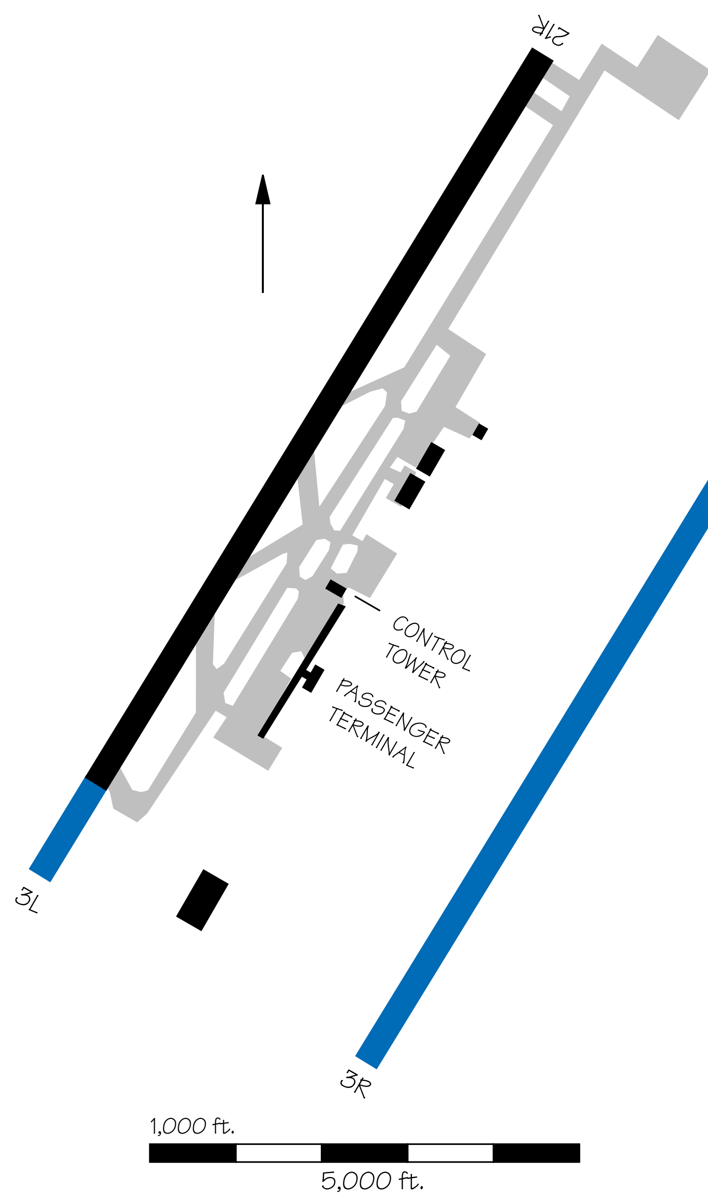
GSO — Greensboro Piedmont Triad International Airport

An extension of Runway 14/32 is planned. It is expected to be operational by 2005, at a cost of $15.7 million. Construction of a new parallel Runway 5L/23R, 5,300 feet north of Runway 5/23, is also being planned. It is expected to be operational by 2020.

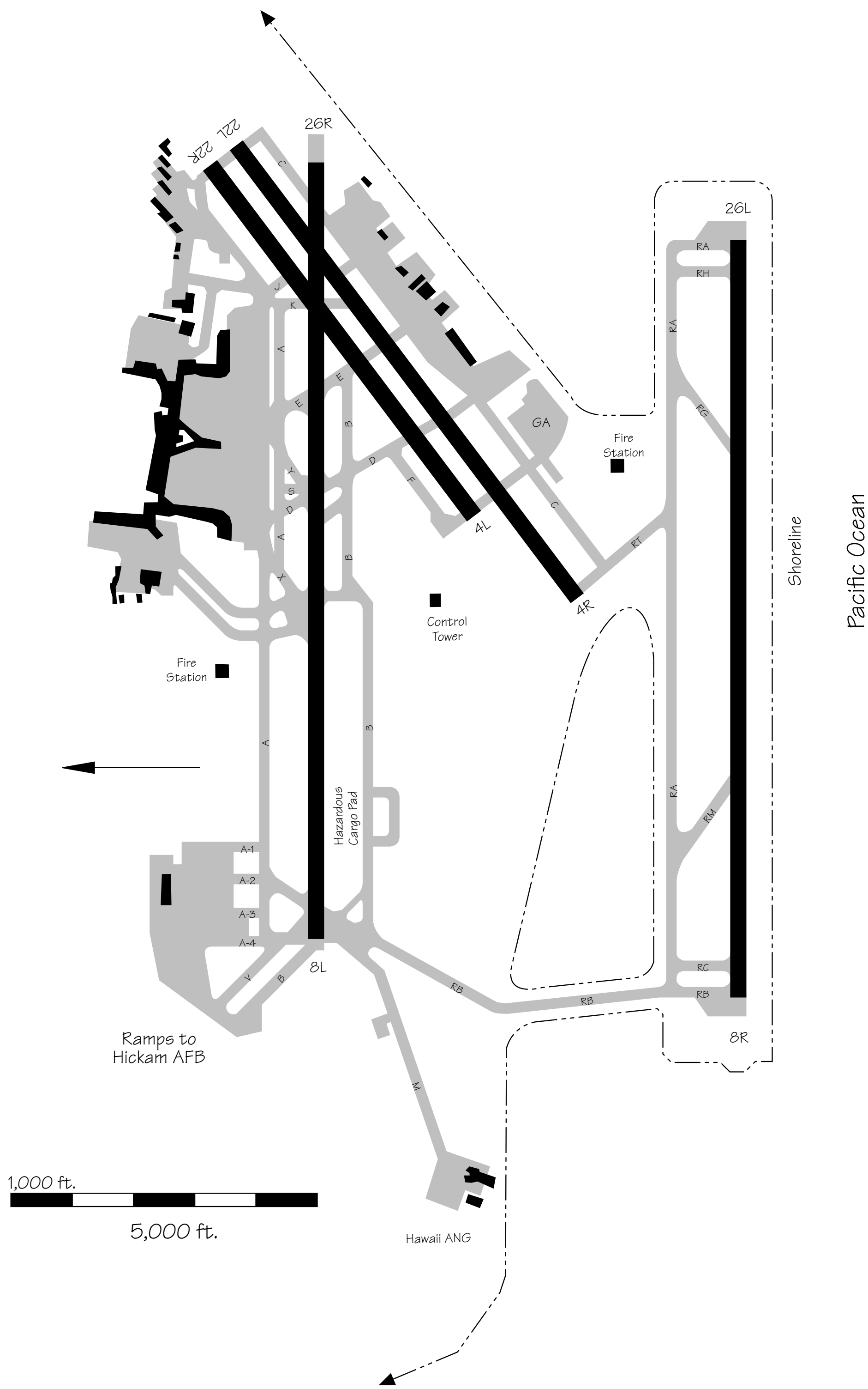


GSP — Greer Greenville-Spartanburg Airport

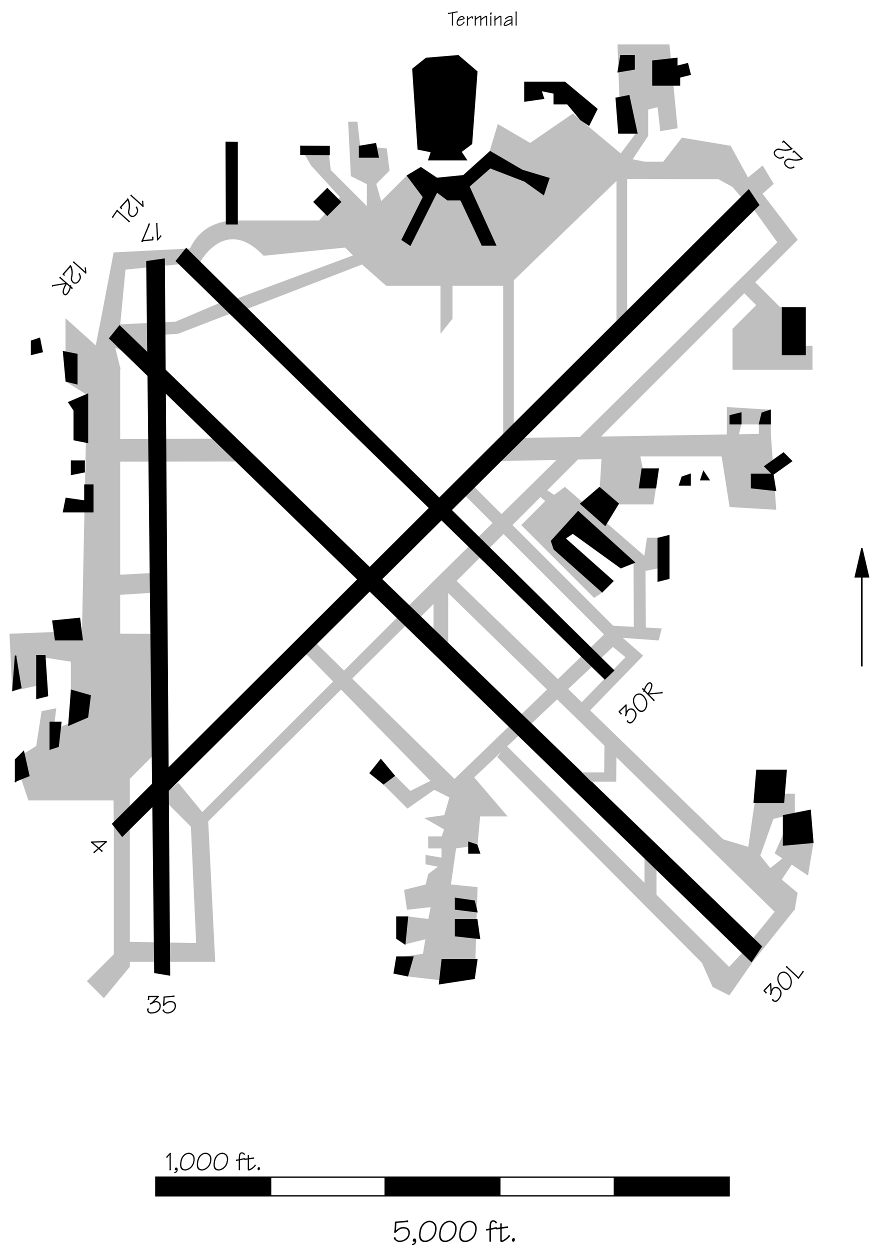
A new parallel runway, Runway 3R/21L, is anticipated in 2015 at an estimated cost of $50 million. Presently, its planned length is 10,000 feet with a 4,350 foot separation from Runway 3/21. This would potentially double hourly IFR arrival capacity Also, an extension of Runway 3L/21R to 12,200 feet is planned. Construction to 11,000 ft is expected to be completed by 1999 at a cost of $34.1 million.



HNL — Honolulu International Airport

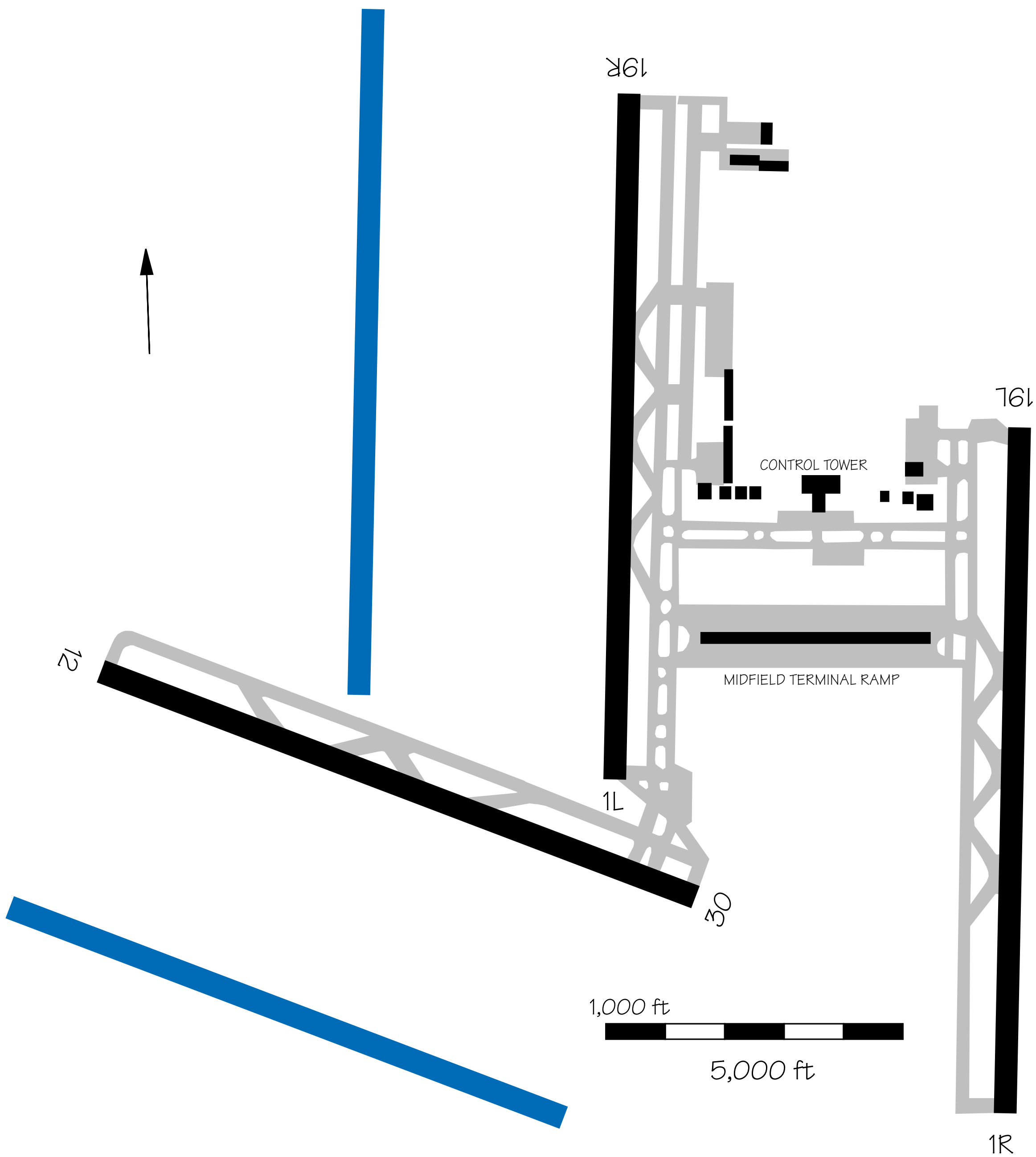


HOU — Houston William P. Hobby Airport



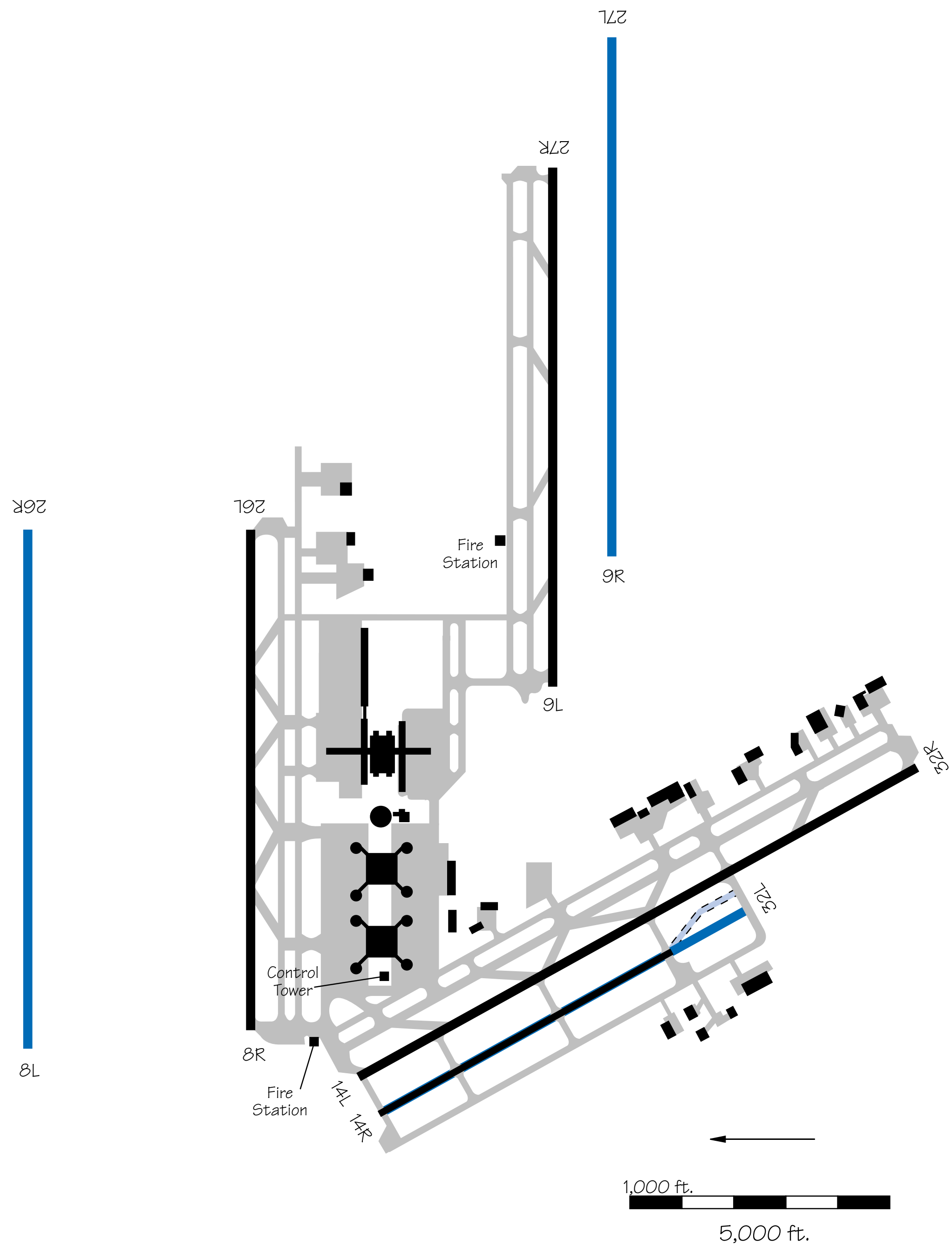
IAD — Washington Dulles International Airport

Two new parallel runways are under consideration. A north-south parallel, Runway 1W/19W, would be located 4,300 feet west of the existing parallels and north of Runway 12/30. Estimated opening data is 2009. This could provide triple independent parallel approaches, if they are approved. A second parallel Runway 12R/30L has been proposed for location 4,300 feet southwest of Runway 12/30. The runway is expected to be completed by 2010.

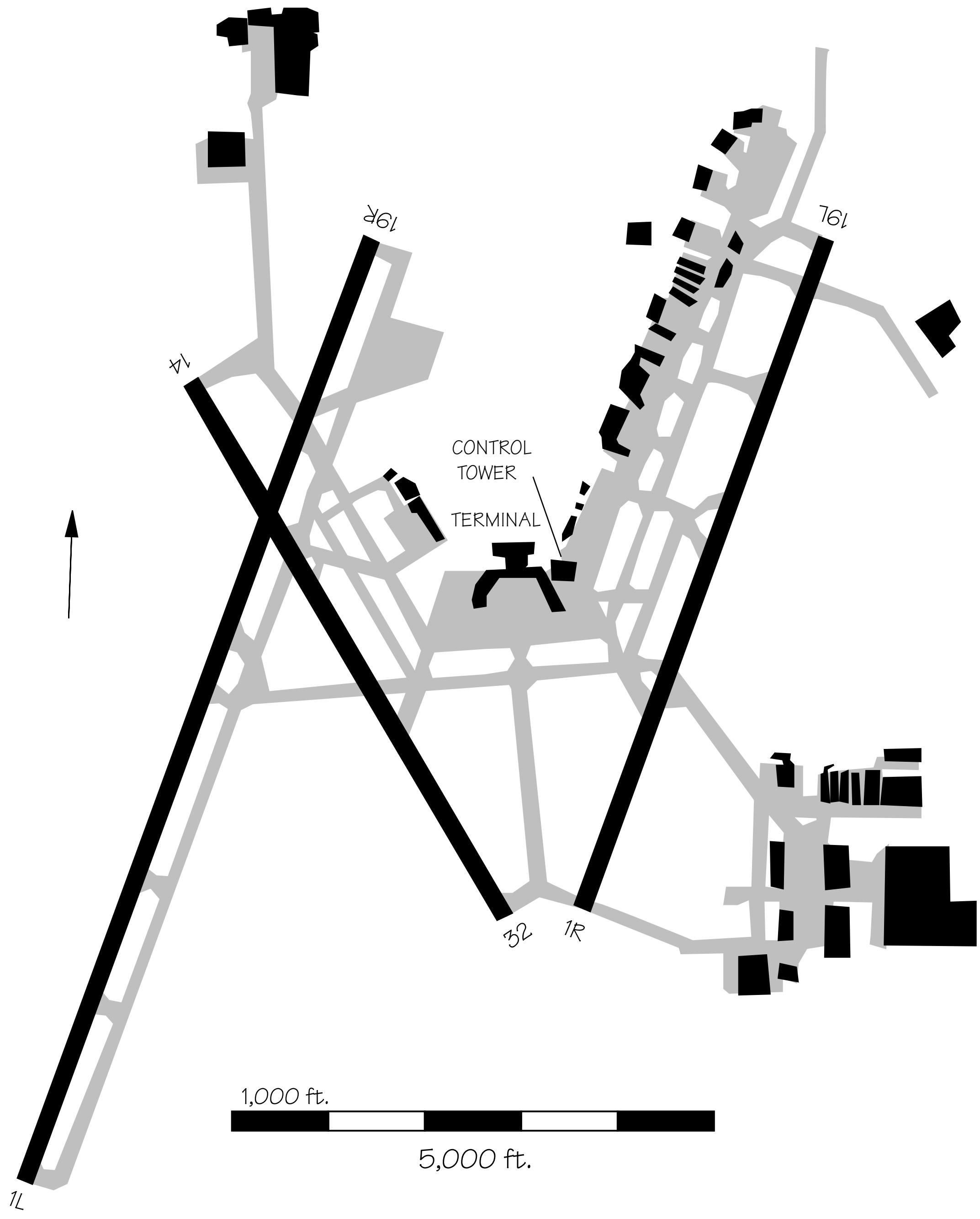


IAH — Houston Intercontinental Airport

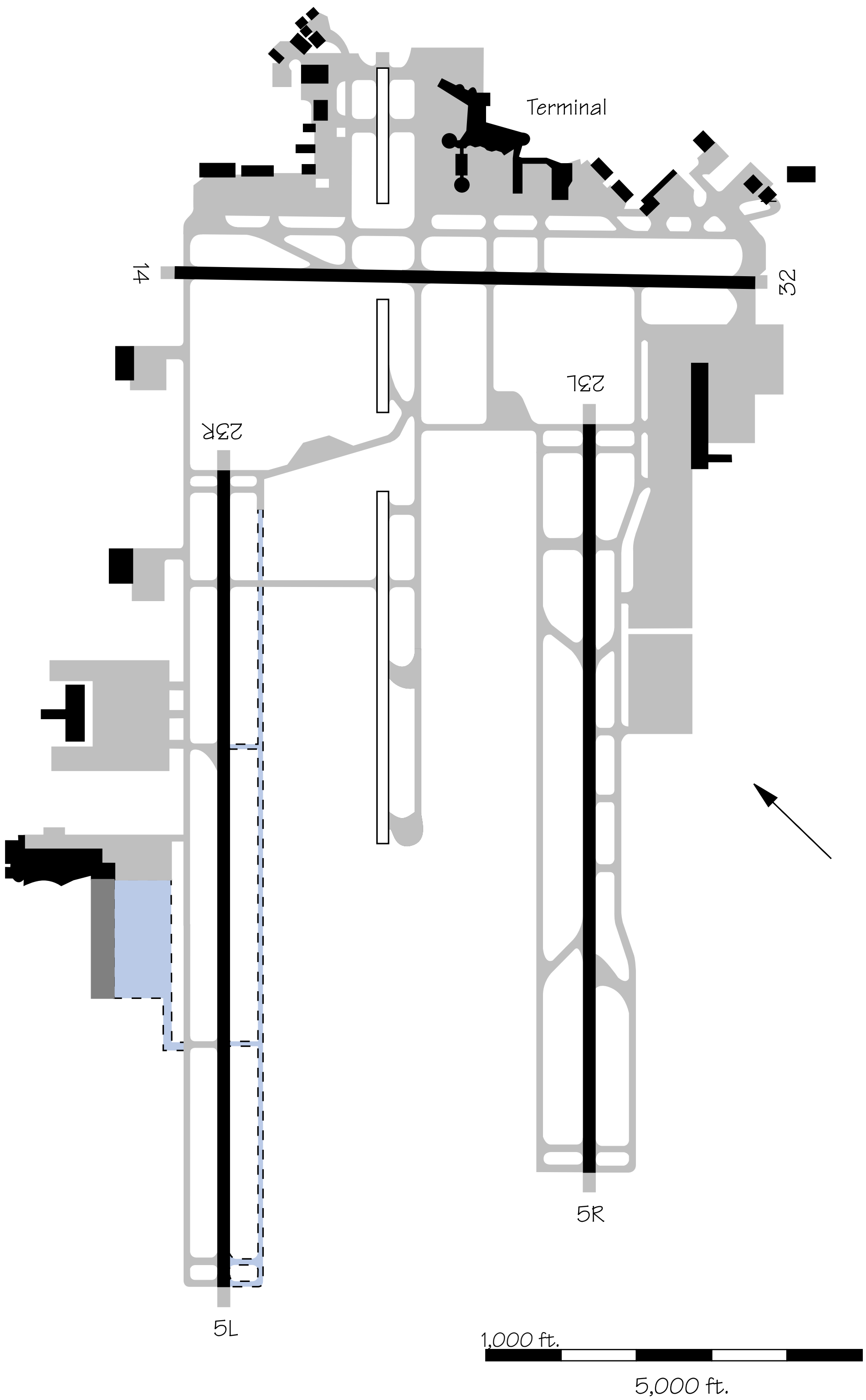
An $8 million 2,000-foot extension to Runway 14R/32L is planned. A new Runway 8L/26R is planned to be parallel to and north of the existing Runway 8/26. Runway 8L/26R, in conjunction with Runways 9/27 and 8/26, has the potential to support triple IFR approaches, if approved. Another new runway, parallel to and south of Runway 9/27, is also planned. Construction is expected to cost $44 million for each new runway.



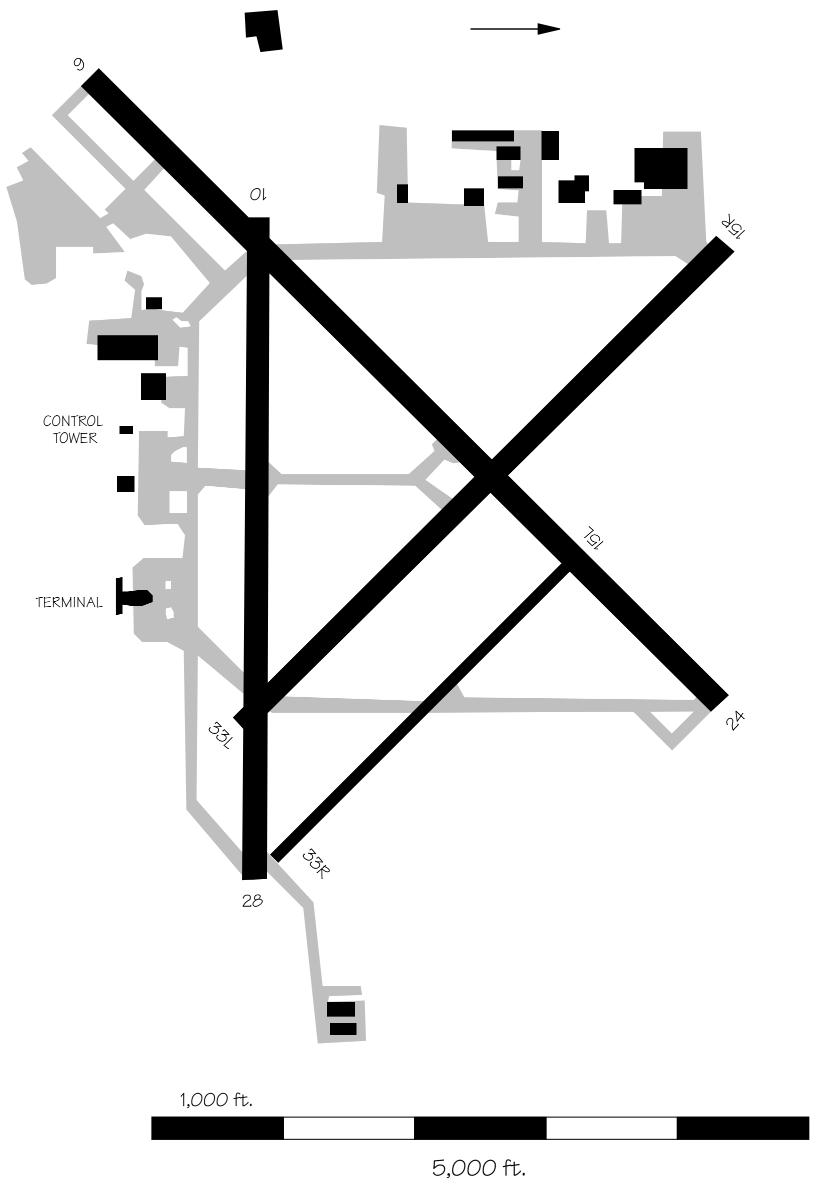
ICT — Wichita Mid-Continent Airport



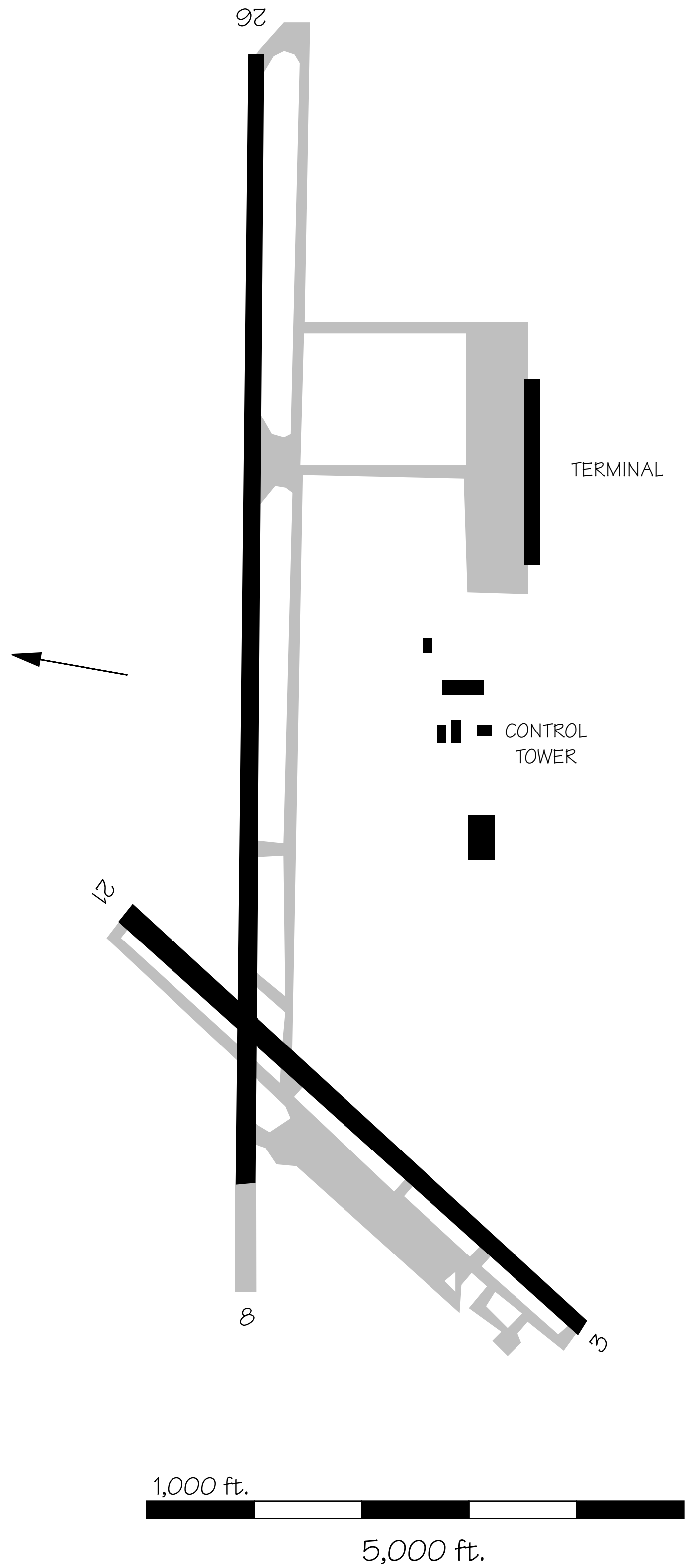
IND — Indianapolis International Airport



ISP — Islip Long Island Mac Arthur Airport

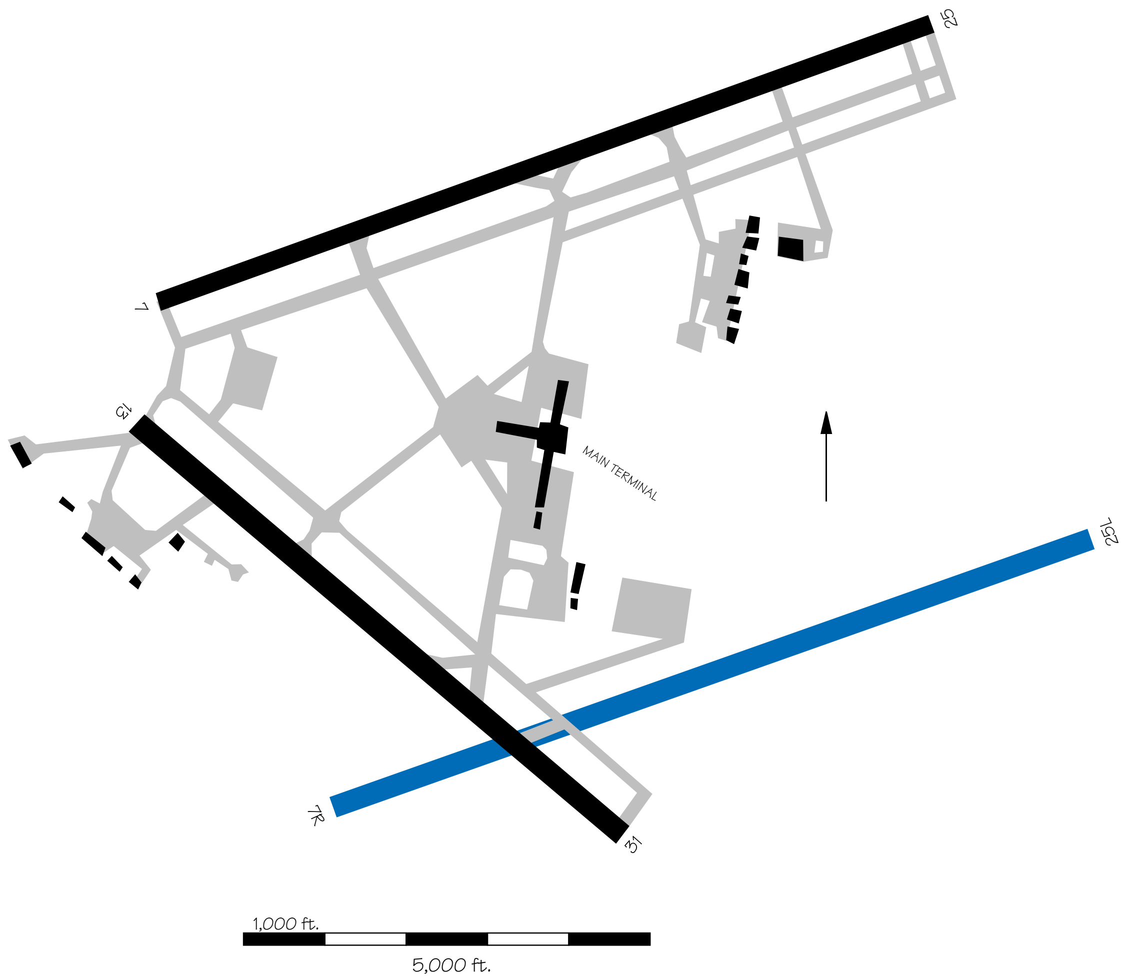


ITO — Hilo International Airport

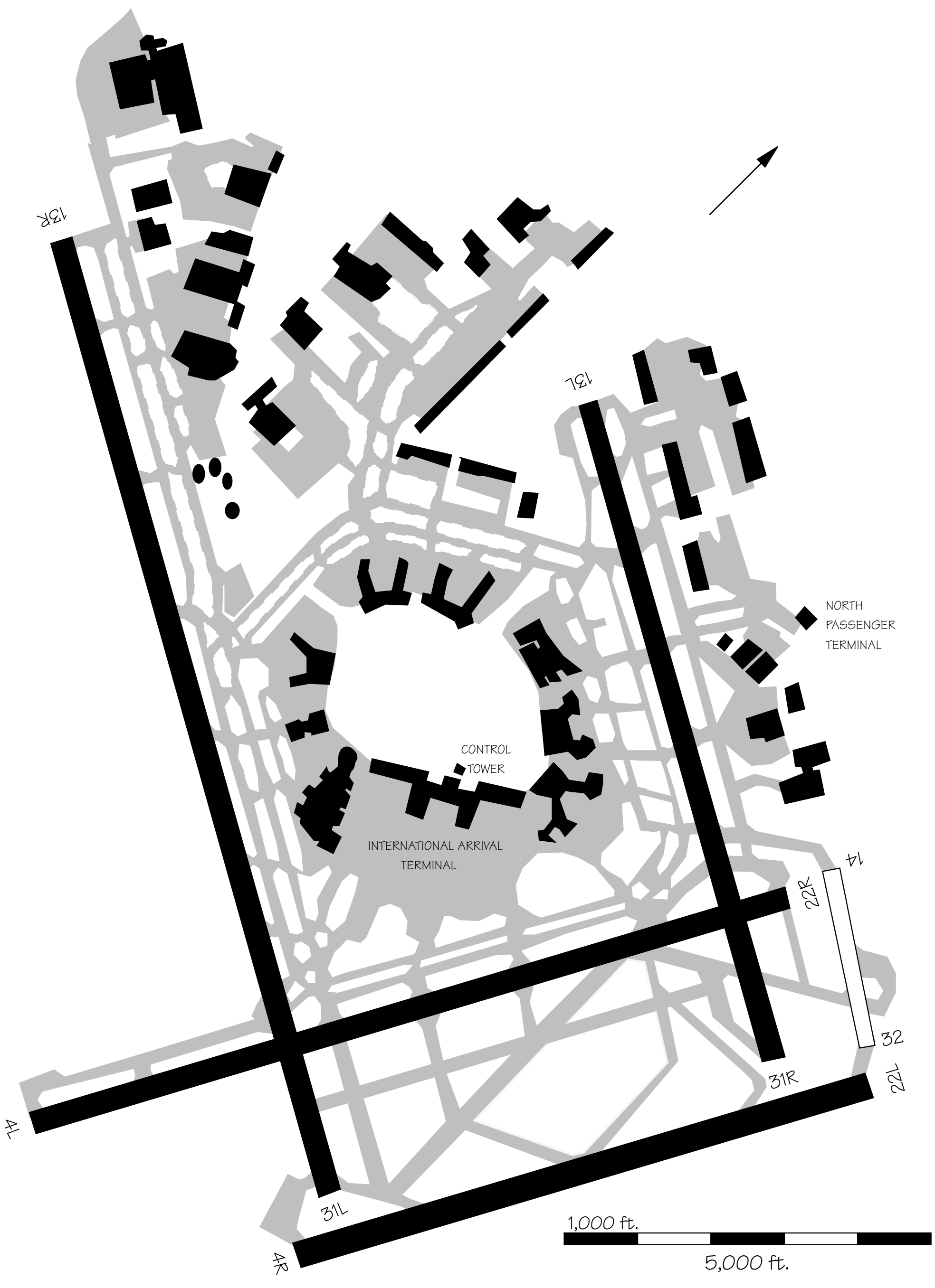


JAX — Jacksonville International Airport

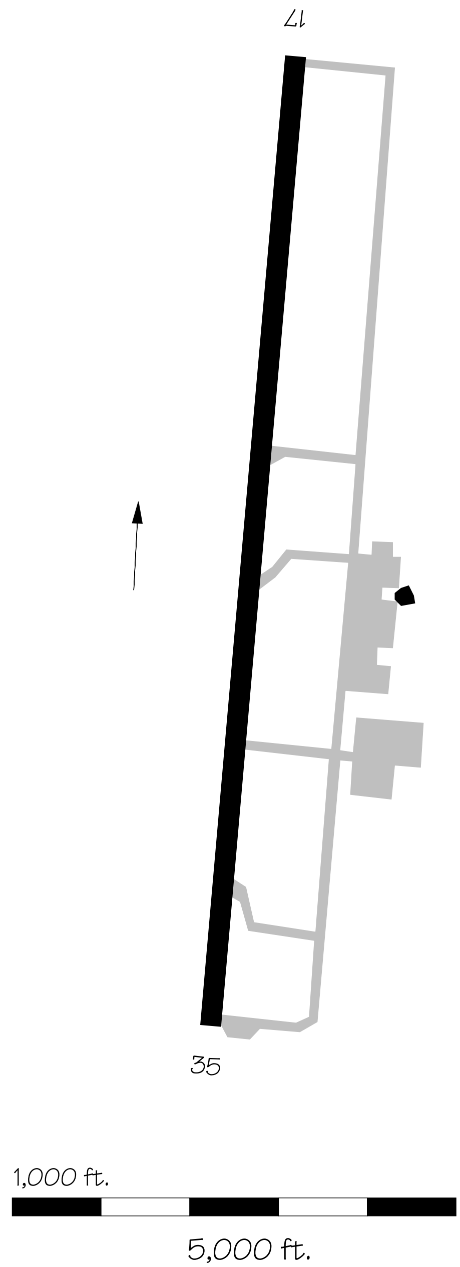
A new parallel Runway 7R/25L is being planned. It will be 6,500 feet south of the existing Runway 7/25, permitting independent parallel IFR operations and potentially doubling Jacksonville's hourly IFR arrival capacity. Construction is scheduled to begin in 2005, with completion expected in 2006. Estimated cost of construction is $50 million.



JFK — New York John F. Kennedy International Airport

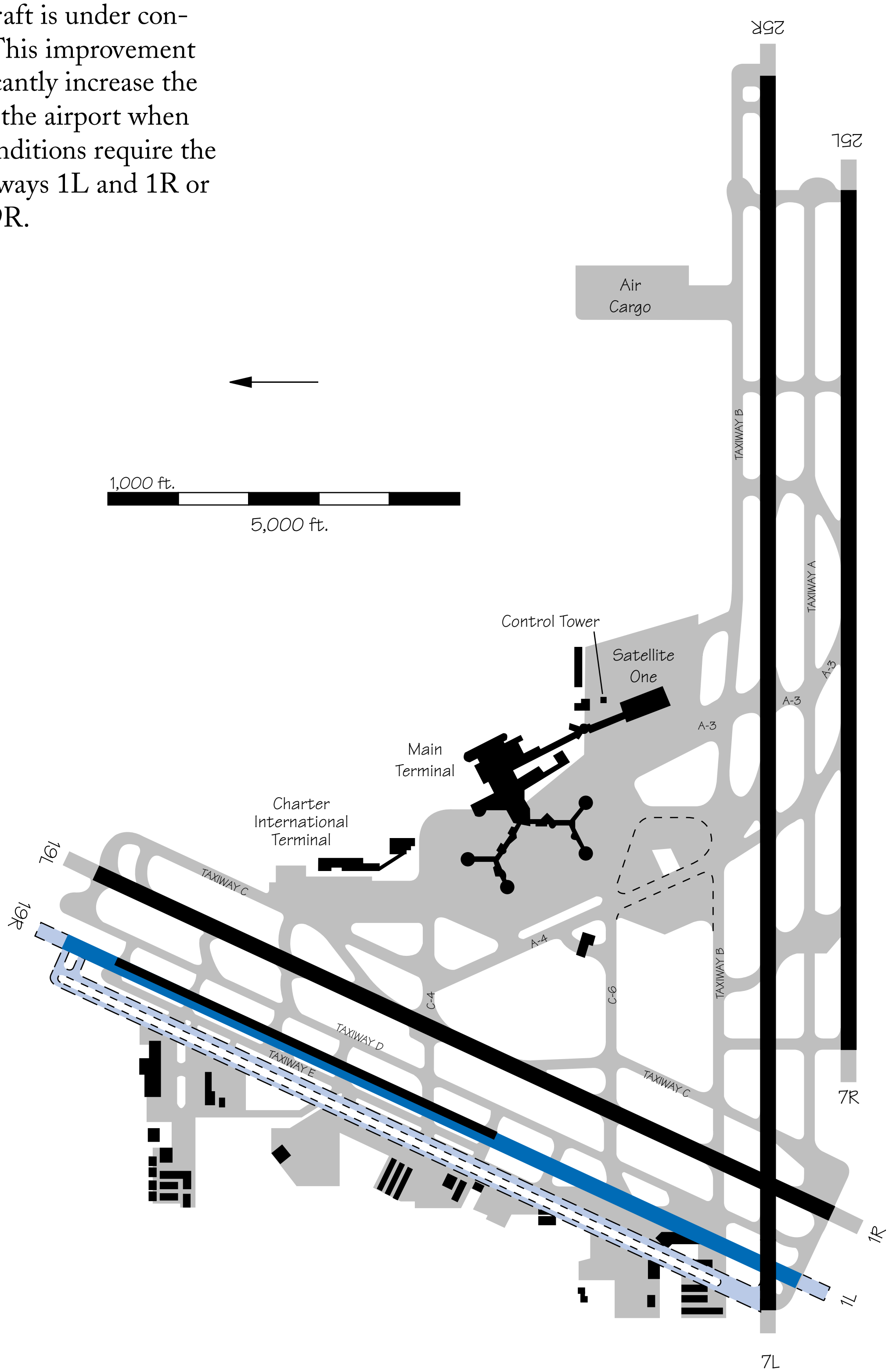


KOA — Kailua-Kona Keahole

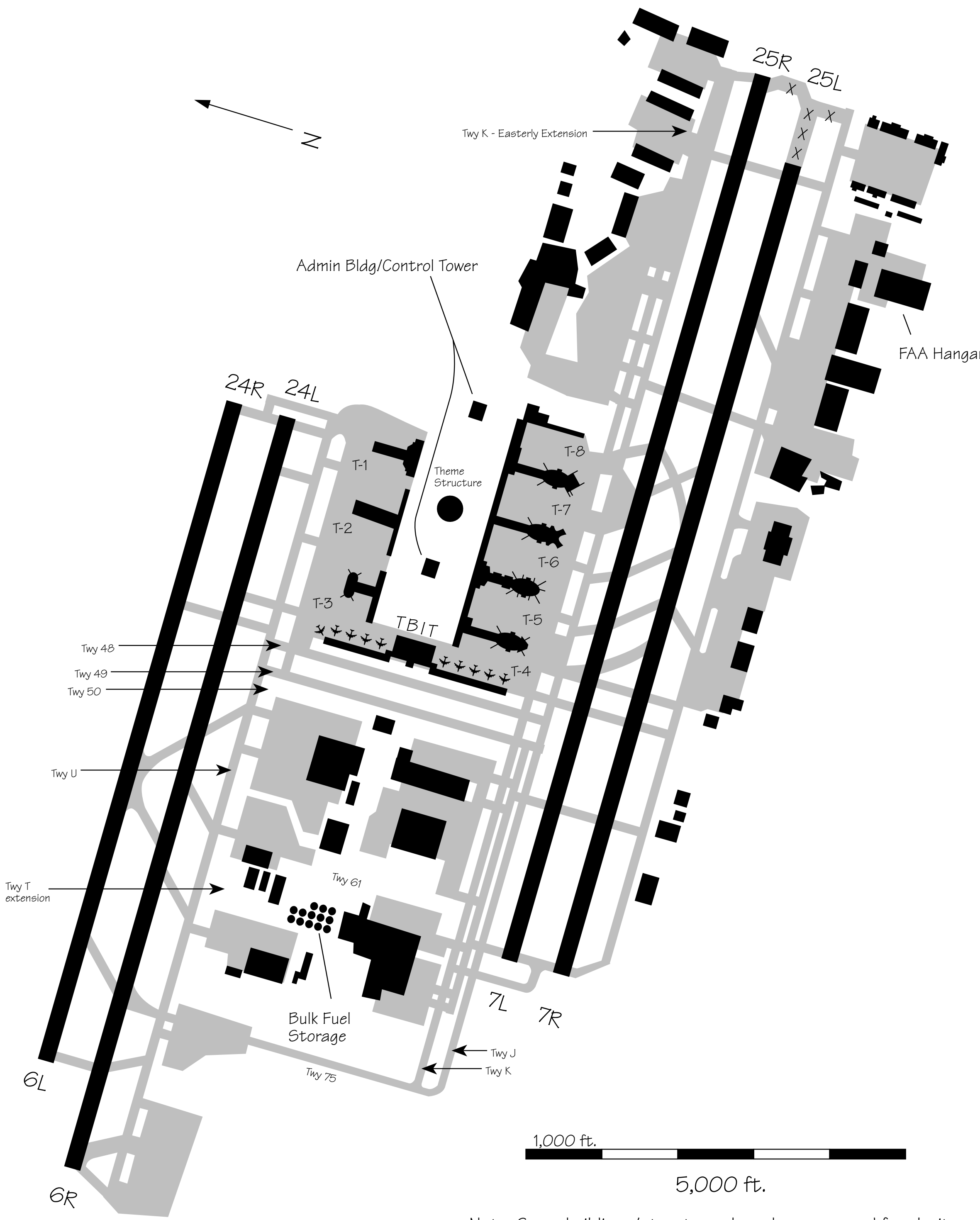


LAS — Las Vegas McCarran International Airport

An upgrade of Runway 1L/19R to accommodate air carrier aircraft is under construction. This improvement will significantly increase the capacity of the airport when weather conditions require the use of Runways 1L and 1R or 19L and 19R.



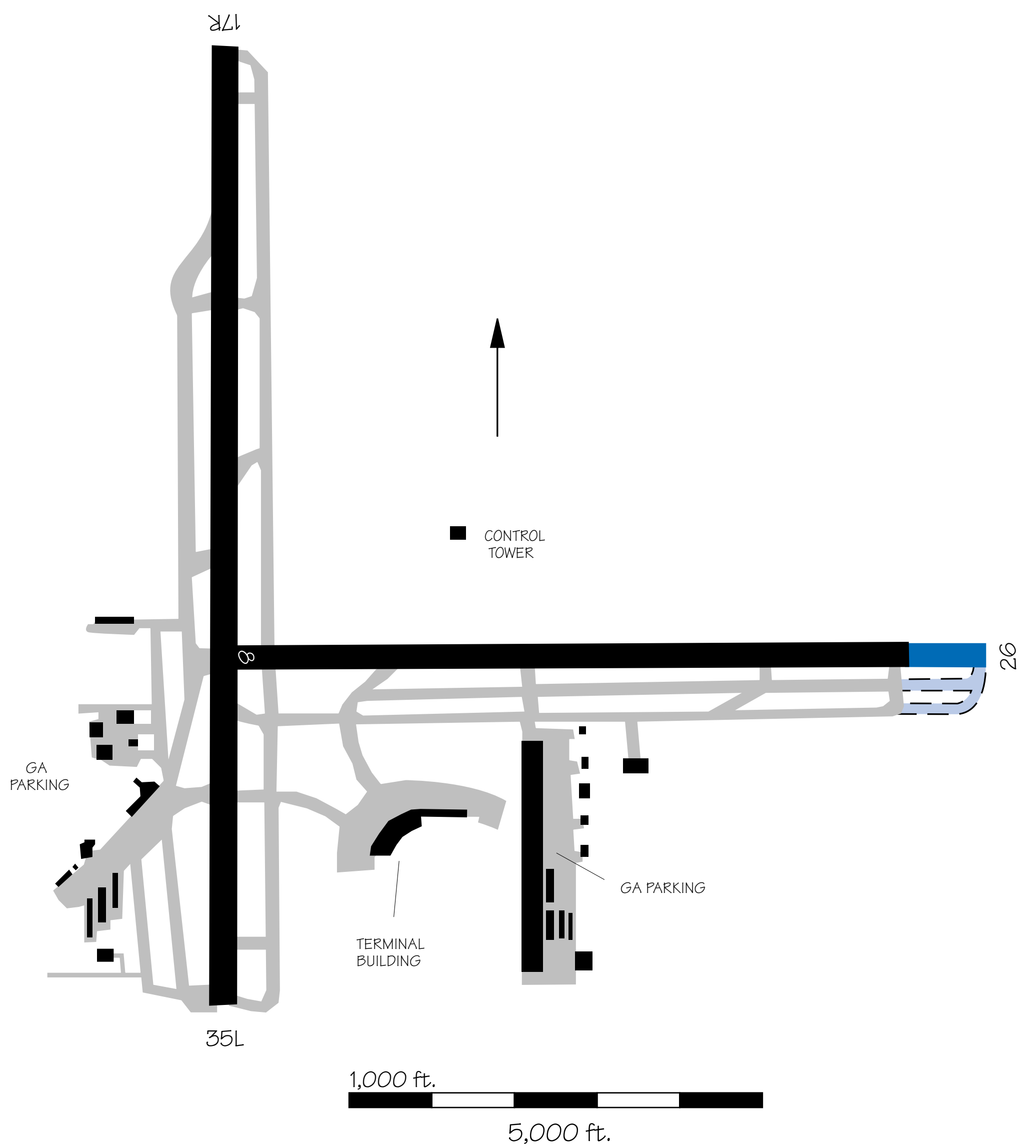
LAX — Los Angeles International Airport



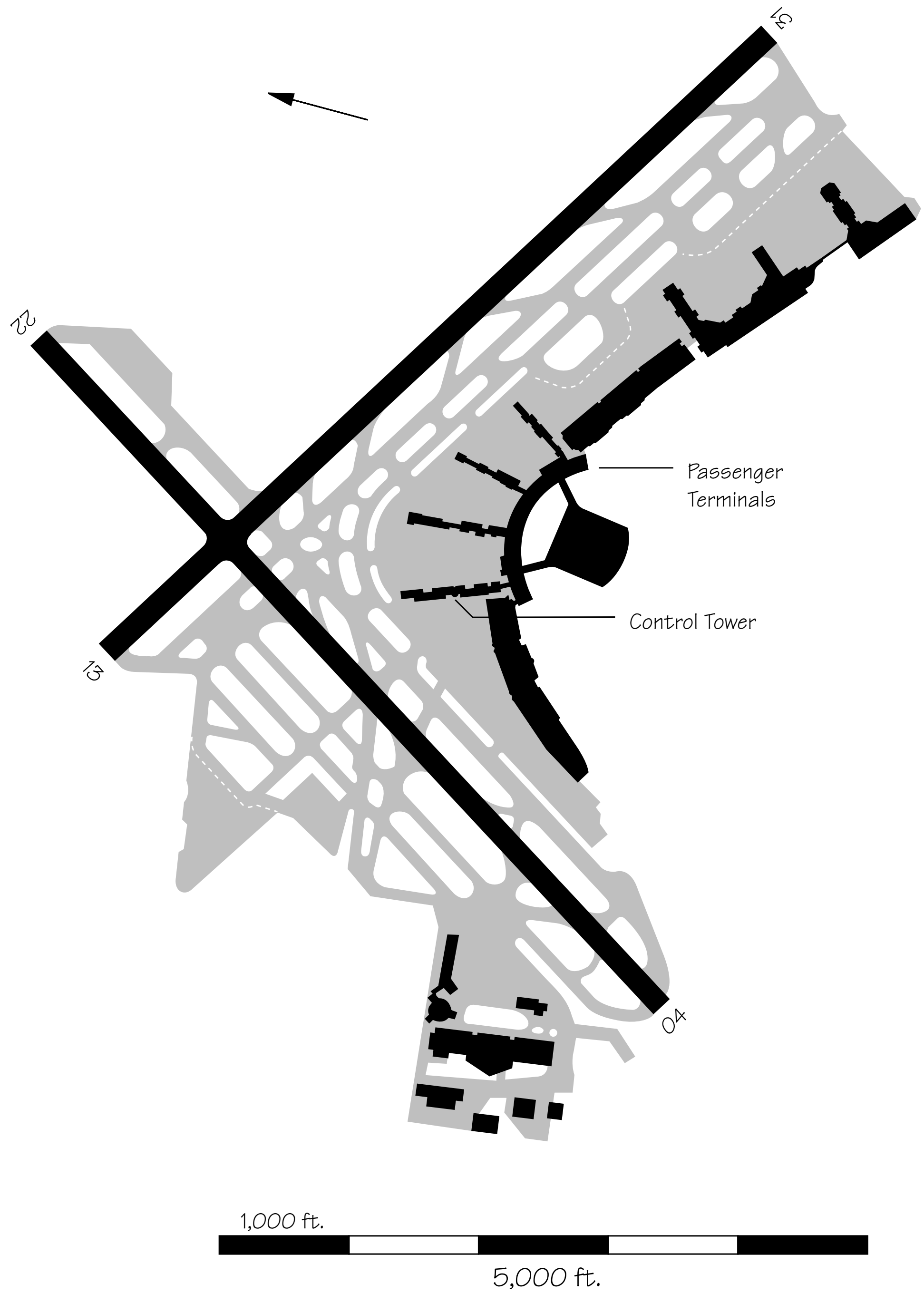
Note: Some buildings/structures have been removed for clarity.

LBB — Lubbock International Airport

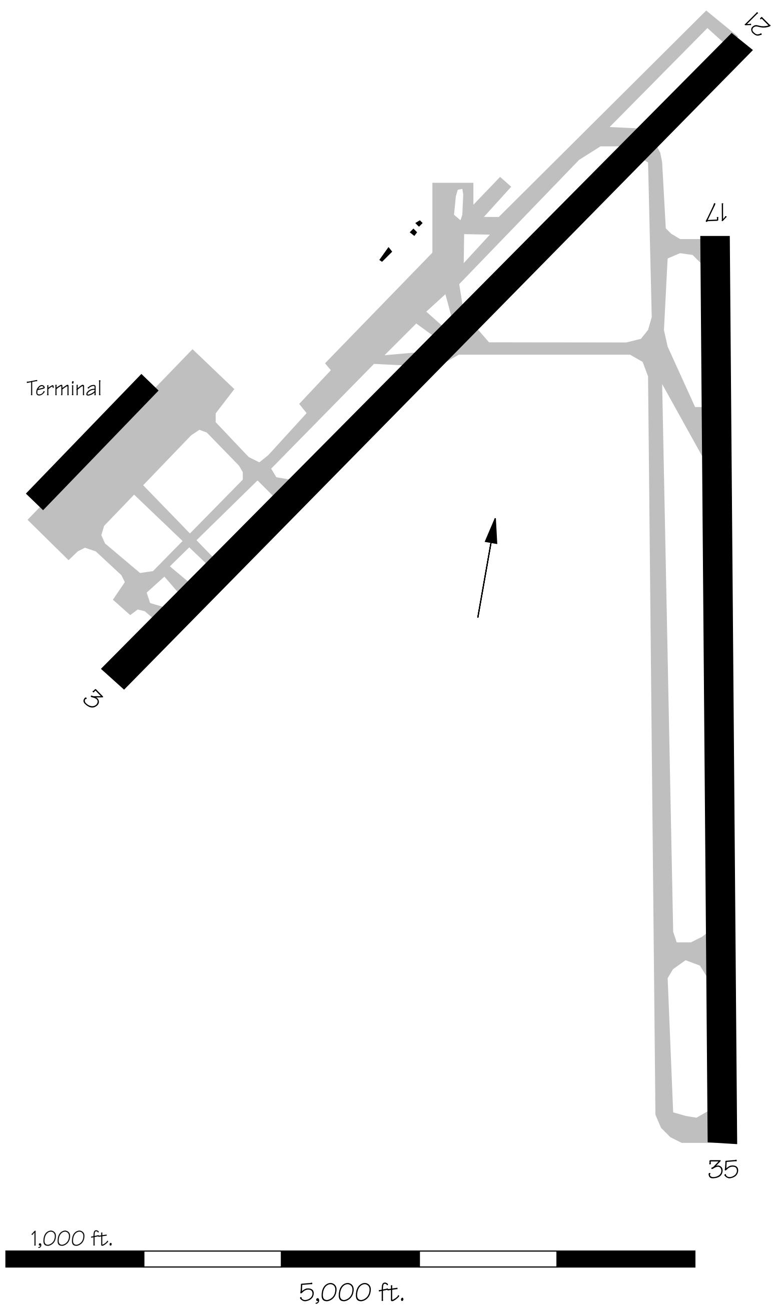
An extension to Runway 8/26 is planned. The start of construction is scheduled for 2004 and the estimated cost is $5 million. It is anticipated that the extension will be operational in 2005.



LGA — New York LaGuardia Airport

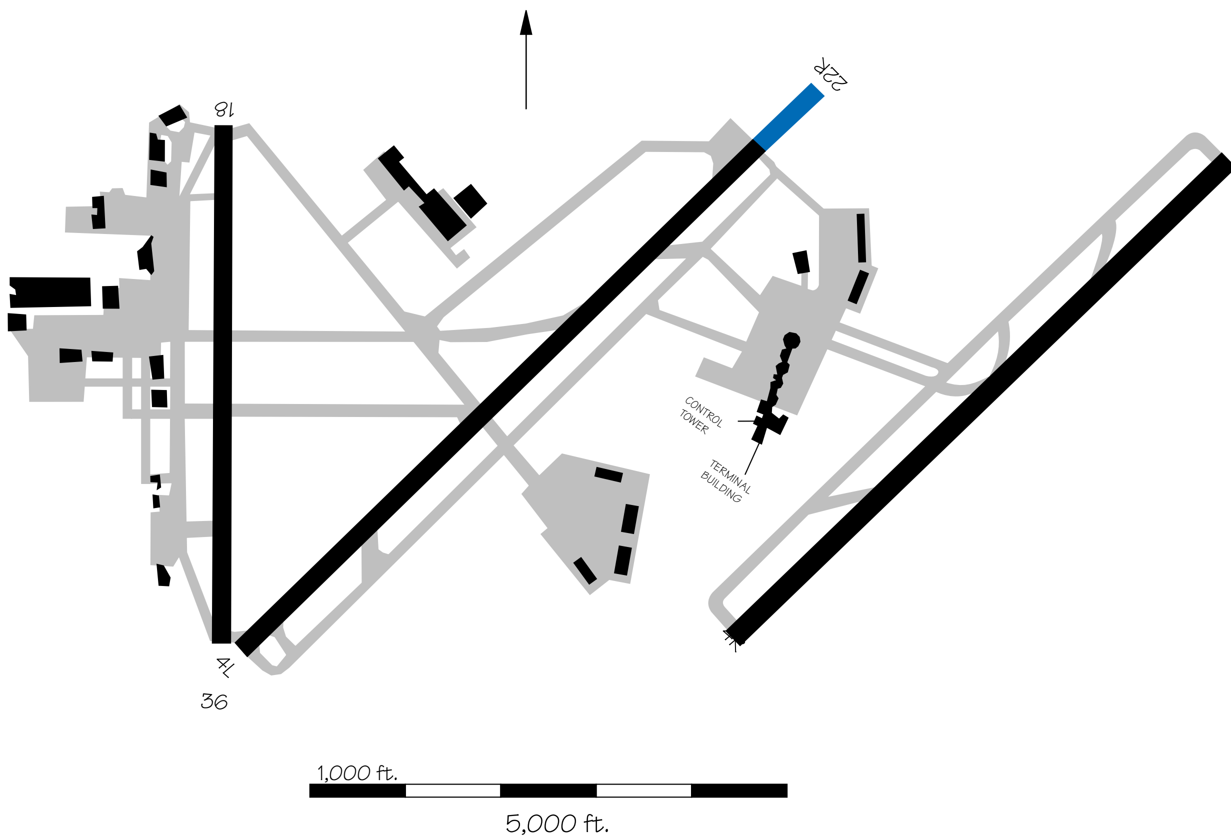


LIH — Lihue Airport



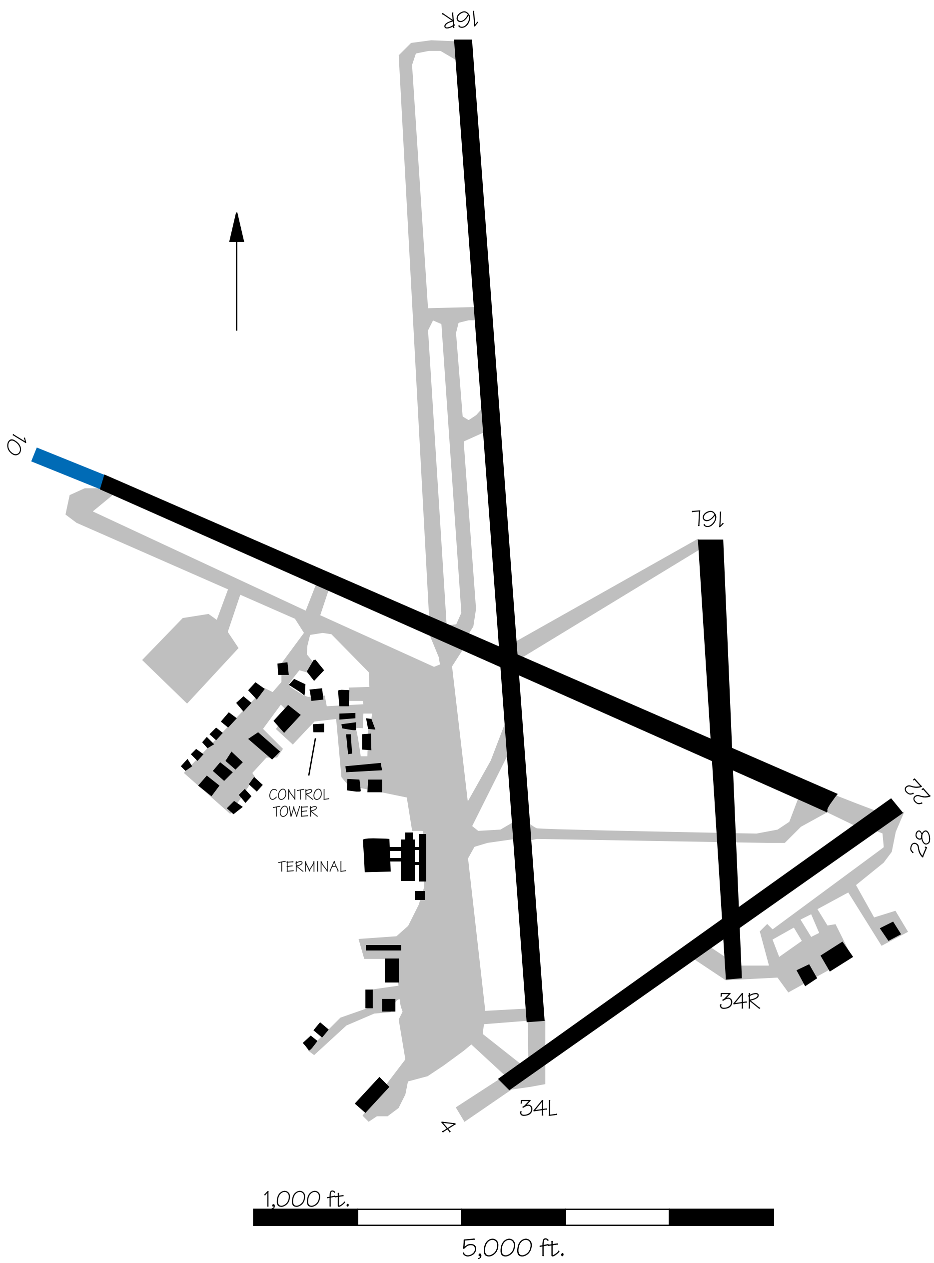
LIT — Little Rock Adams Field

An extension of Runway 4L/22R is underway, and should be operational in early 1998. The estimated cost of construction is $31 million.



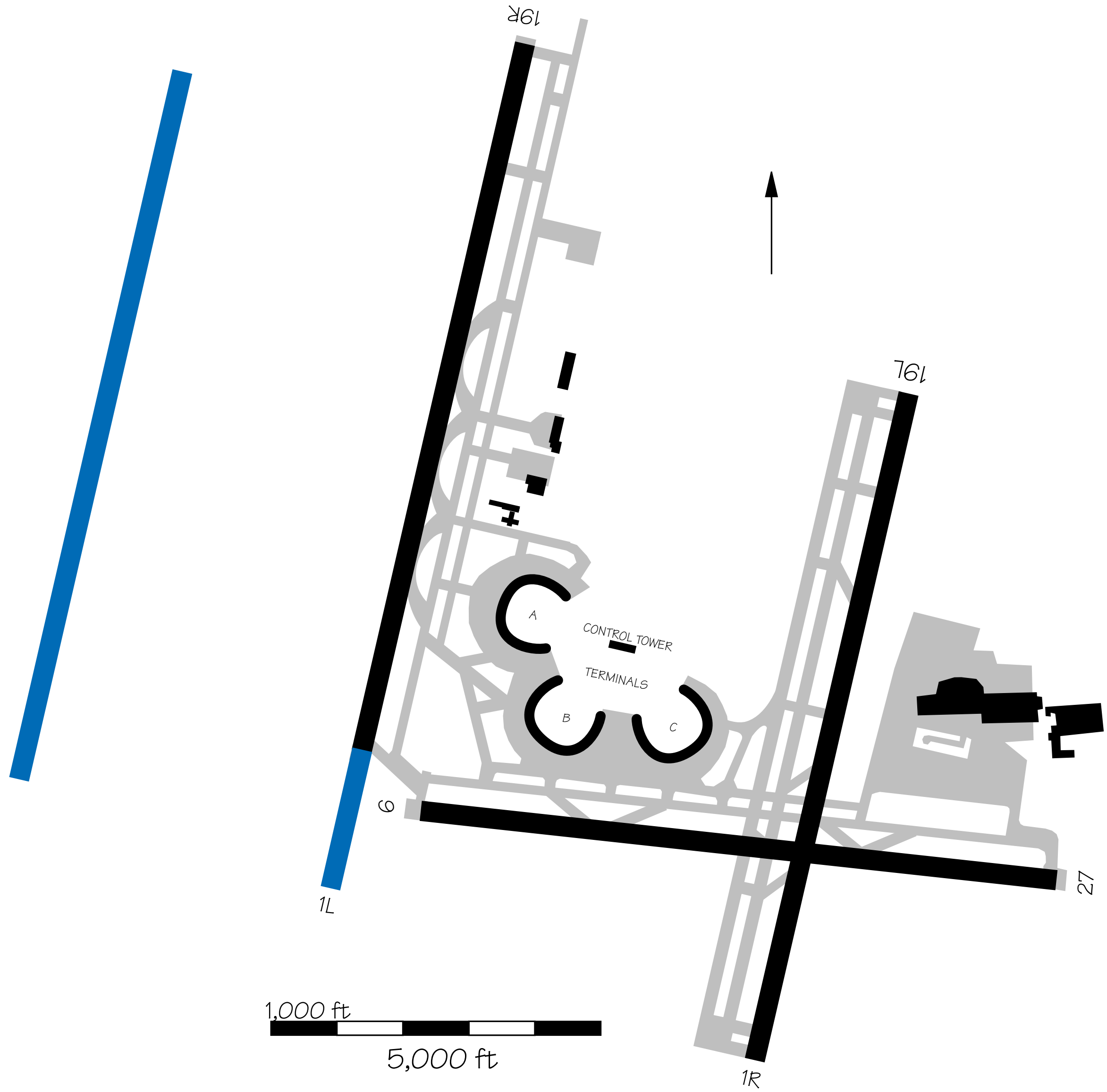
MAF — Midland International Airport

An extension to Runway 10/28 is planned, and construction is scheduled to begin in 2007.



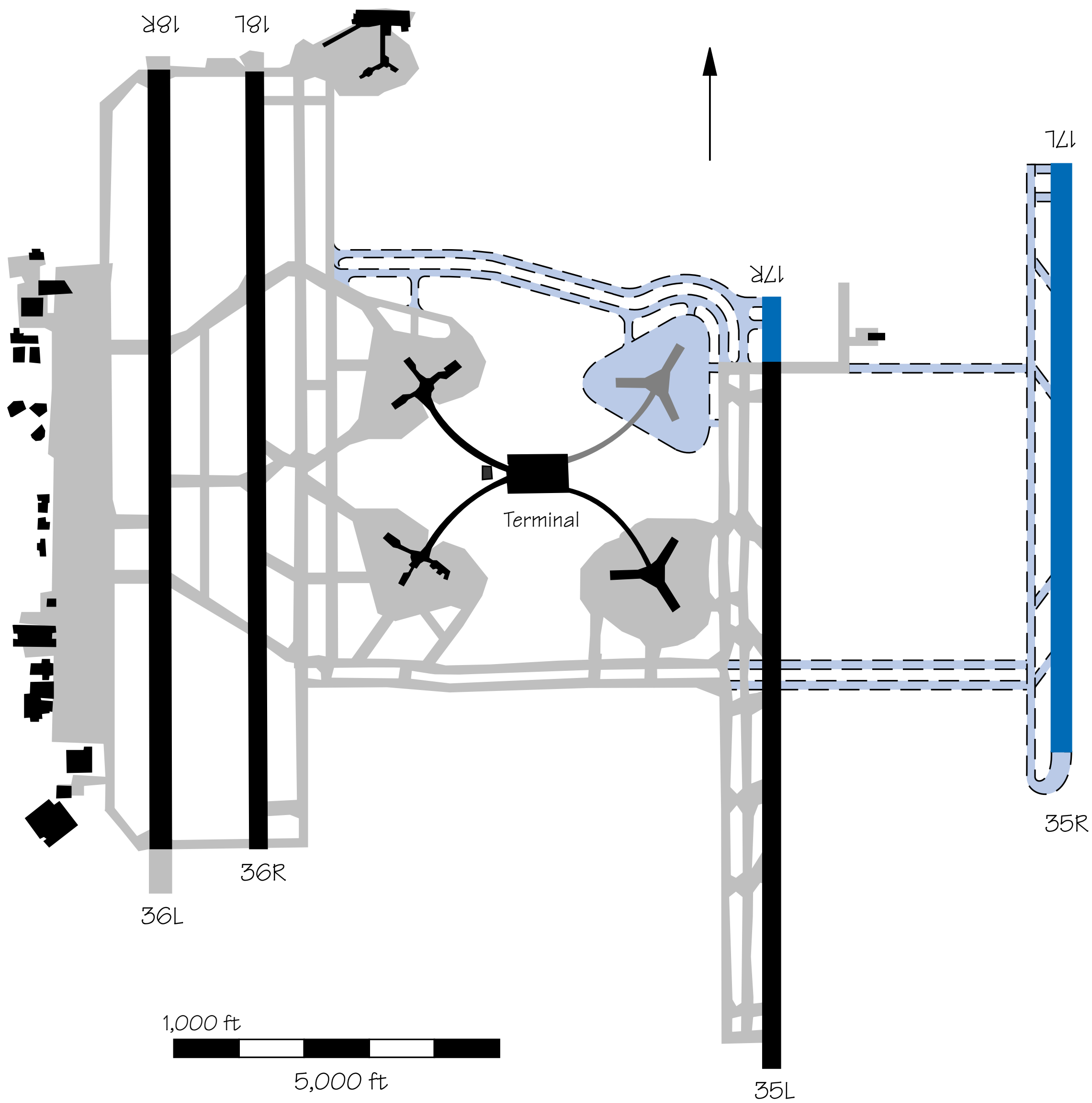
MCI — Kansas City International Airport

In accordance with the Airport Master Plan, an extension of Runway 1L/19R is currently planned. One additional parallel runway west of the existing north-south runway isbeing considered.

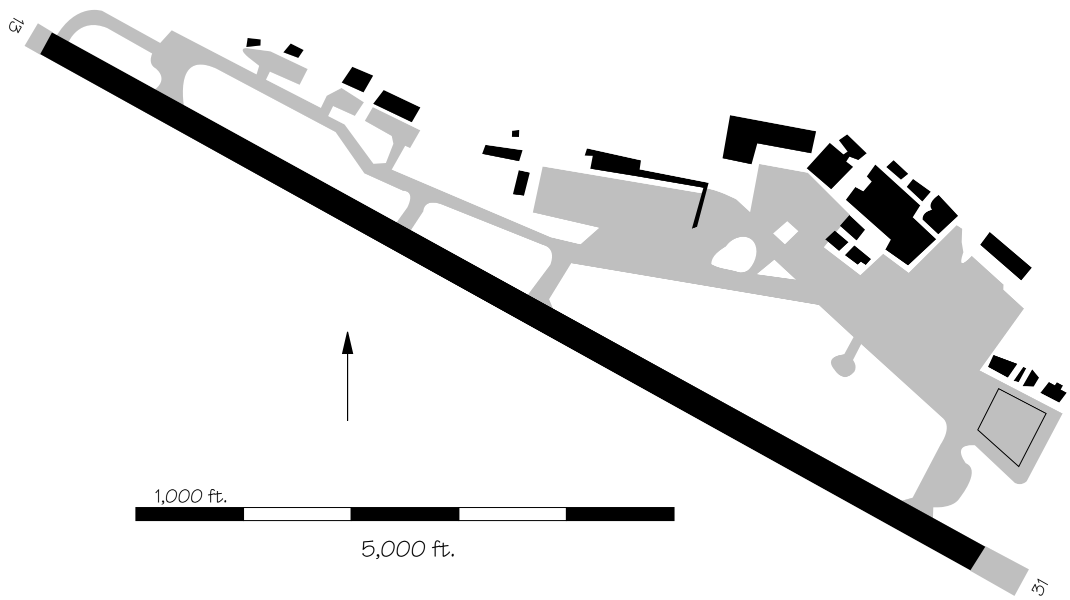


MCO — Orlando International Airport

Environmental mitigation for a fourth north-south runway, Runway 17L/35R, began October 10, 1990. The runway is expected to be operational in 2002. It will be located 4,300 feet east of Runway 17R/35L. This may permit triple independent IFR operations. The estimated cost of construction of this runway is $137 million. Also planned is a 1,000 ft. extension to Runway 17R/35L.

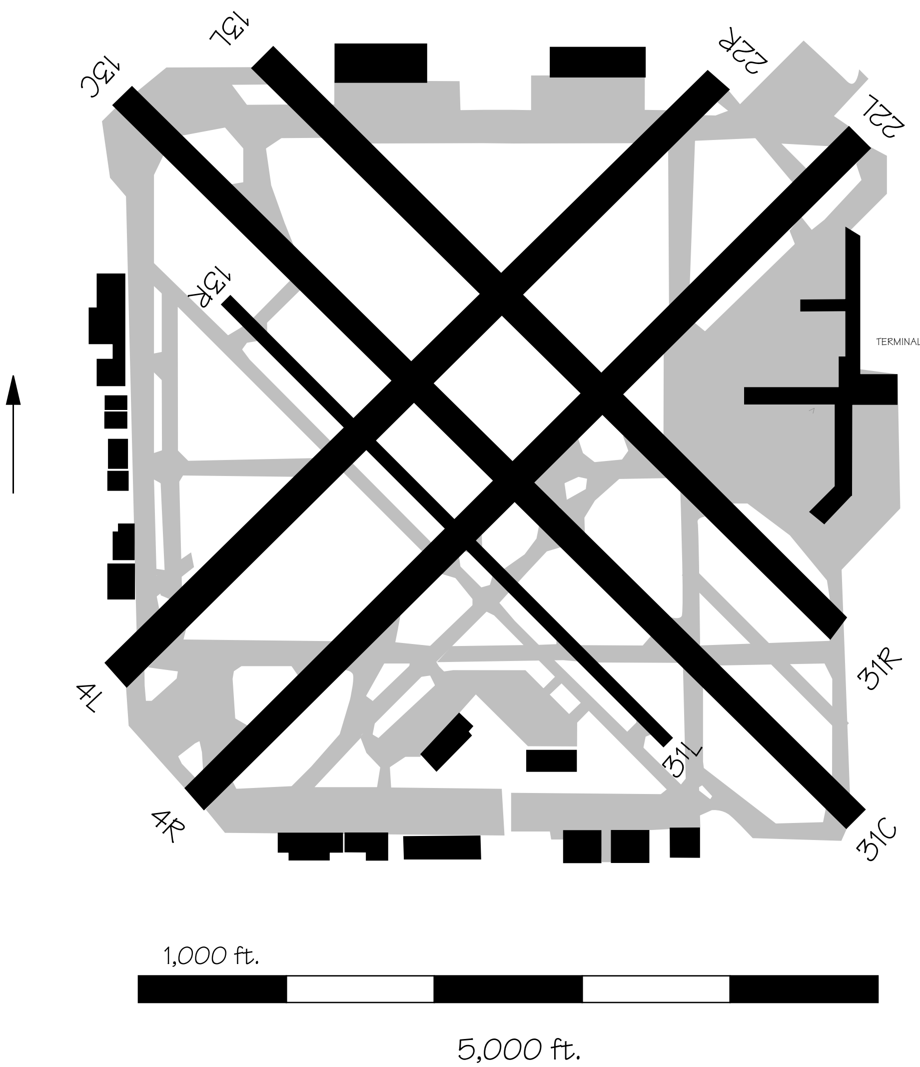


MDT — Harrisburg International Airport



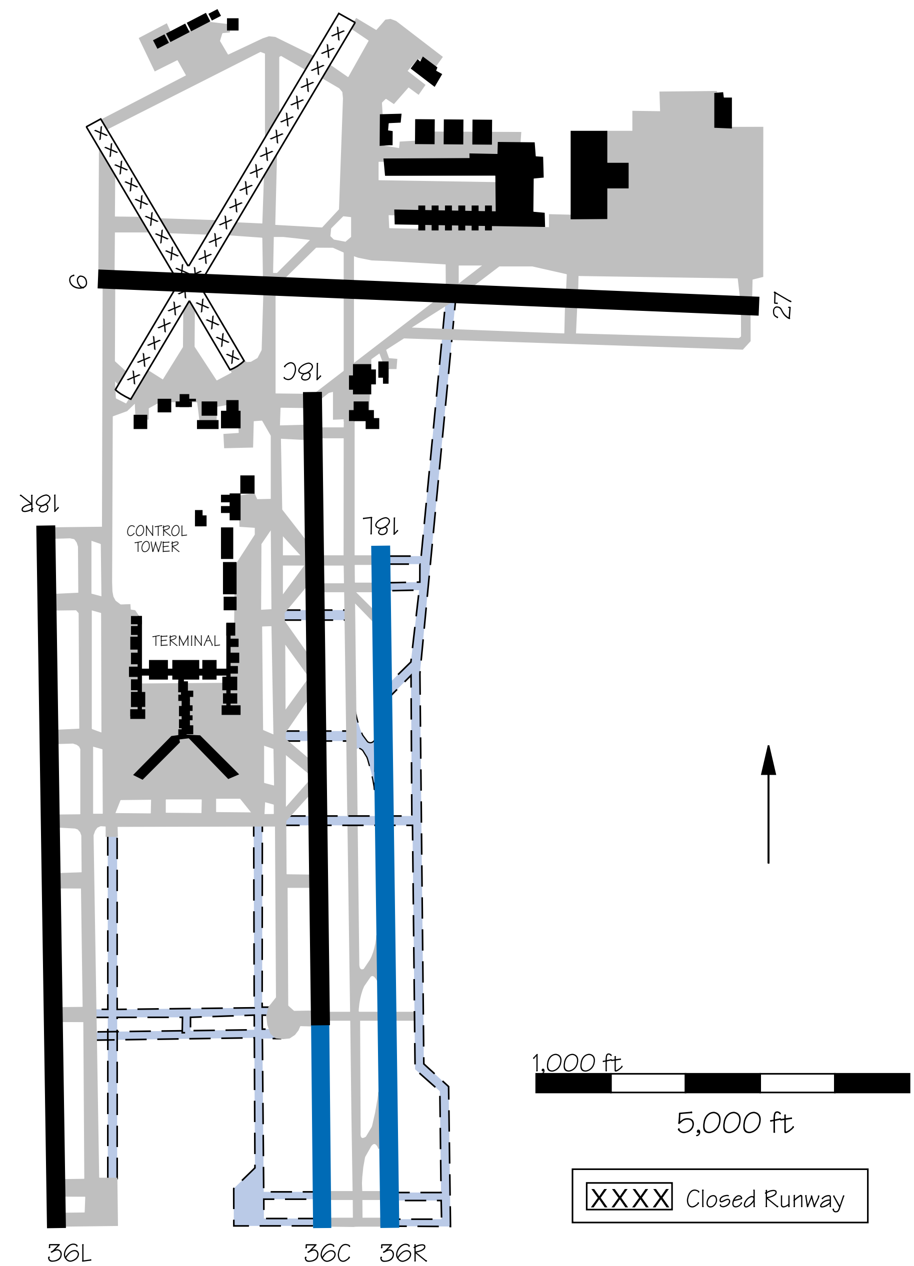
MDW — Chicago Midway Airport

Reconstruction of Runway 4R/22L is scheduled to start in 1997, with a projected cost of $32 million. The project is expected to be completed that same year.



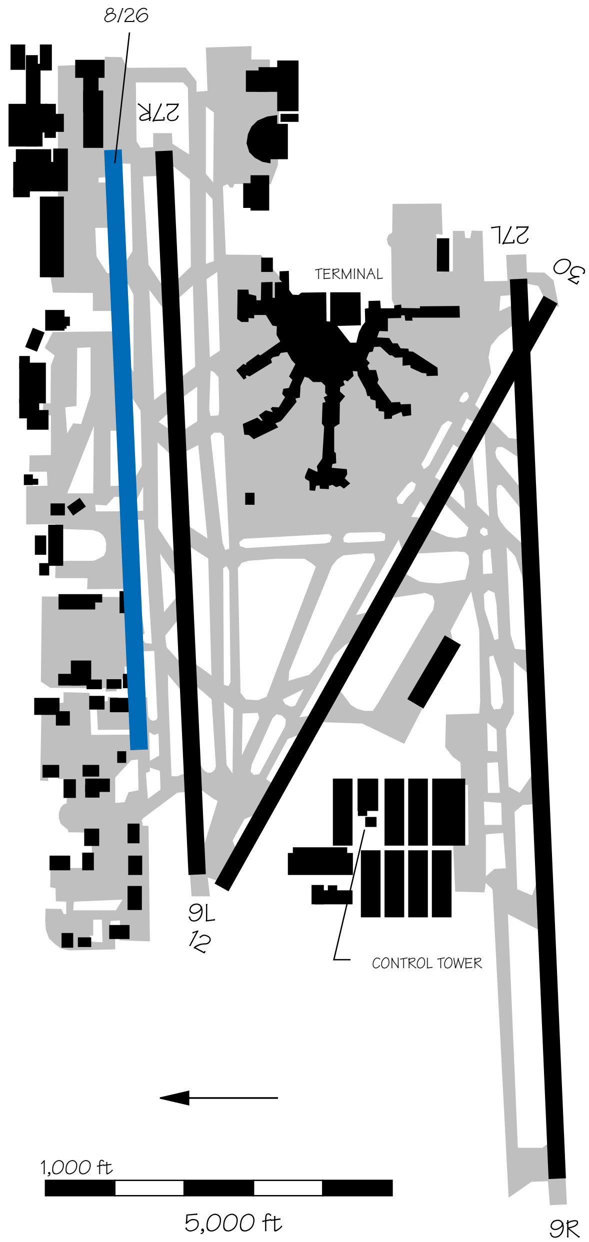
MEM — Memphis International Airport

Construction of a new north-south parallel Runway 18L/36R began in 1993. It will be located about 900 feet east of Runway 18C/36C (old 18L/36R) and 4,300 feet from Runway 18R/36L, thus allowing independent parallel approaches. This will increase present hourly IFR arrival capacity by about 33 percent. The new runway will be operational in early 1997. The estimated cost is $146.1 million. A reconstruction and extension of Runway 18C/36C is also planned. Construction is expected to start in 1997 and be completed by 1999 at a cost of $94.6 million.



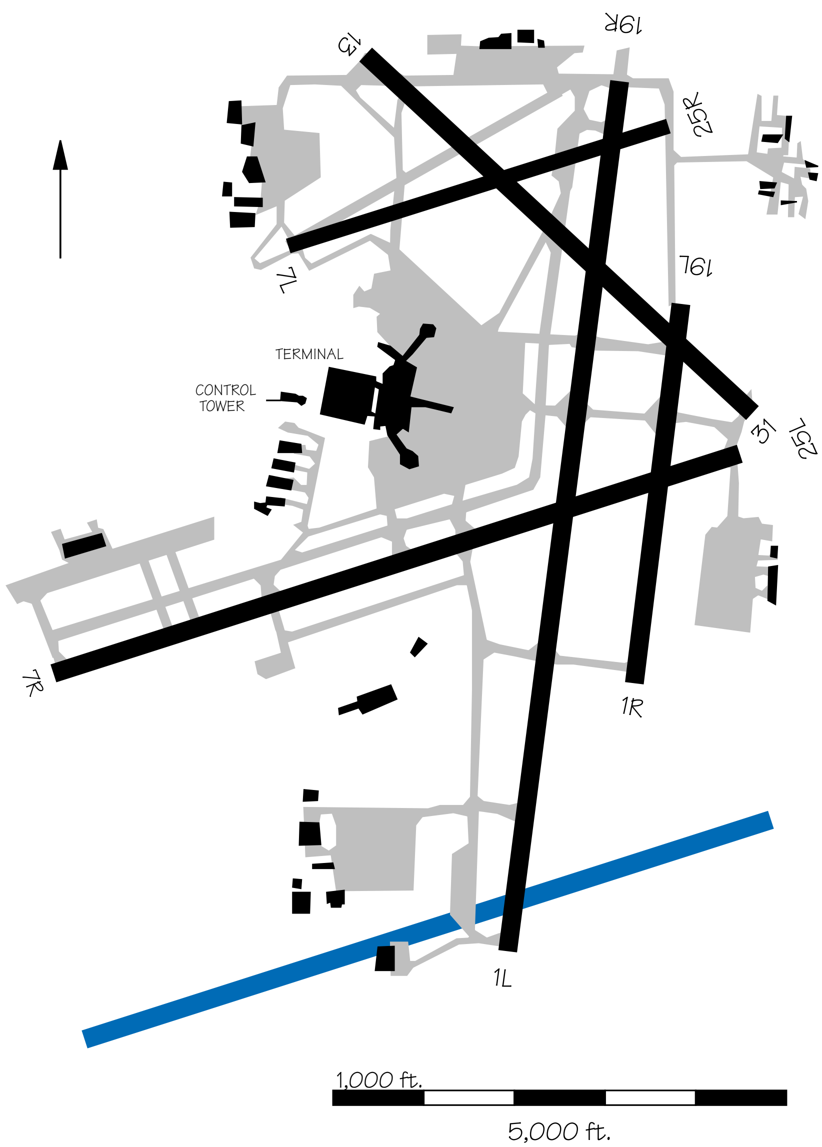
MIA — Miami International Airport

Construction of a new air carrier runway 8,600 feet long and 800 feet north of existing Runway 9L/27R is expected to start in 1998 and be completed by 2000. The estimated cost of construction is $149 million. An EIS is expected to be completed in late 1997.



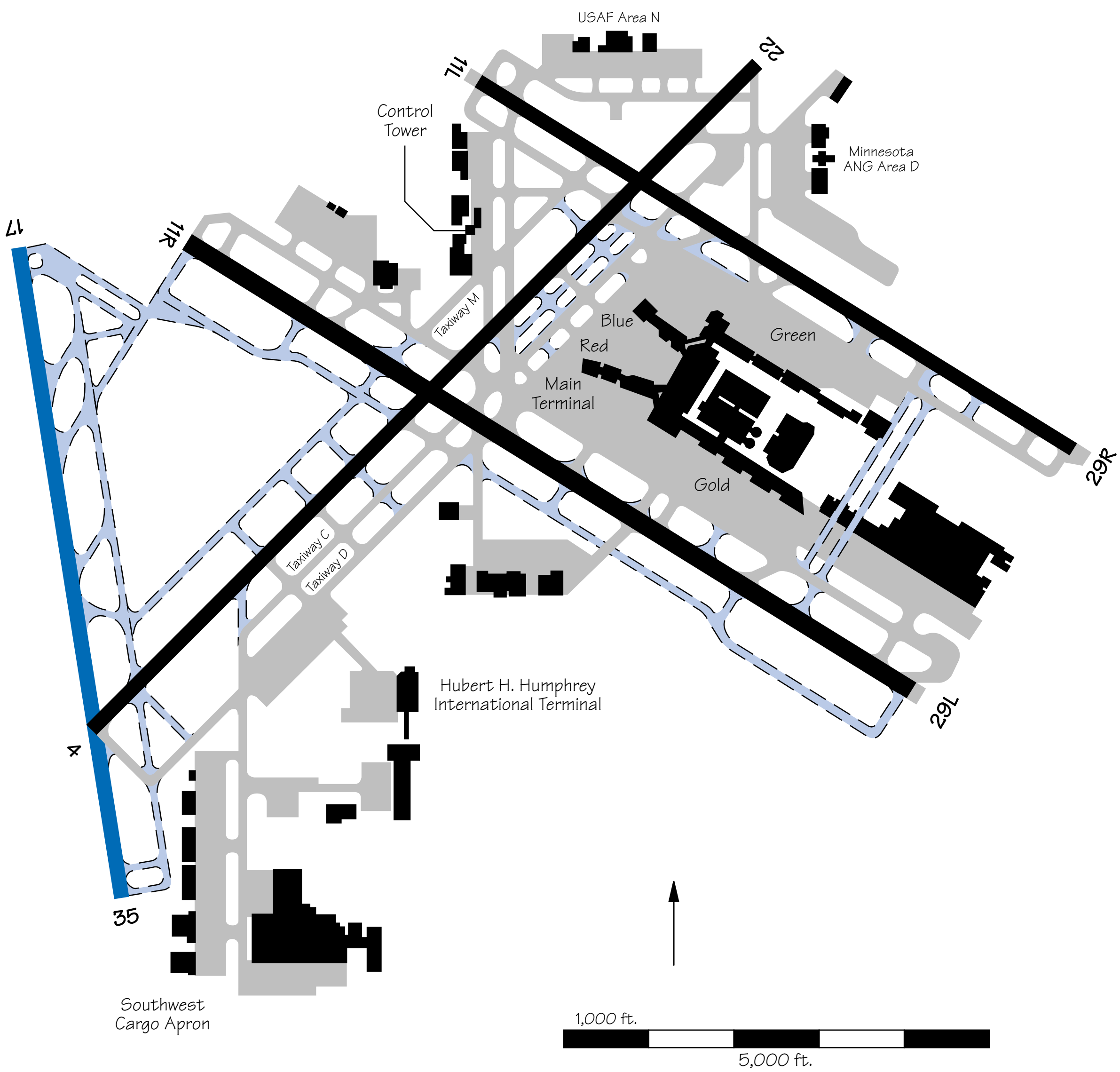
MKE — Milwaukee General Mitchell International Airport

A capacity demand analysis is being done to determine when construction of a new parallel Runway 7R/25L, 3,500 feet south of the existing runway, is needed. An EIS is in progress for the extension of Runway 7L/25R. Realignment of Runway 7L/25R was completed in 1996.



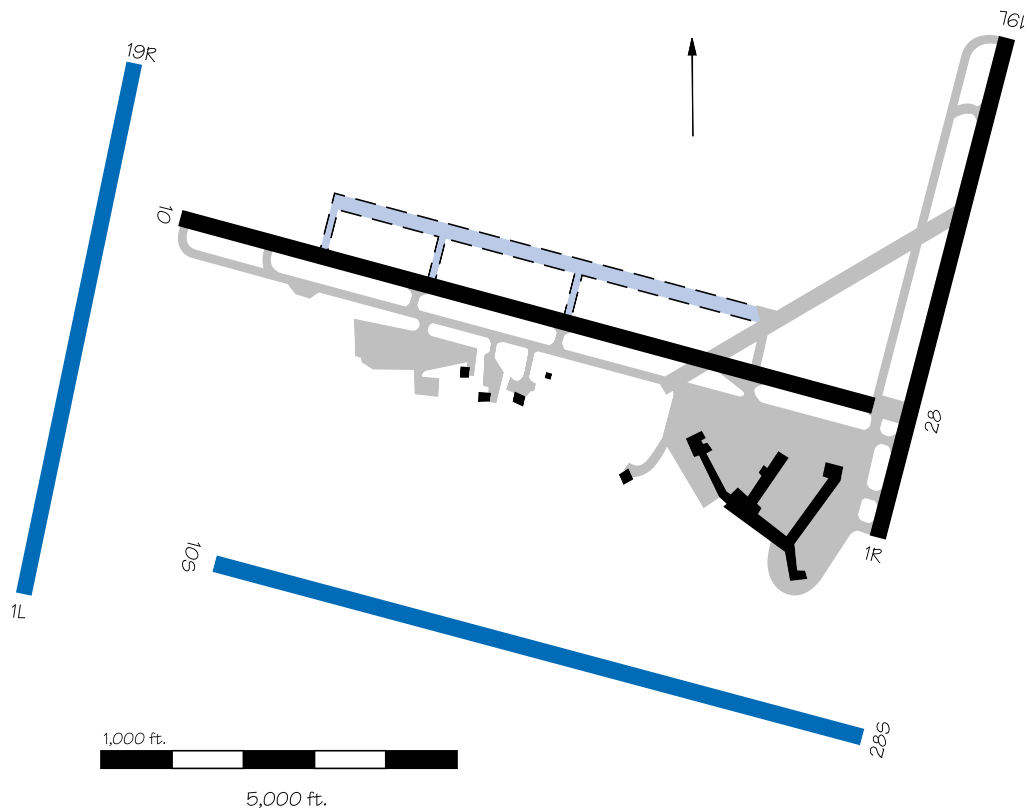
MSP — Minneapolis-St. Paul International Airport

The extension of Runway 4/22, 2,750 feet to the southwest which brought the runway length to 11,000 feet, became operational in October 1996. A new 8,000 ft air carrier runway, Runway 17/35, is planned for 2003, at an estimated cost of $120 million.



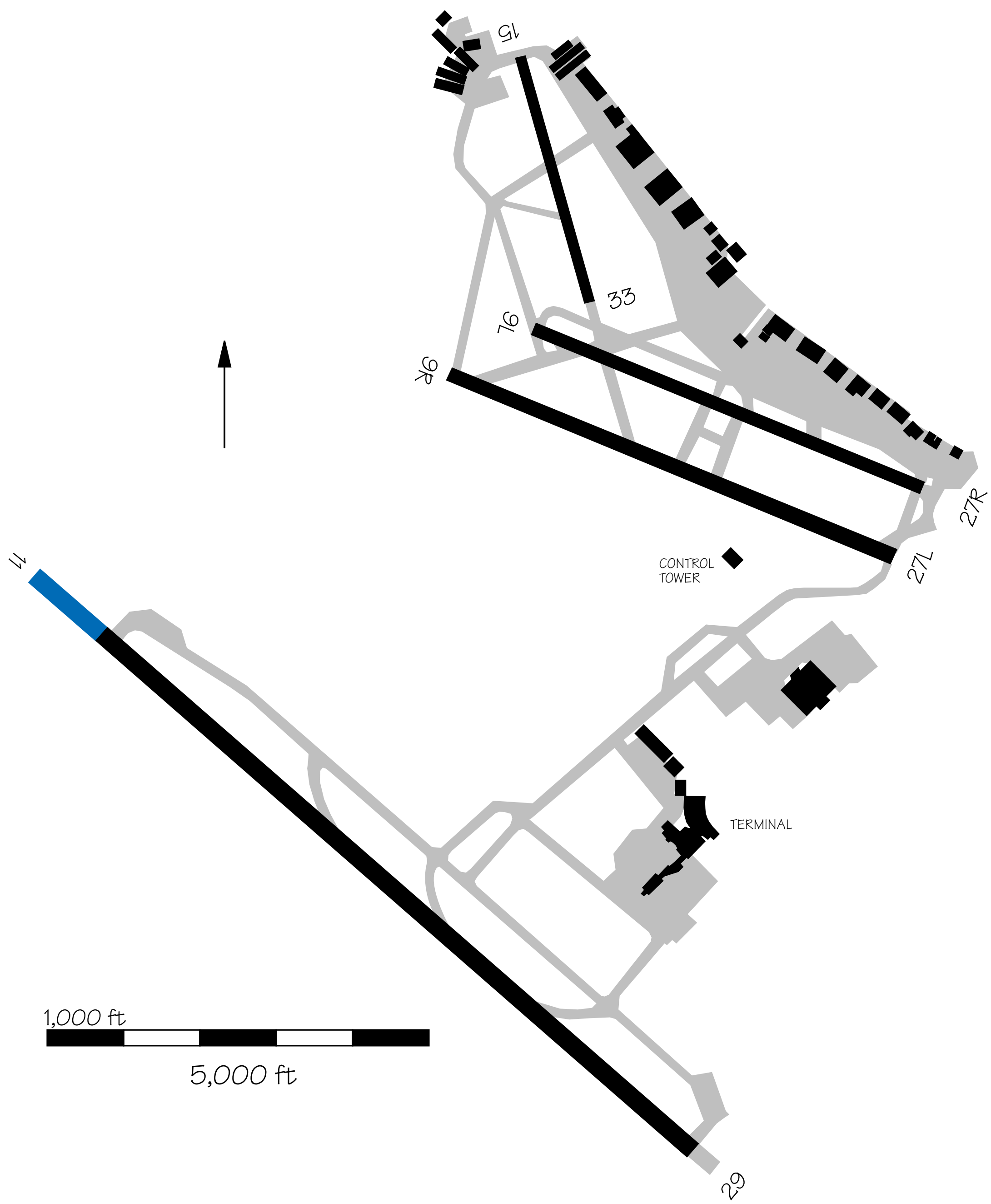
MSY — New Orleans International Airport

A new north-south runway, Runway 1L/19R, is planned. This new runway will be parallel to the existing Runway 1/19 and will be located west of the threshold of Runway 10, approximately 11,000 feet away from Runway 1/19. This will allow independent parallel operations, doubling IFR hourly arrival capacity. Pending environmental approvals, construction could begin as early as 2000 and be completed in 2005, at an approximate cost of $400 million. As an alternative to this north-south runway, the airport is considering the construction of an east/west parallel runway, Runway 10S/28S, 4,300 feet to the south of existing Runway 10/28, off of present airport property. The airport is also constructing a north parallel east/west taxiway approximately 800 feet north of and parallel to the existing Runway 10/28, which could later be converted into a 6,000-foot commuter and general aviation runway. The estimated cost of construction is $34 million, and the expected operational date is late 1999.



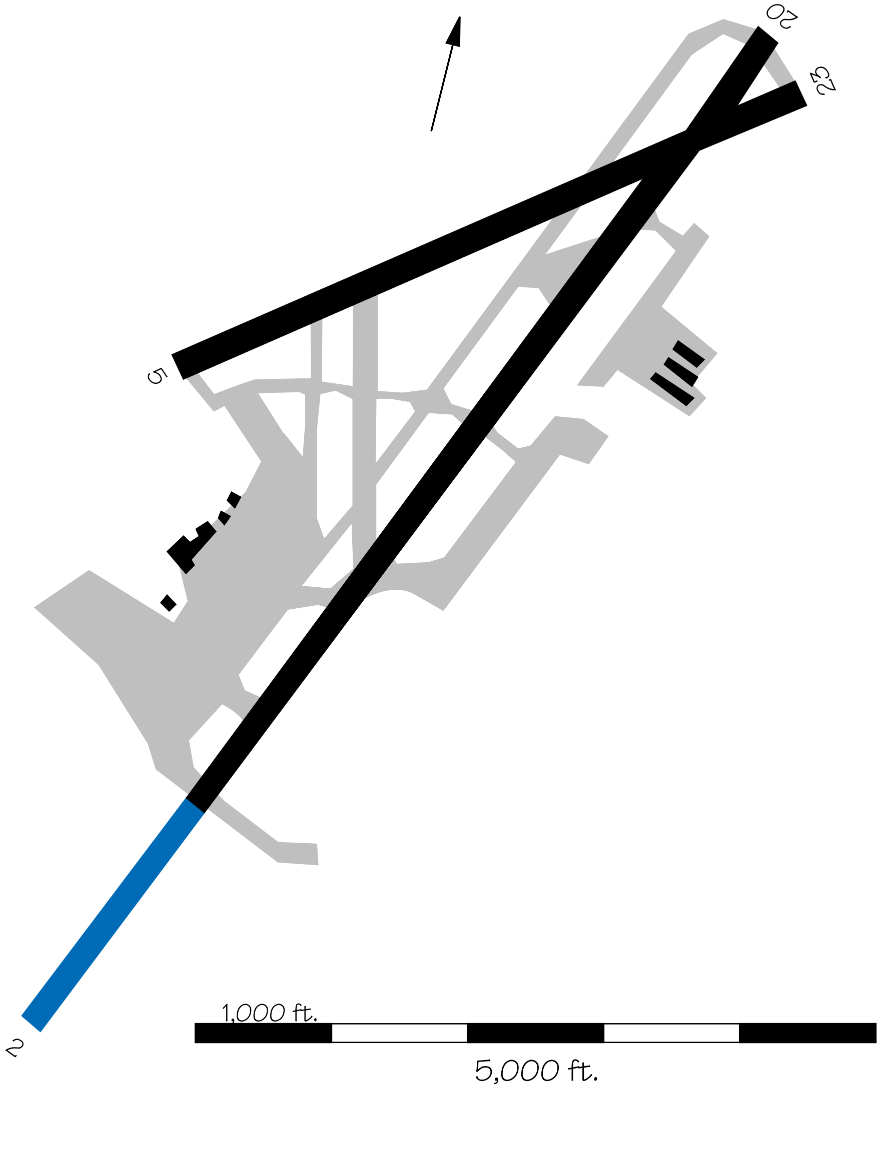
OAK — Metropolitan Oakland International Airport

An extension to Runway 11/29 is planned for ultimate development.



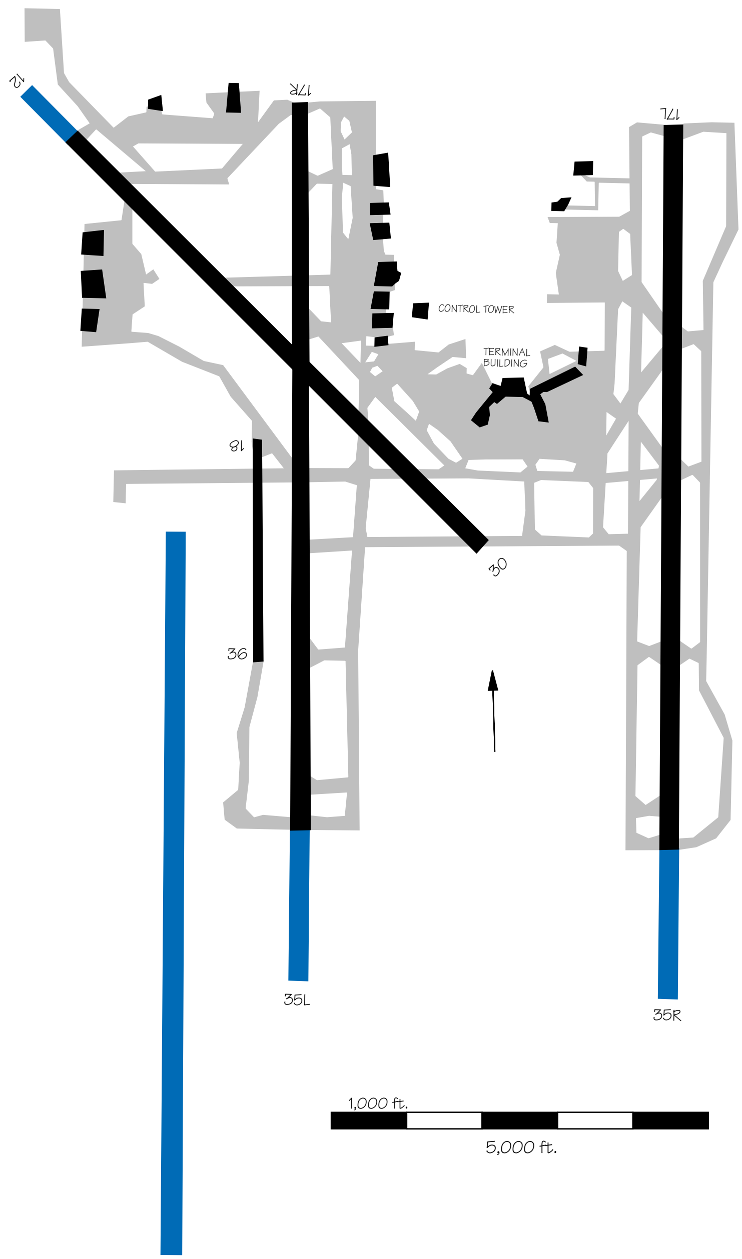
OGG — Kahului Airport

An extension of Runway 2/20 is being planned. An EIS is underway, and the extension could be operational by mid-1998, at a cost of $40 million.



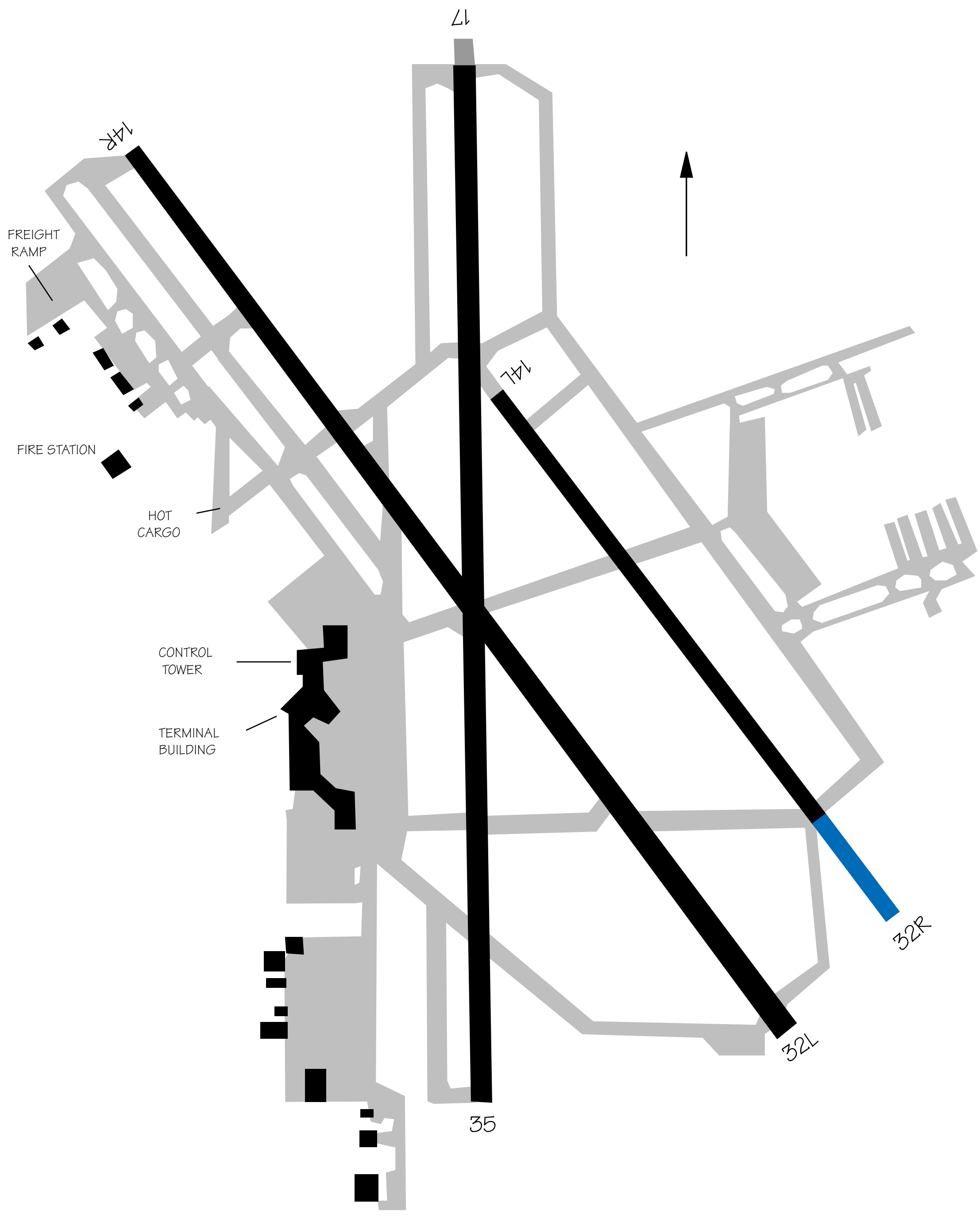
OKC — Oklahoma City Will Rogers World Airport

Construction of a new west parallel runway 1,600 feet west of Runway 17R/35L is planned to be operational by 2004. Estimated cost of construction is $13 million. Extensions to both north/south runways, Runways 17L/35R and 17R/35L, are also planned. The estimated costs of extending the runways is $8 million each. Construction of the extension to Runway 17R/35L is expected to start in 2001 and be completed by 2014. A 1,200 foot extension to the northwest of Runway 13/31 is planned as well. Construction is stated to begin in 2003, be completed in 2005, and cost $5 million.

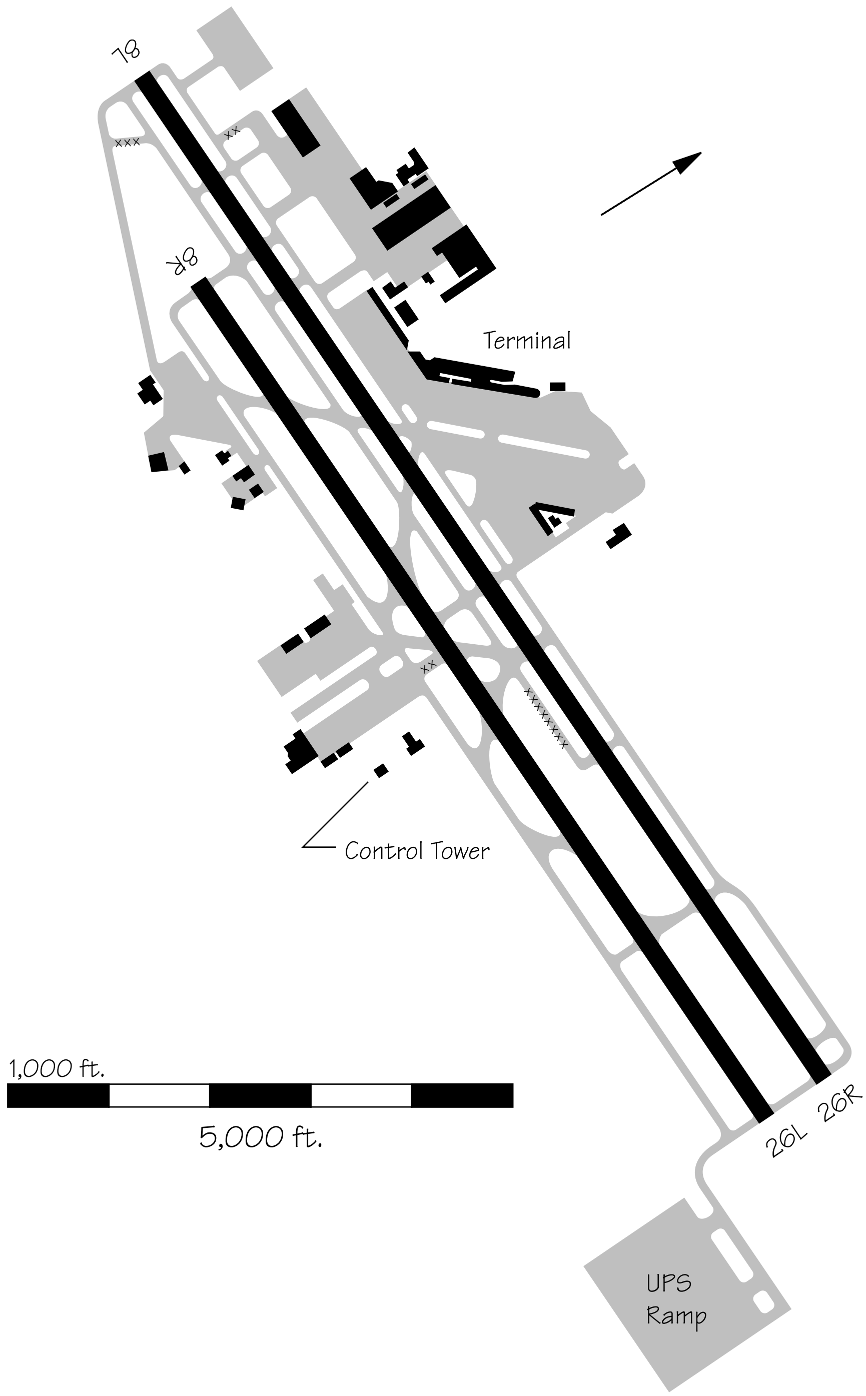


OMA — Omaha Eppley Airfield

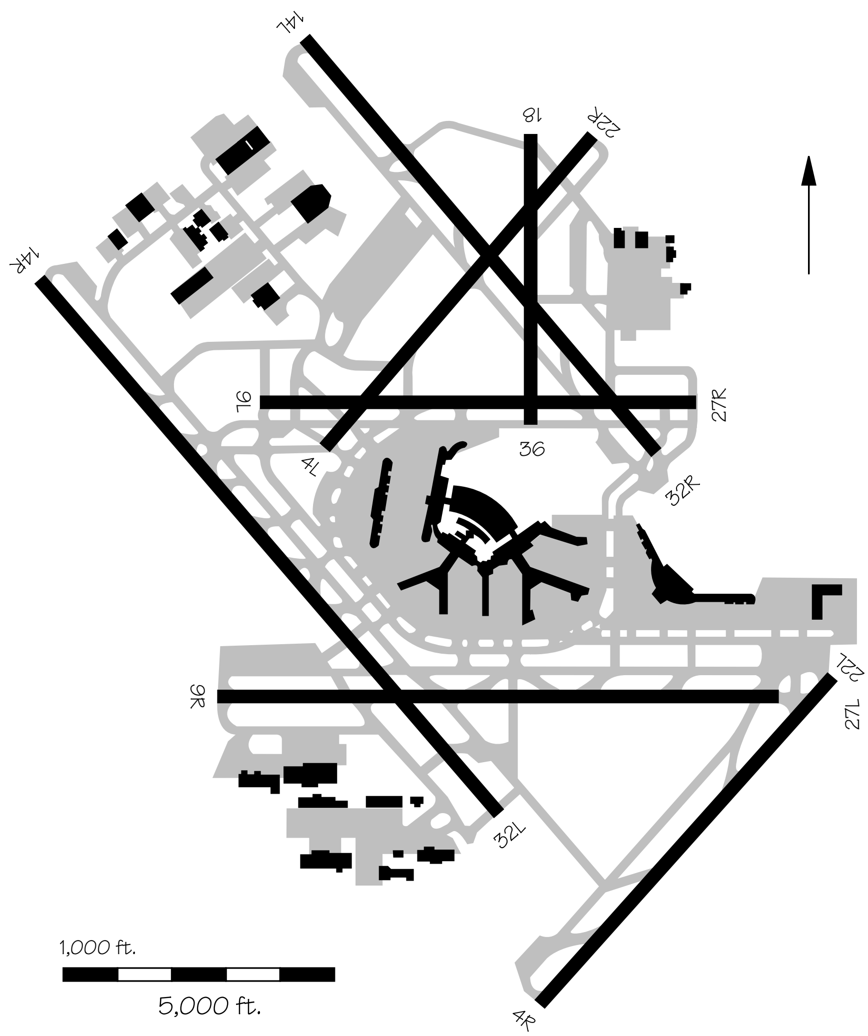
A 1,000 foot extension of Runway 14R/32L was completed in late 1996, with a cost of $9 million, including the relocation of ILS equipment.



ONT — Ontario International Airport

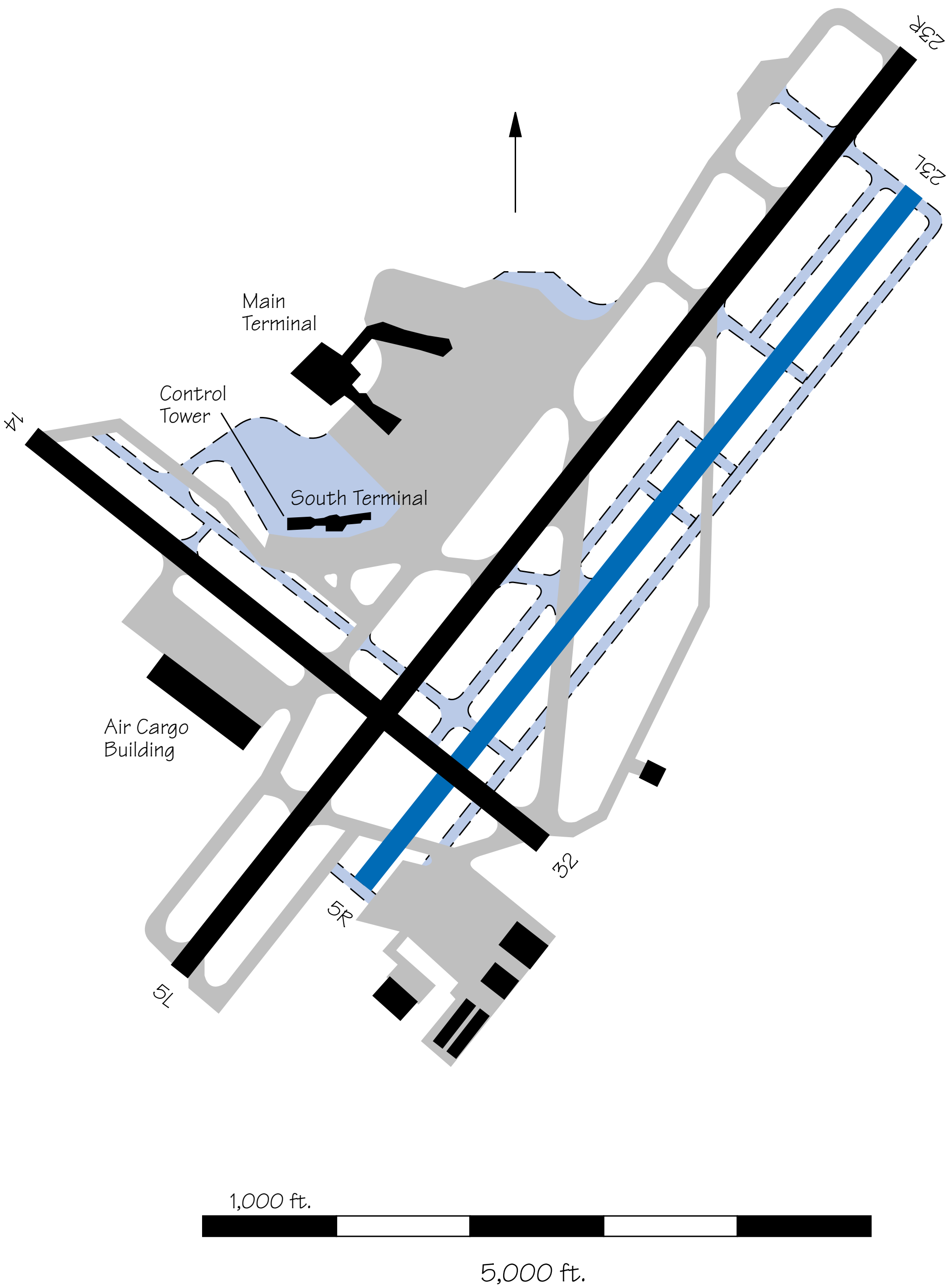


ORD — Chicago O'Hare International Airport



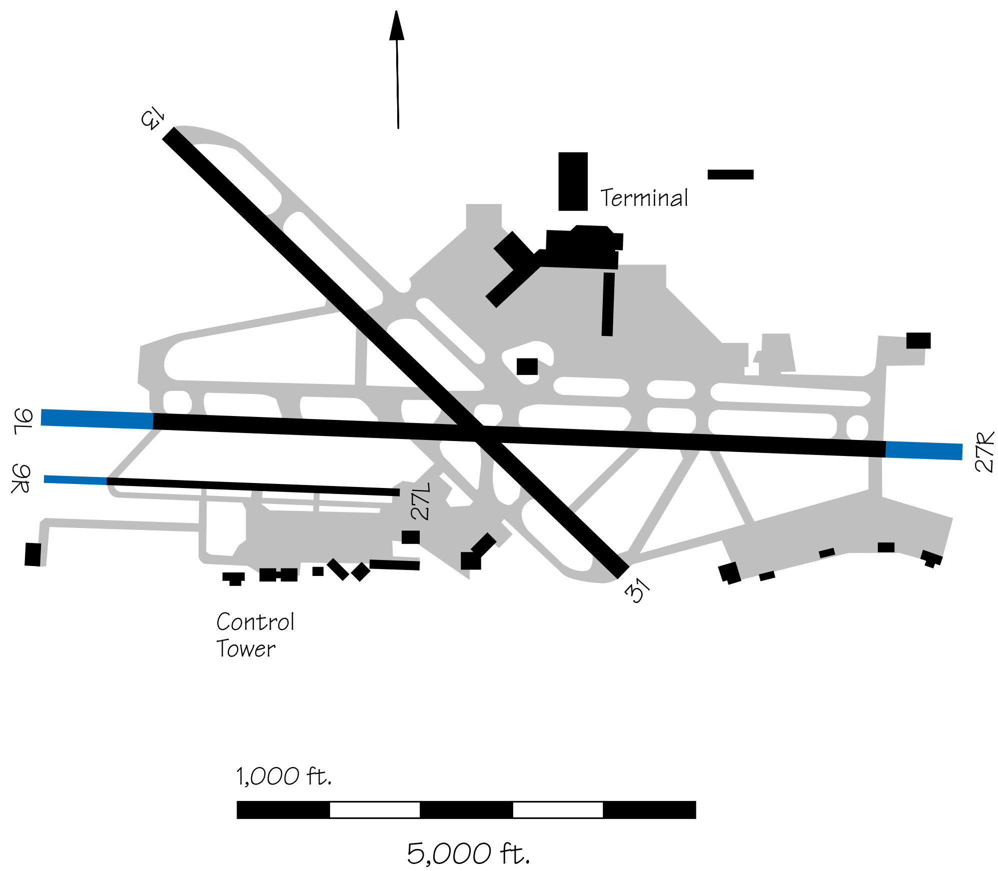
ORF — Norfolk International Airport

A new air carrier runway, Runway 5R/23L, 800 feet south of Runway 5/23 was recommended by the Eastern Region Capacity Design Team. A Master Plan Update is currently underway. The runway could be operational by 2005, at en estimated cost of $75 million, providing the airport can acquire the small amount of additional land required.

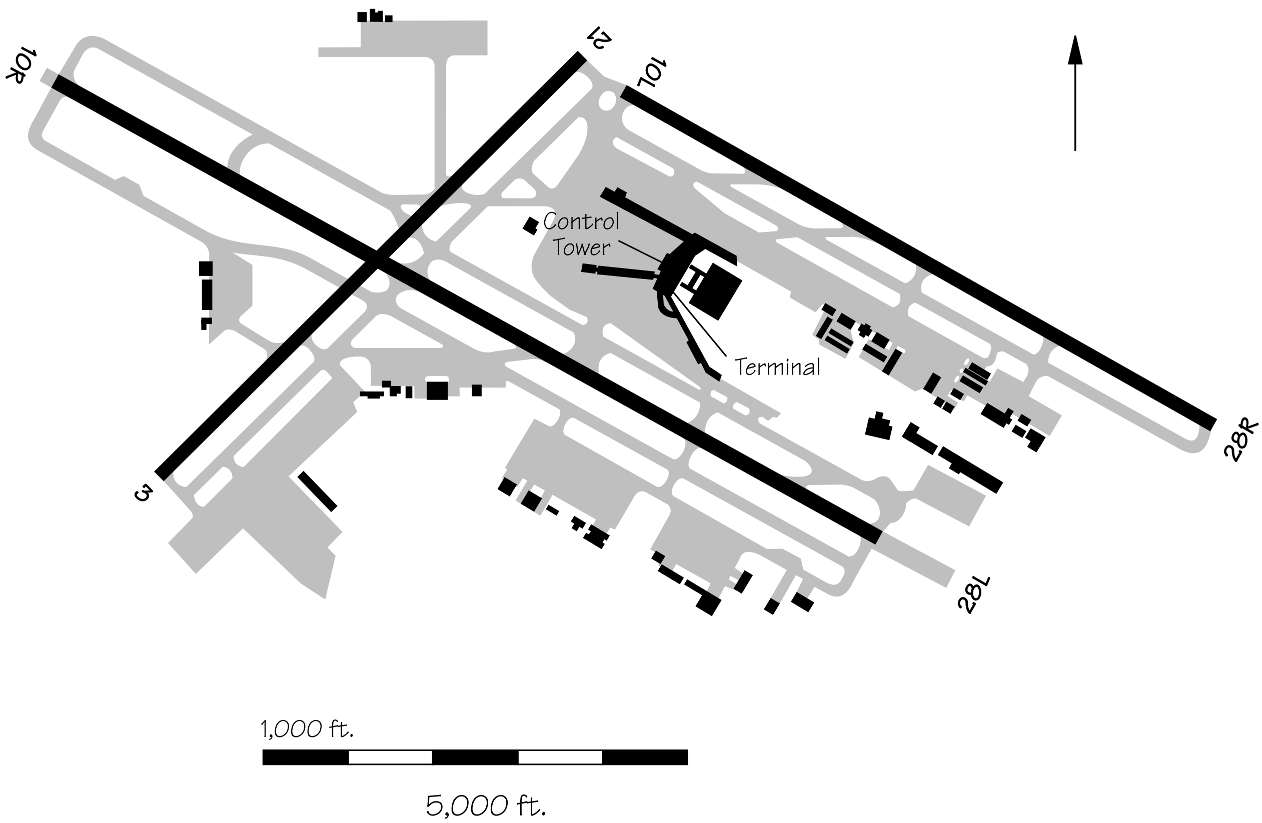


PBI — Palm Beach International Airport

Runway 9L/27R is planned to be extended 1,200 feet to the west and 811 feet to the east, for a total length of 10,000 feet. The total estimated project cost is $10 million. The EIS is planned to be completed in late 1997. Construction is planned to start in 1998 and be completed in 1999. Also a 700 foot extension of Runway 9R/27L to the west is being considered for completion in 2001 at a cost of $0.5 million.

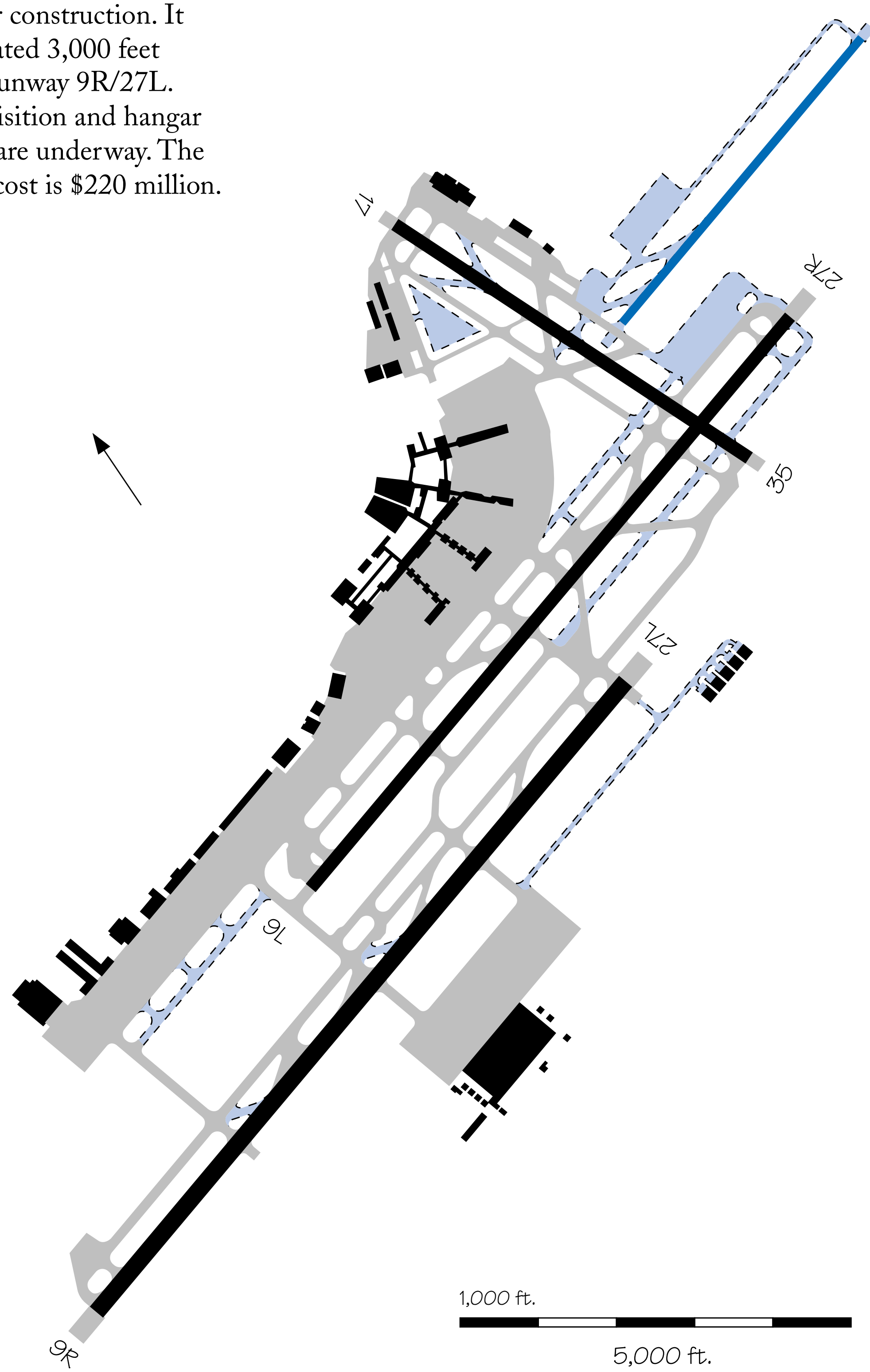


PDX — Portland International Airport



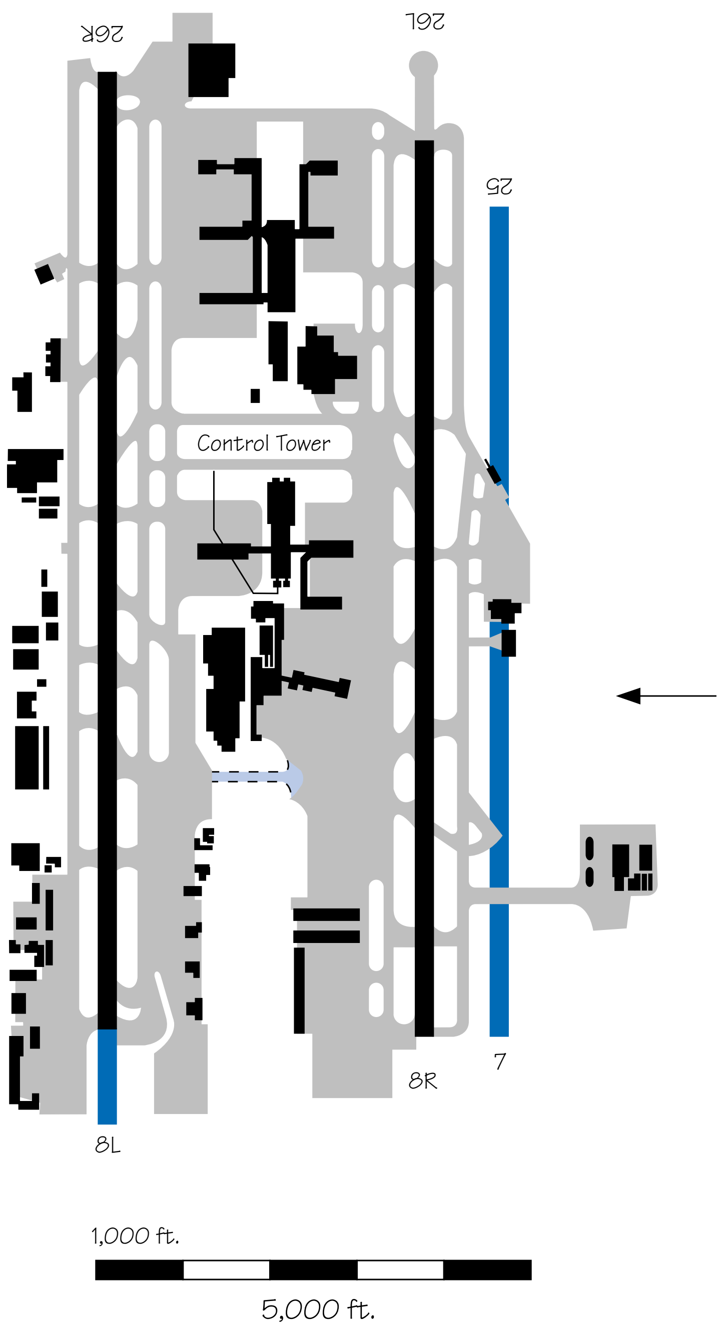
PHL — Philadelphia International Airport

A new 5,000-foot parallel commuter runway, Runway 8/26 is under construction. It will be located 3,000 feet north of Runway 9R/27L. Land acquisition and hangar relocation are underway. The estimated cost is $220 million.



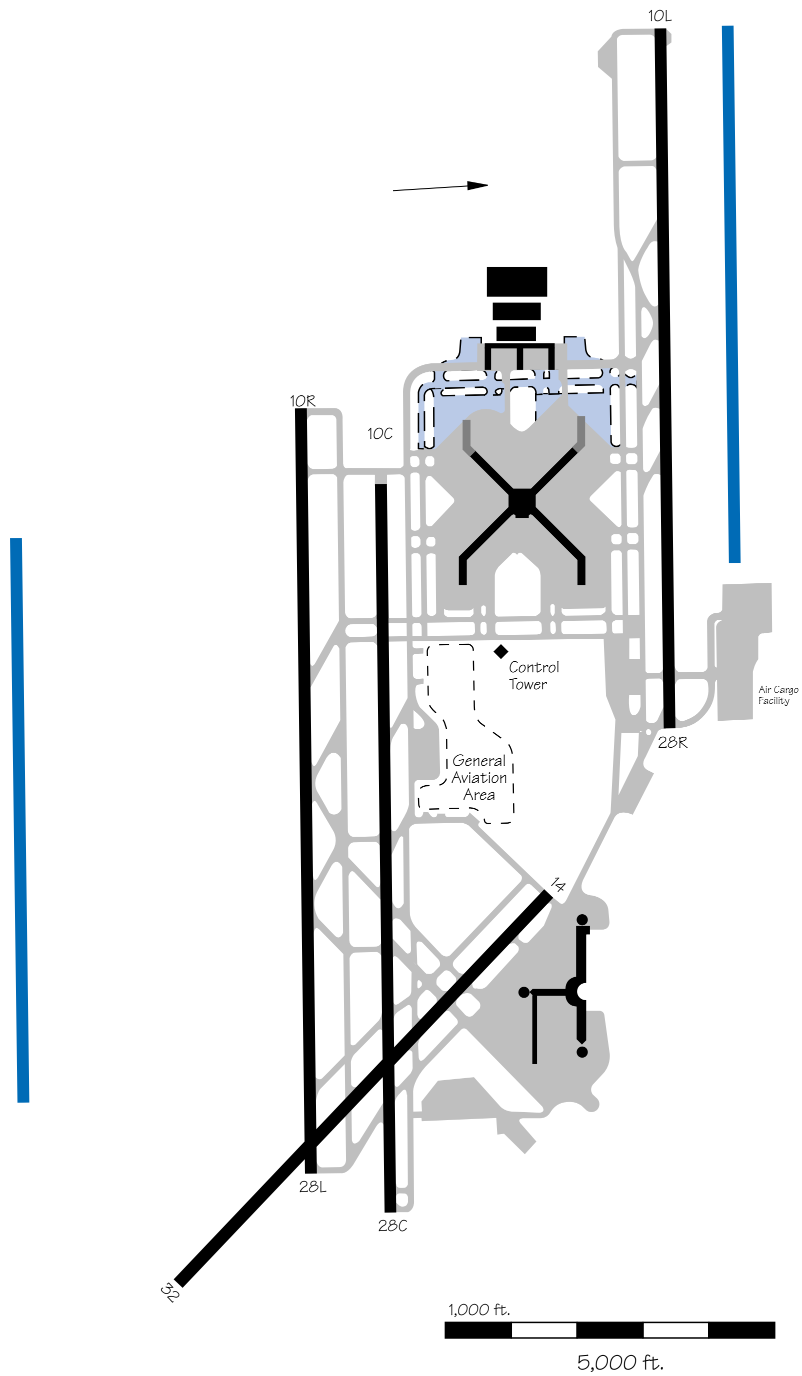
PHX — Phoenix Sky Harbor International Airport

A new 9,500-foot third parallel runway, Runway 7/25, is proposed 800 feet south of Runway 8R/26L. The estimated cost of construction is $88 million. The estimated operational date for the first 7,800 feet of Runway 7/25 is 1997; the remaining 1,700 feet of the runway is not scheduled at this time. In addition, an extension of Runway 8L/26R is under consideration. The estimated cost of construction is $7.0.

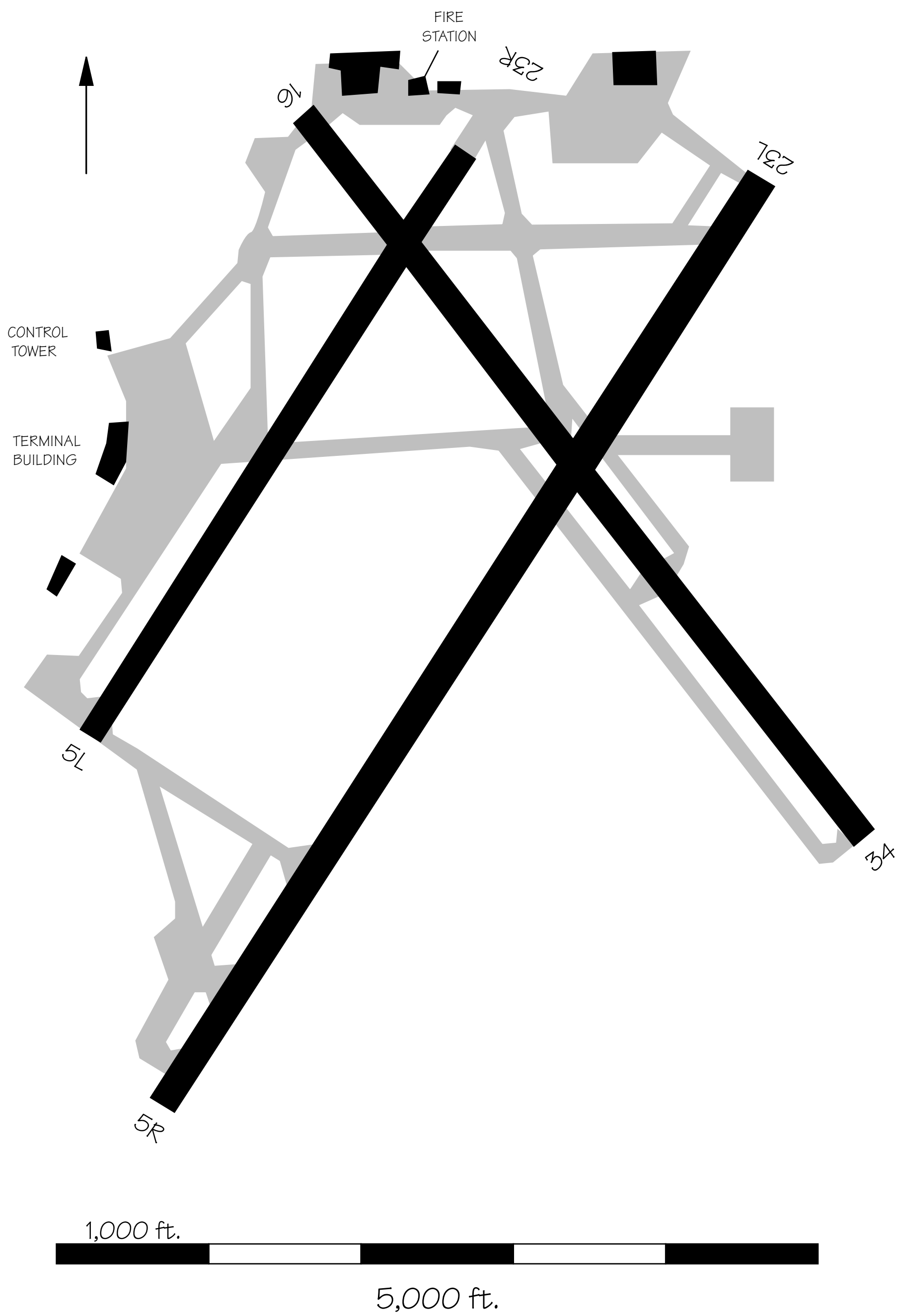


PIT — Greater Pittsburgh International Airport

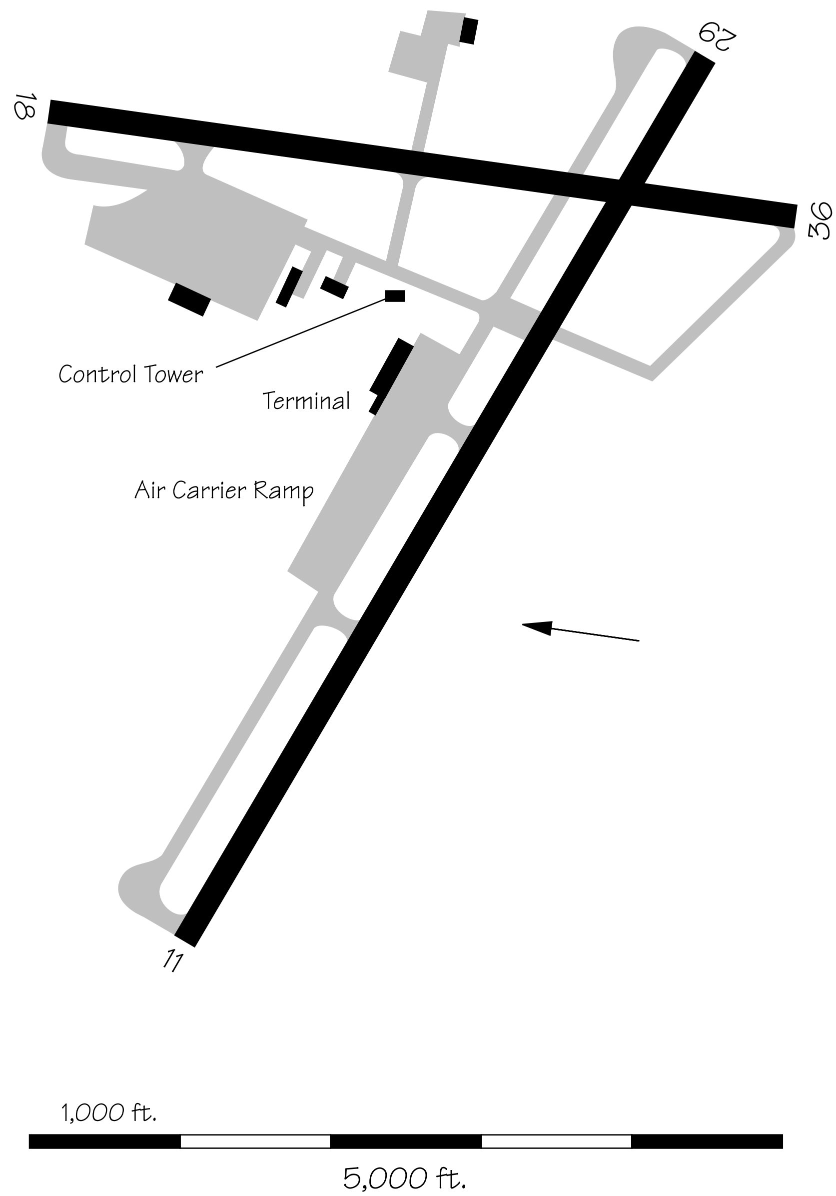
A recently completed Master Plan has recommended that at least two new runways will be needed within a twenty year planning period to accommodate projected Baseline (normal growth) forecast demands and achieve acceptable aircraft delay times and associated delay costs. Construction of the two east/west runways include a northern parallel and a southern parallel, with the latter as the preferred first-build runway. The southern parallel will be located approximately 4,300 feet south of existing Runway 10R/28L and should be operational by the time the airport reaches 495,000 annual aircraft operations. The northern parallel runway will be located 1,000 feet north of existing Runway 10L/28R and should be operational by the time the airport reaches 522,000 annual aircraft operations.



PVD — Providence Theodore Francis Green State Airport



PWM — Portland International Jetport

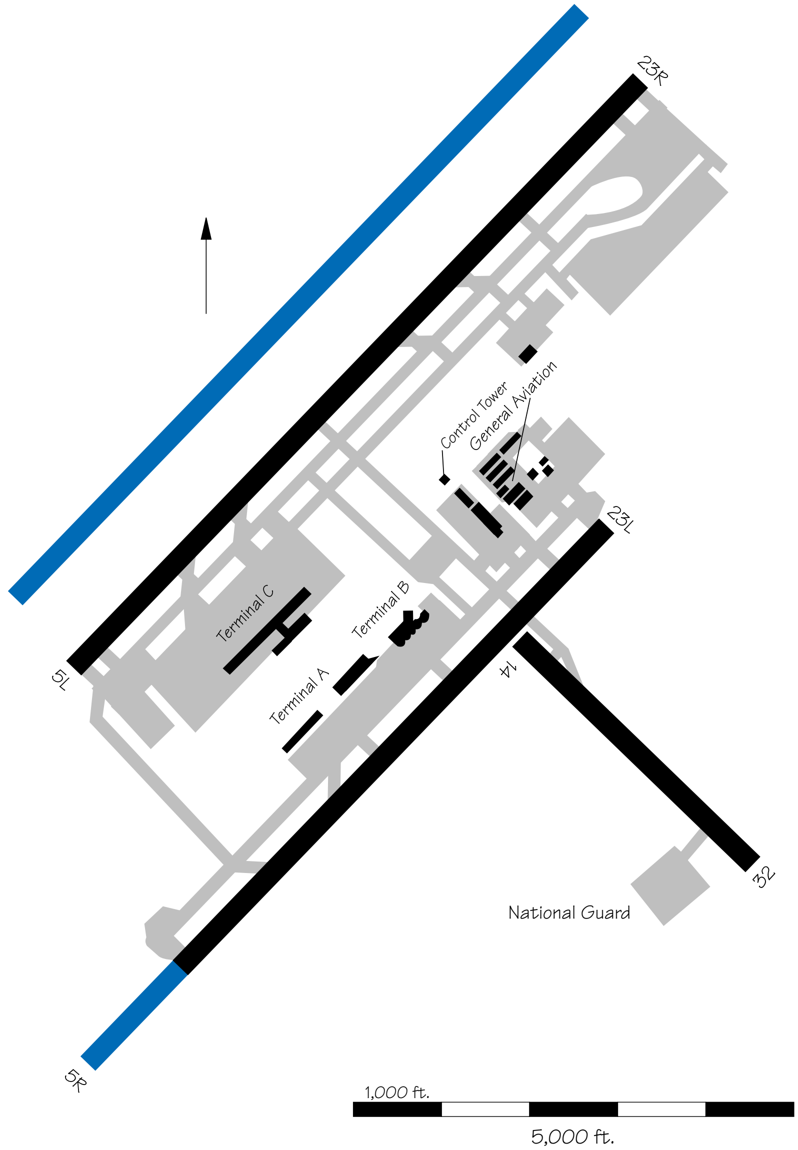


RDU — Raleigh-Durham International Airport

Addition of a new 9,500 ft. parallel runway located approximately 1,050 feet west of existing Runway 5L/23R. The northernmost threshold of the new west runway would be co-located with the approach threshold to Runway 23R. The proposed taxiway network serving this airfield complex would include a full-length parallel taxiway and six high-speed exit taxiways, all located on the terminal side of the new runway.

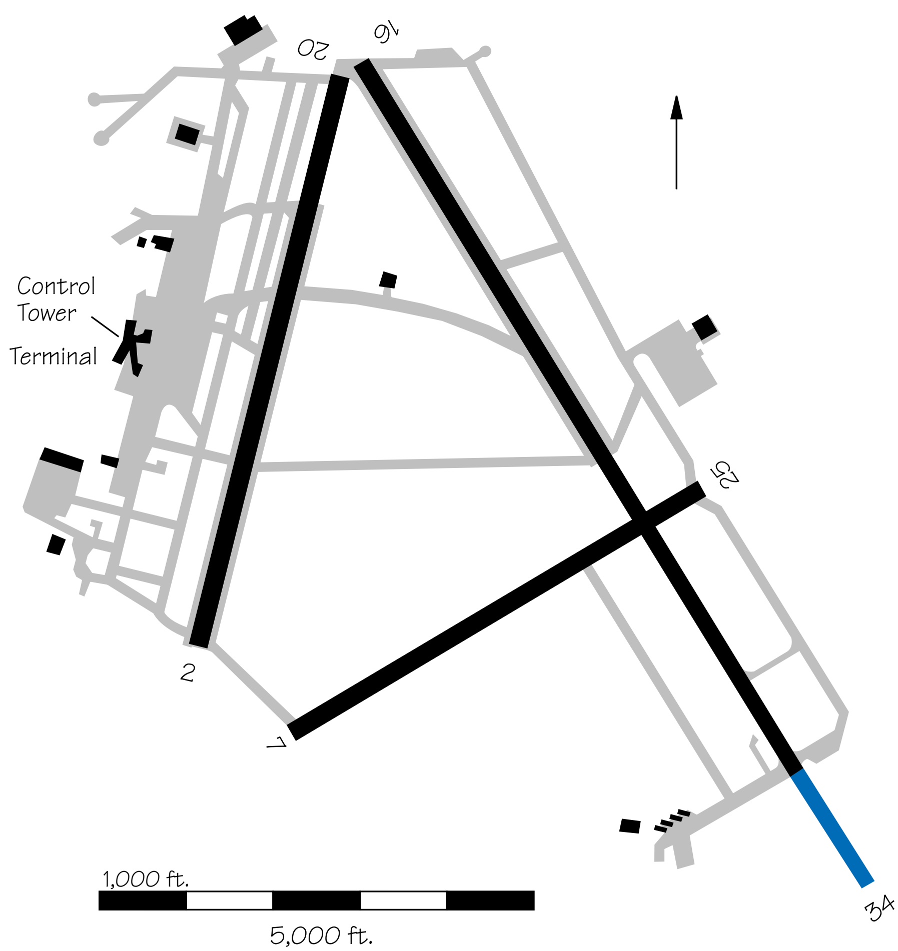
Addition of a 1,500 ft. runway extension to south end of existing Runway 5R/23L, bringing the total useable length for landings and take-offs to 9,000 ft. A second full-length parallel taxiway, complete with taxiway connections would be programmed together with exit taxiway modifications to high-speed exit configurations.

Further taxiway enhancements to the overall airfield include the planned relocation of Taxiway D to a position more proximate to Taxiway C, two crossfield taxiways at the north end of the airfield, and a taxiway connecting the air cargo area to the general aviation area.

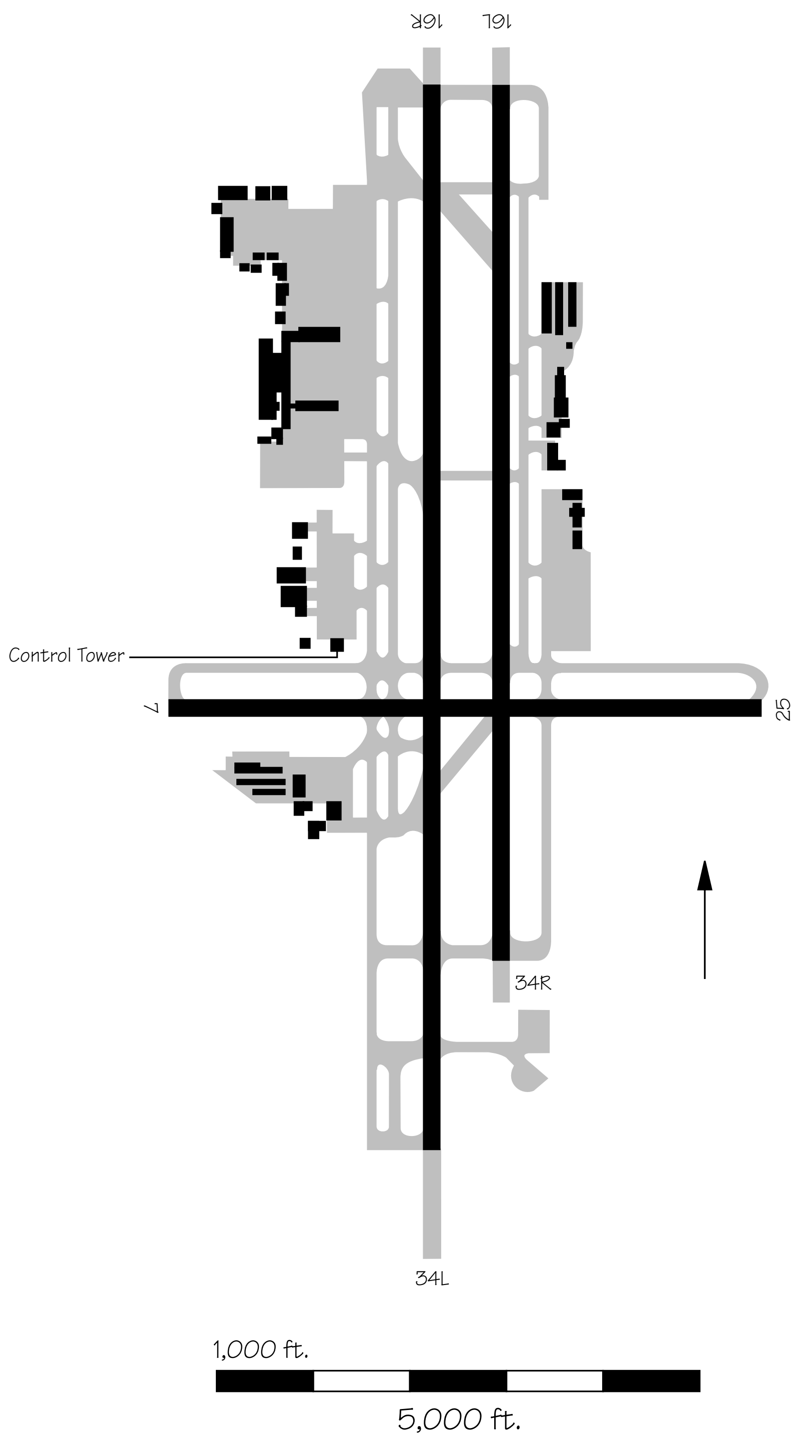


RIC — Richmond International Airport

An extension of Runway 16/34 is planned for an operational date of early 1997. The estimated cost of construction is $45 million.

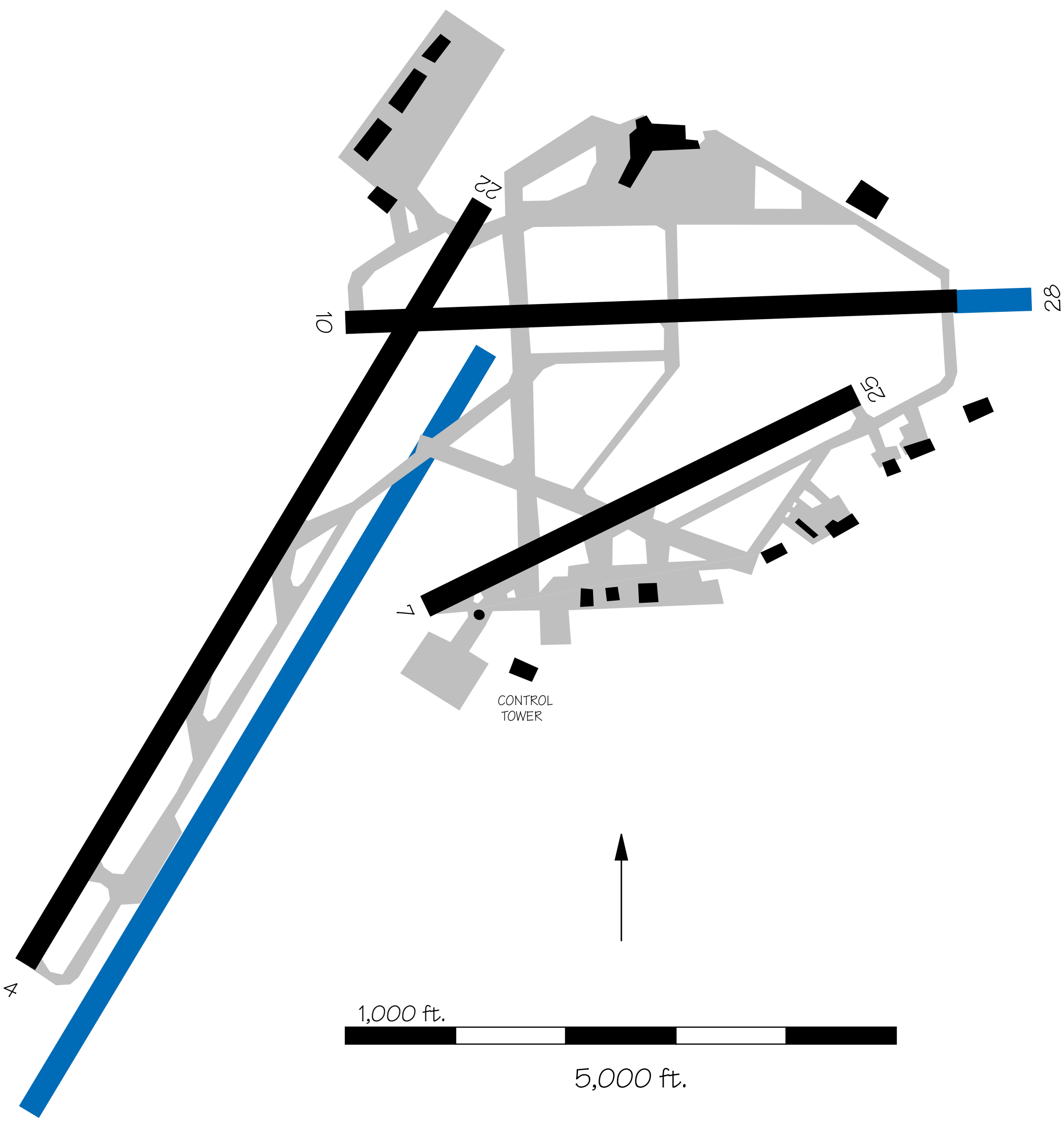


RNO — Reno Tahoe International Airport



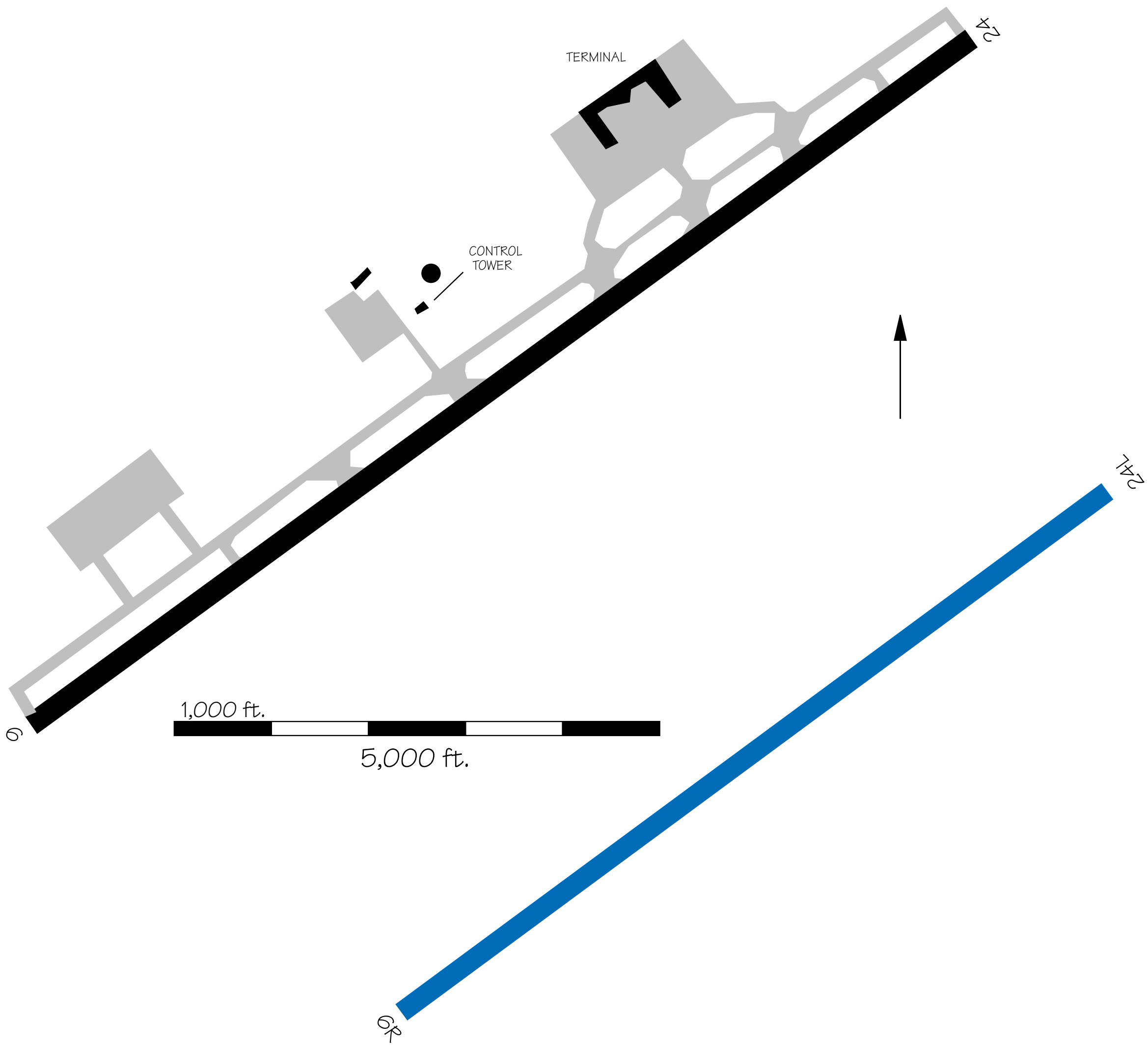
ROC — Greater Rochester International Airport

Construction of an extension to Runway 10/28 is being considered. The estimated cost of construction is $3.2 million. An extension to Runway 4/22 is also being considered, and is expected to cost $4 million. Construction of a new parallel Runway 4R/22L 700 feet southeast of Runway 4/22 is estimated to cost $10 million. These runway improvements are anticipated post 2000. Environmental assessments have not yet been started for these projects.

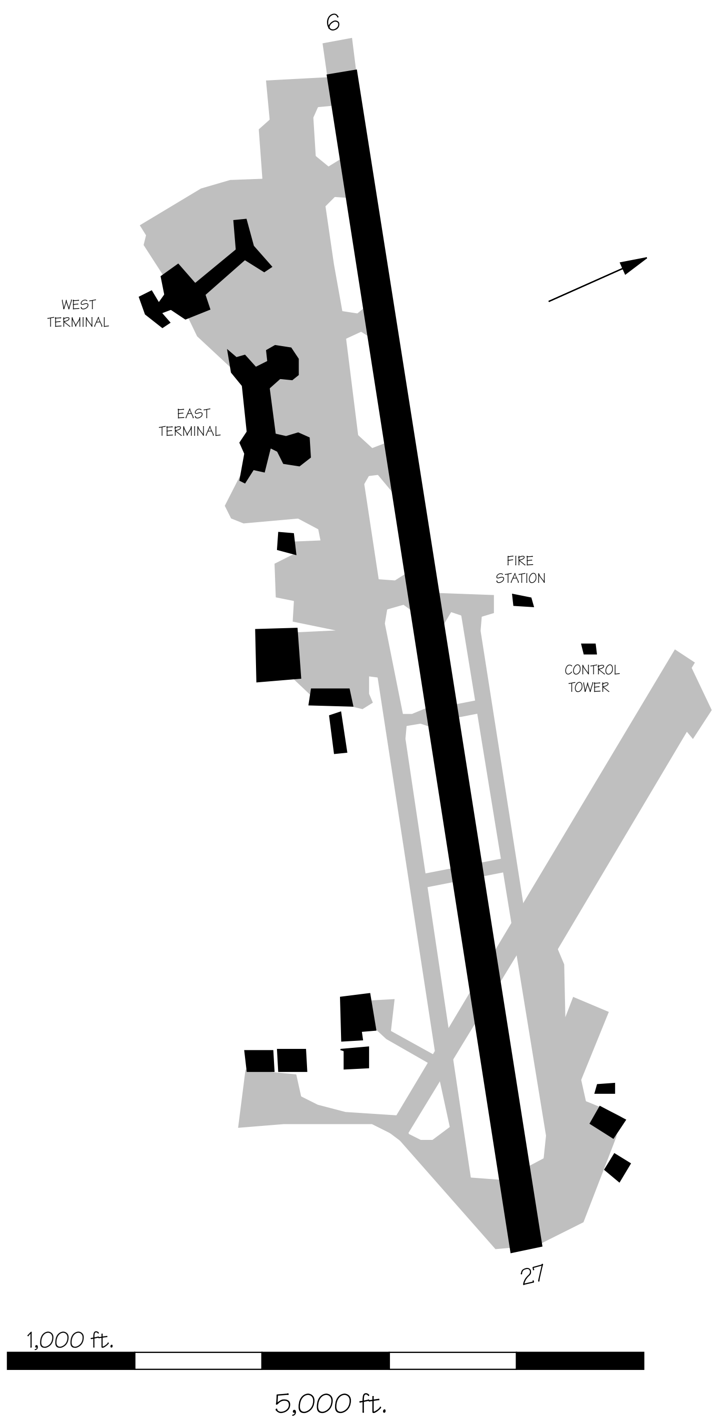


RSW — Fort Myers Southwest Florida Regional Airport

Planning has begun for a new 9,100 foot parallel runway, Runway 6R/24L, 4,300 feet or more southeast of Runway 6/24. Construction is expected to begin in 2000. The new runway should be operational by 2002. The estimated cost of the project is $80 million. This new runway will support independent parallel operations.

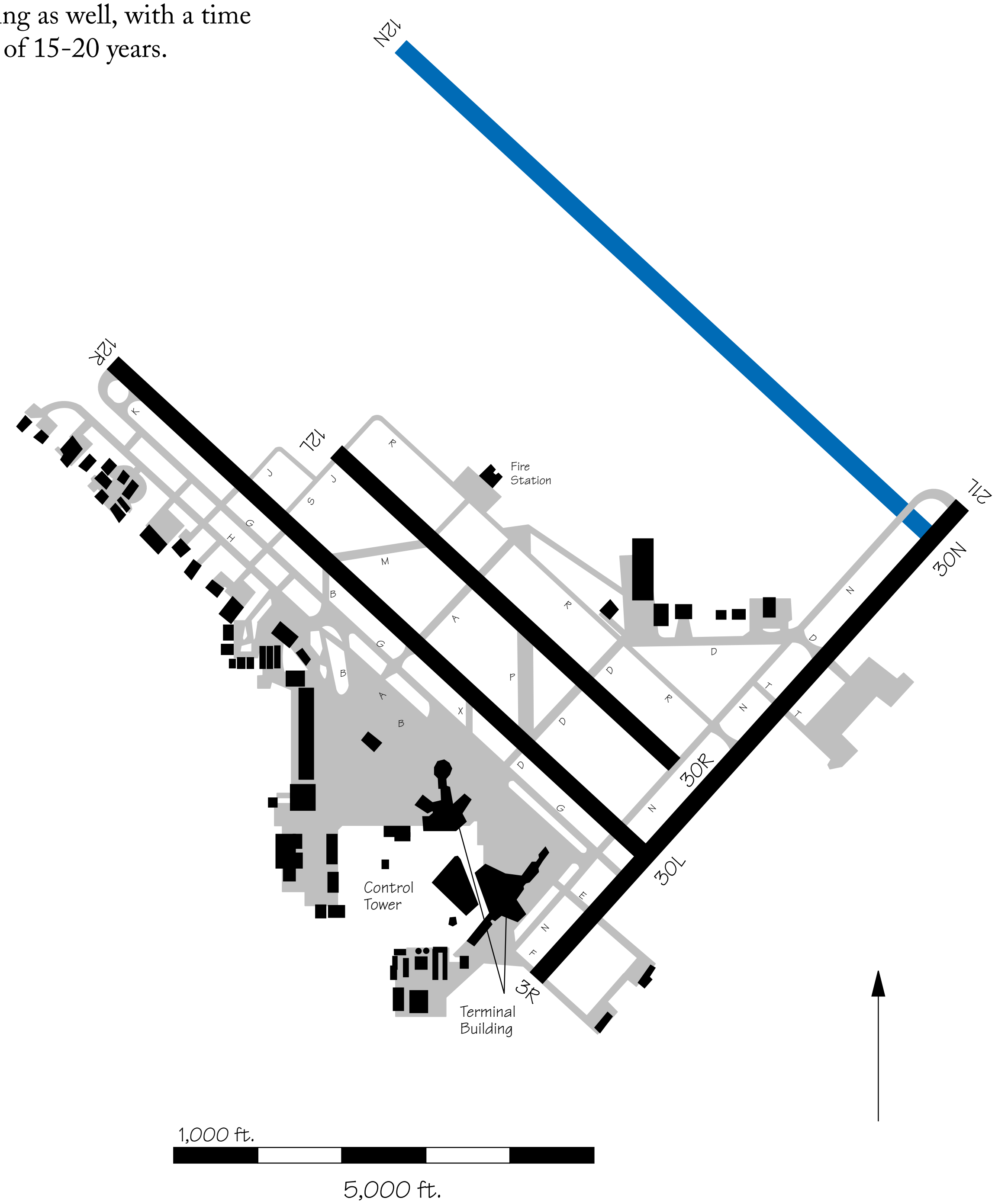


SAN — San Diego International Lindberg Field



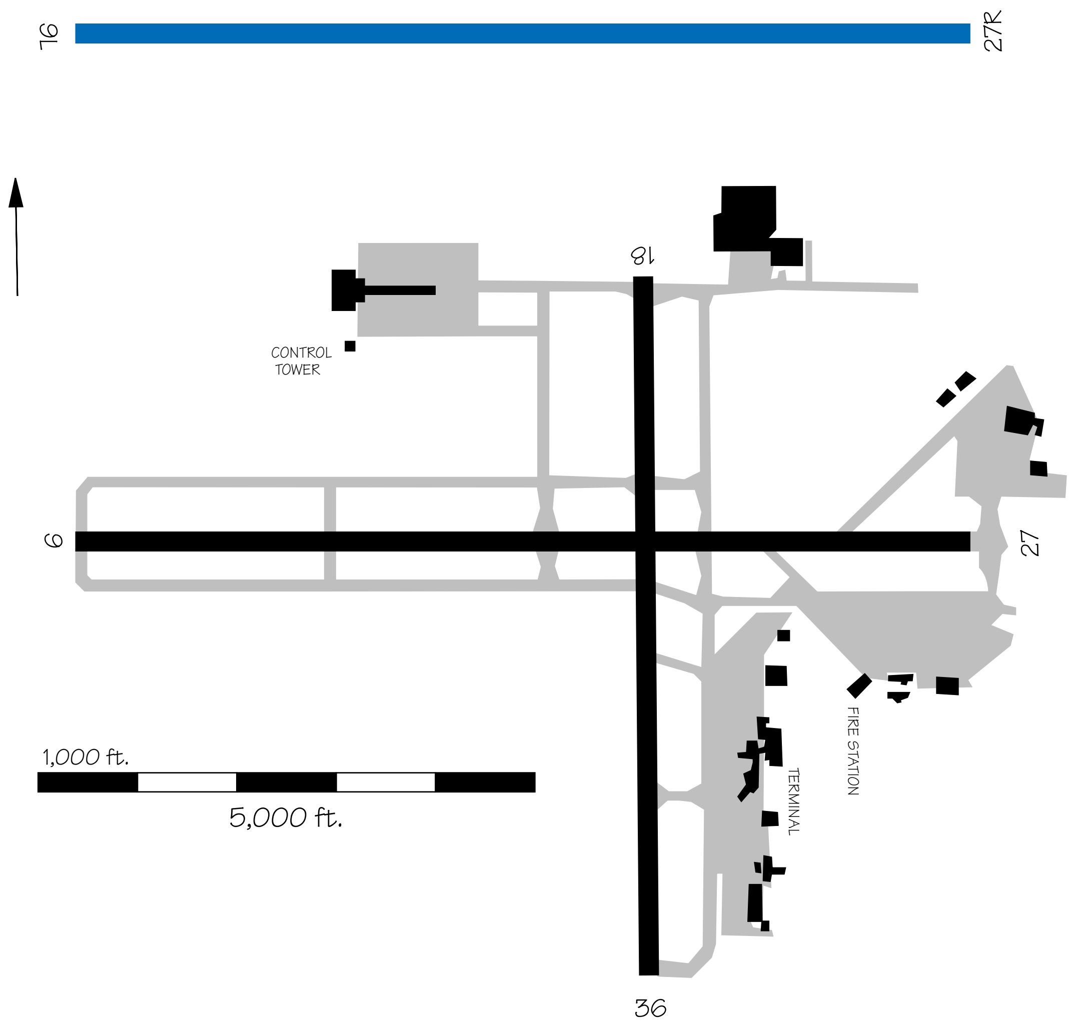
SAT — San Antonio International Airport

Reconstruction and extension of Runway 12L/30R for air carrier operations is being planned for beyond 2000, as demand warrants. A third parallel runway, Runway 12N/30N, is in the long term planning as well, with a time frame of 15-20 years.



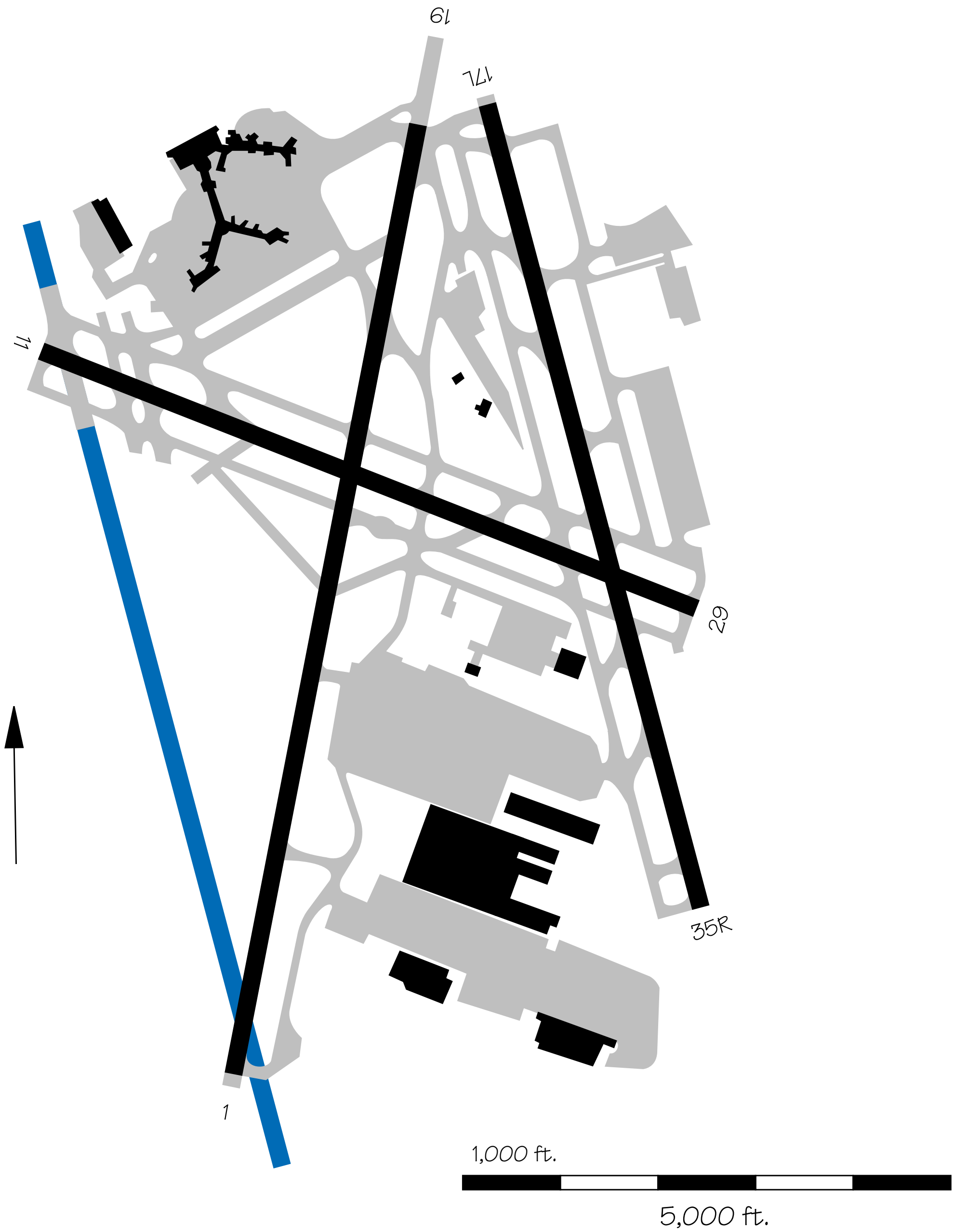
SAV — Savannah International Airport

A new 9,000-foot parallel runway, Runway 9L/27R, approximately 5,000 feet north of Runway 9/27, is expected to be constructed in 2020, with an estimated cost of $20 million.



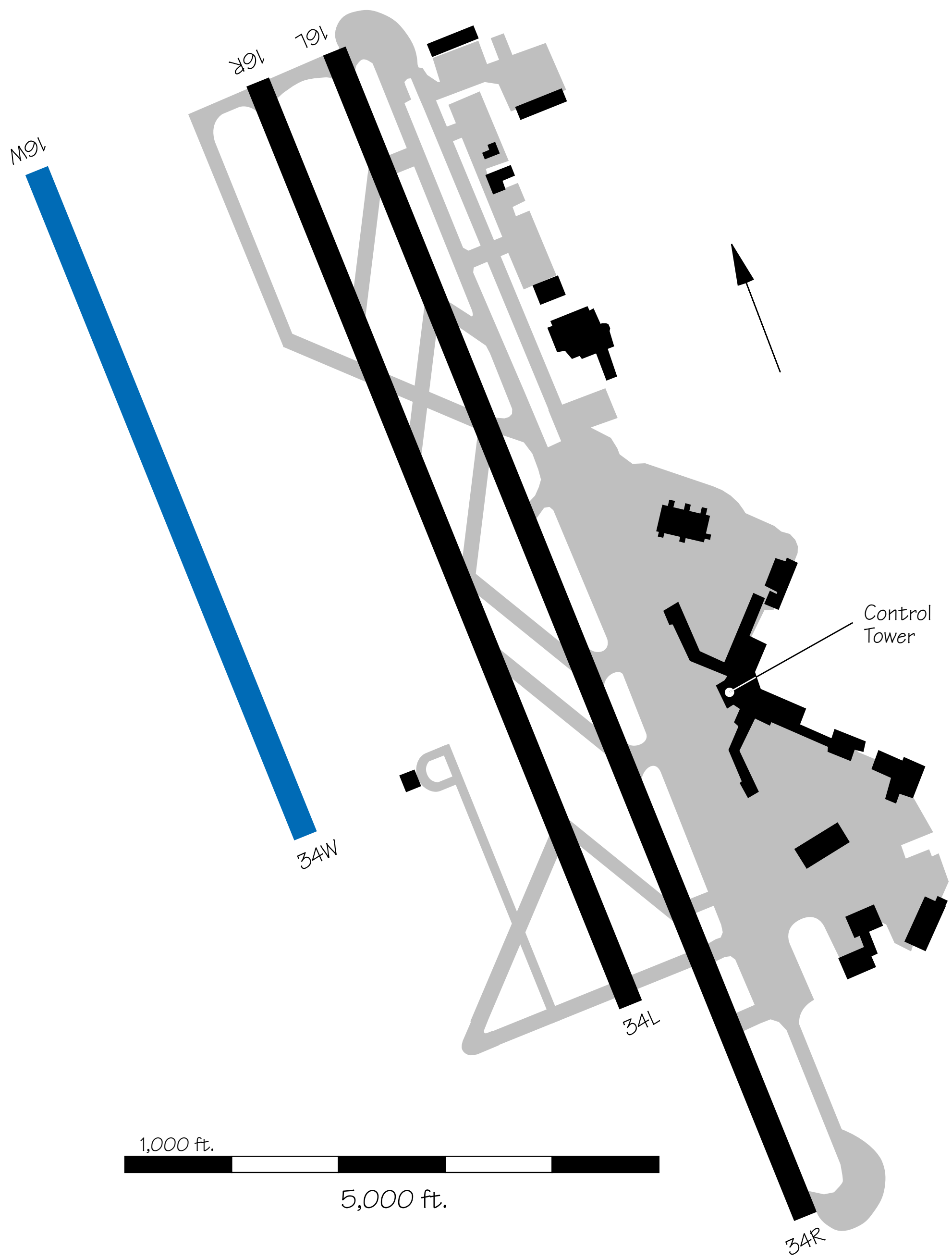
SDF — Louisville Standiford Field

Construction is underway for two new parallel runways, 4,950 feet apart. They will be numbered Runways 17R/35L and 17L/35R and will be 10,000 and 8,580 feet long, respectively. They will replace Runway 1/19, which will be closed. The estimated cost of construction is $59 million for Runway 17R/35L. Runway 17L/35R is complete, and Runway 17R/35L is expected to be completed in 1997. The two runways will permit independent parallel IFR operations.

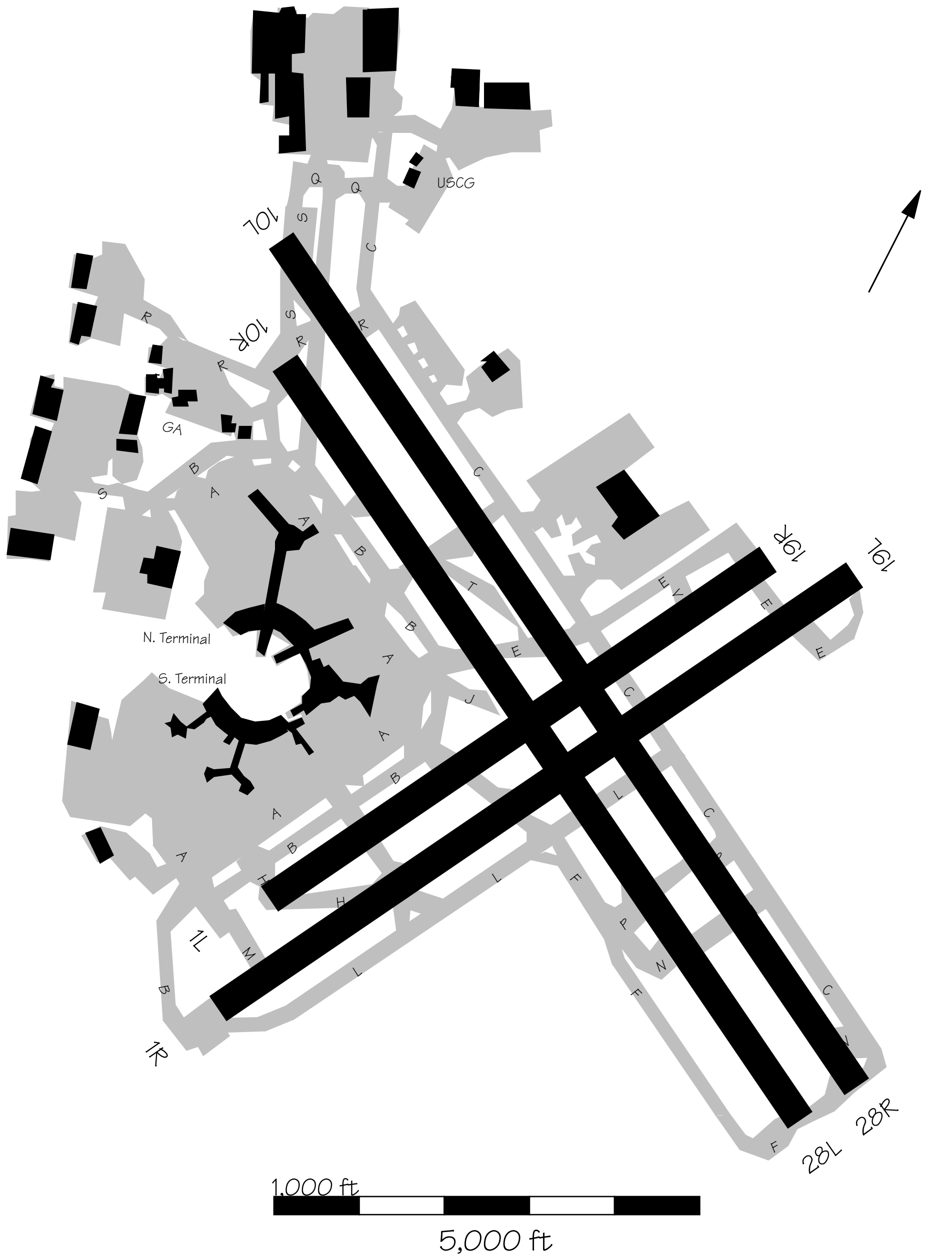


SEA — Seattle-Tacoma International Airport

Potential airport improvements include a new Runway 16W/34W, 8,500 feet in length, which will be located 2,500 feet from Runway 16L/34R. A decision on construction will be made in 1997, and the estimated cost of construction is $400 million.

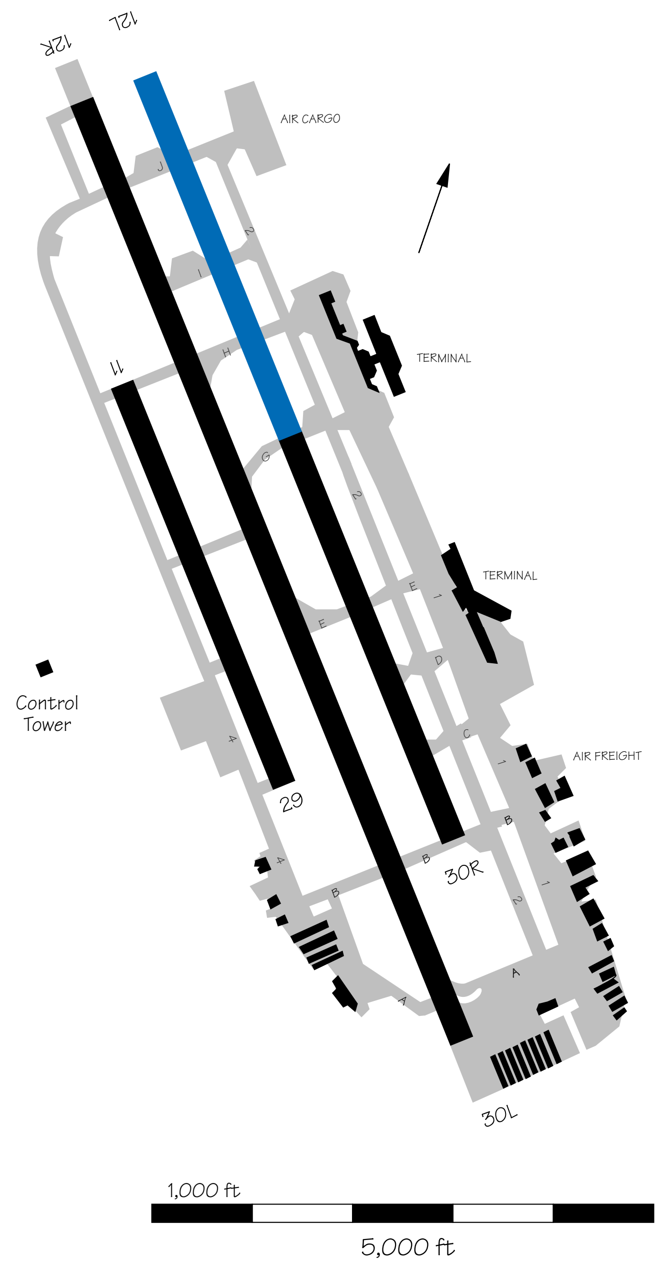


SFO — San Francisco International Airport

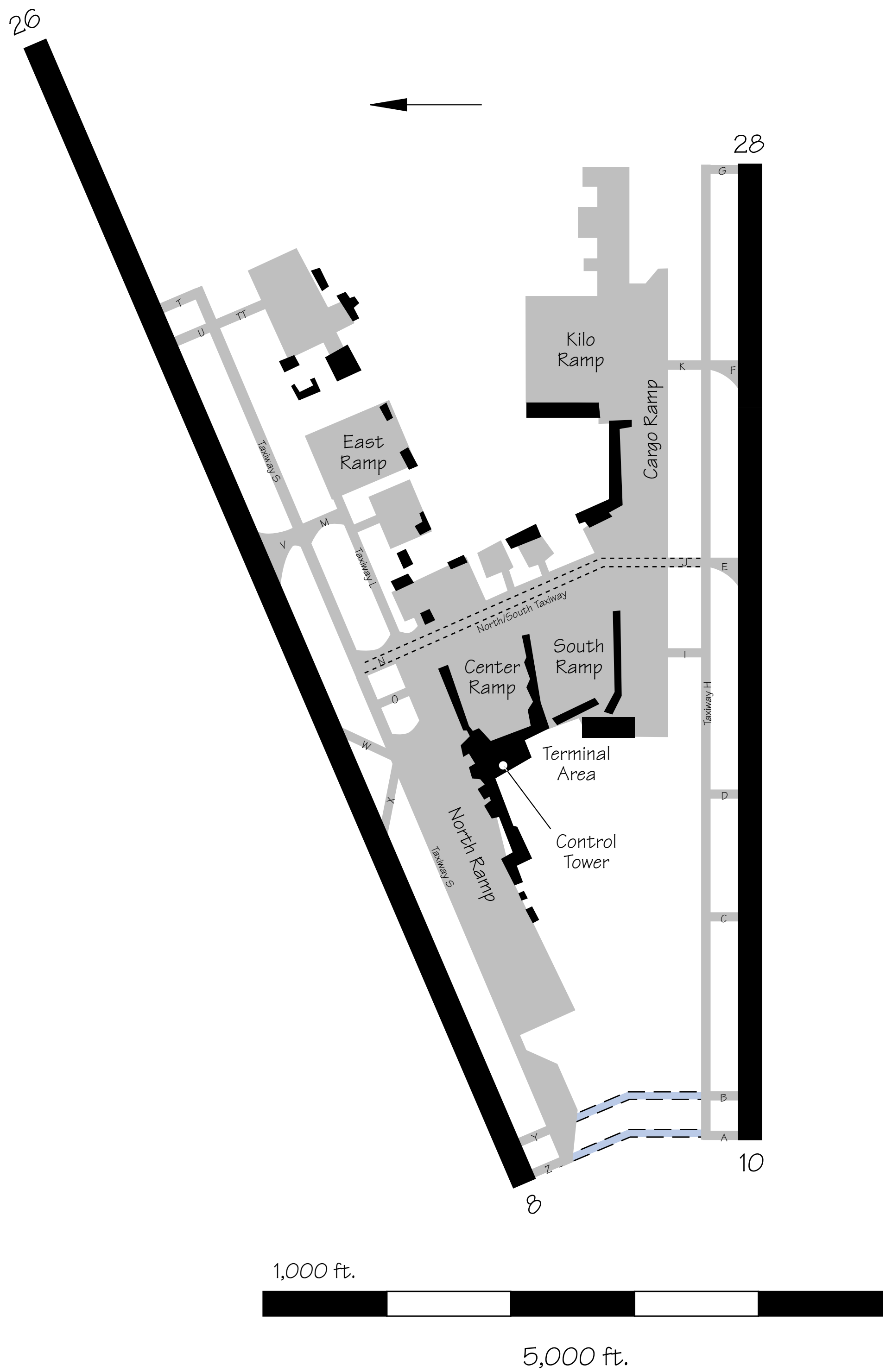


SJC — San Jose International Airport

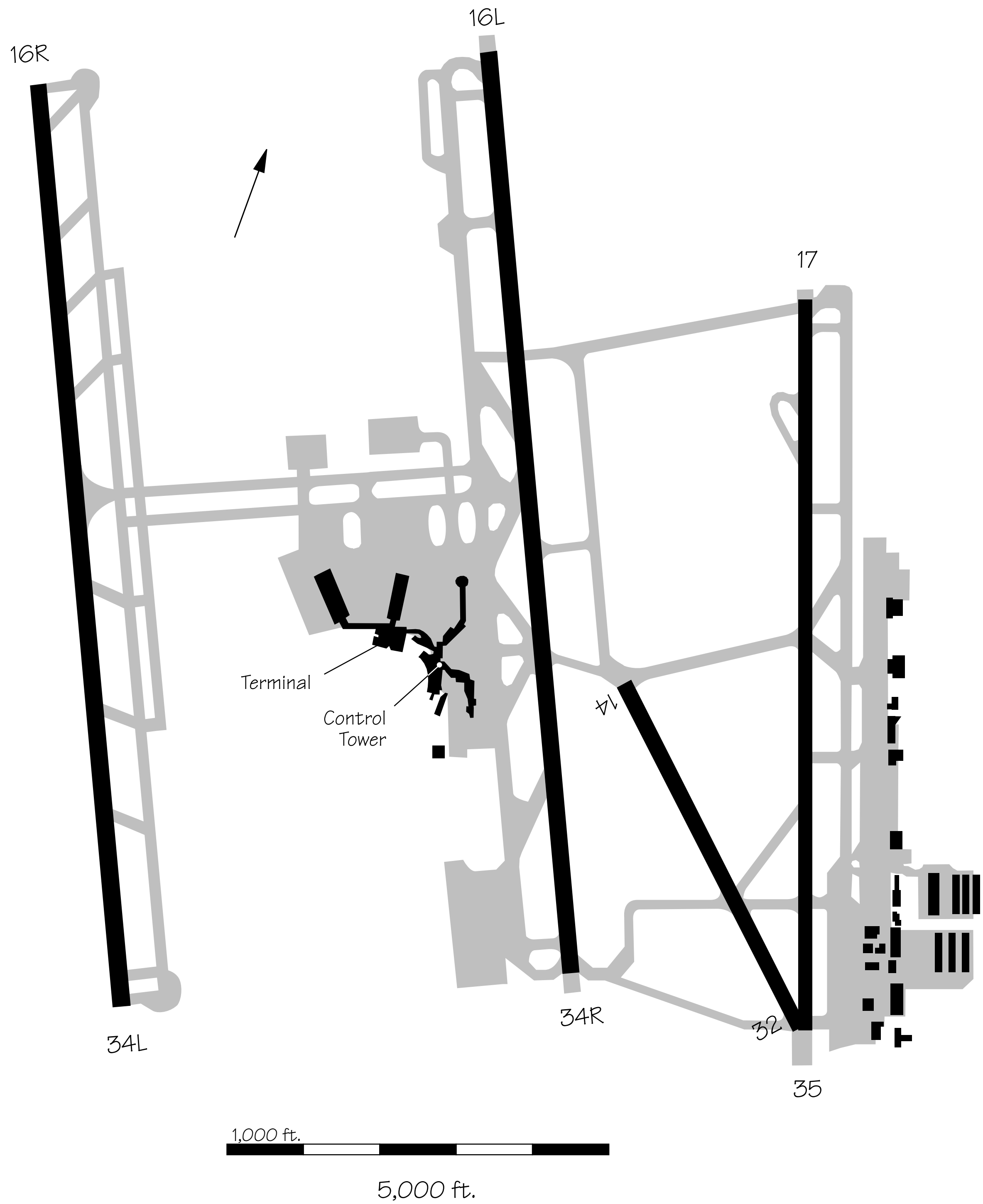
Environmental documentation is currently being prepared in support of the extension of Runway 12L/30R. If this option is determined to be environmentally acceptable and is adopted by the sponsor, construction will begin in 1997.



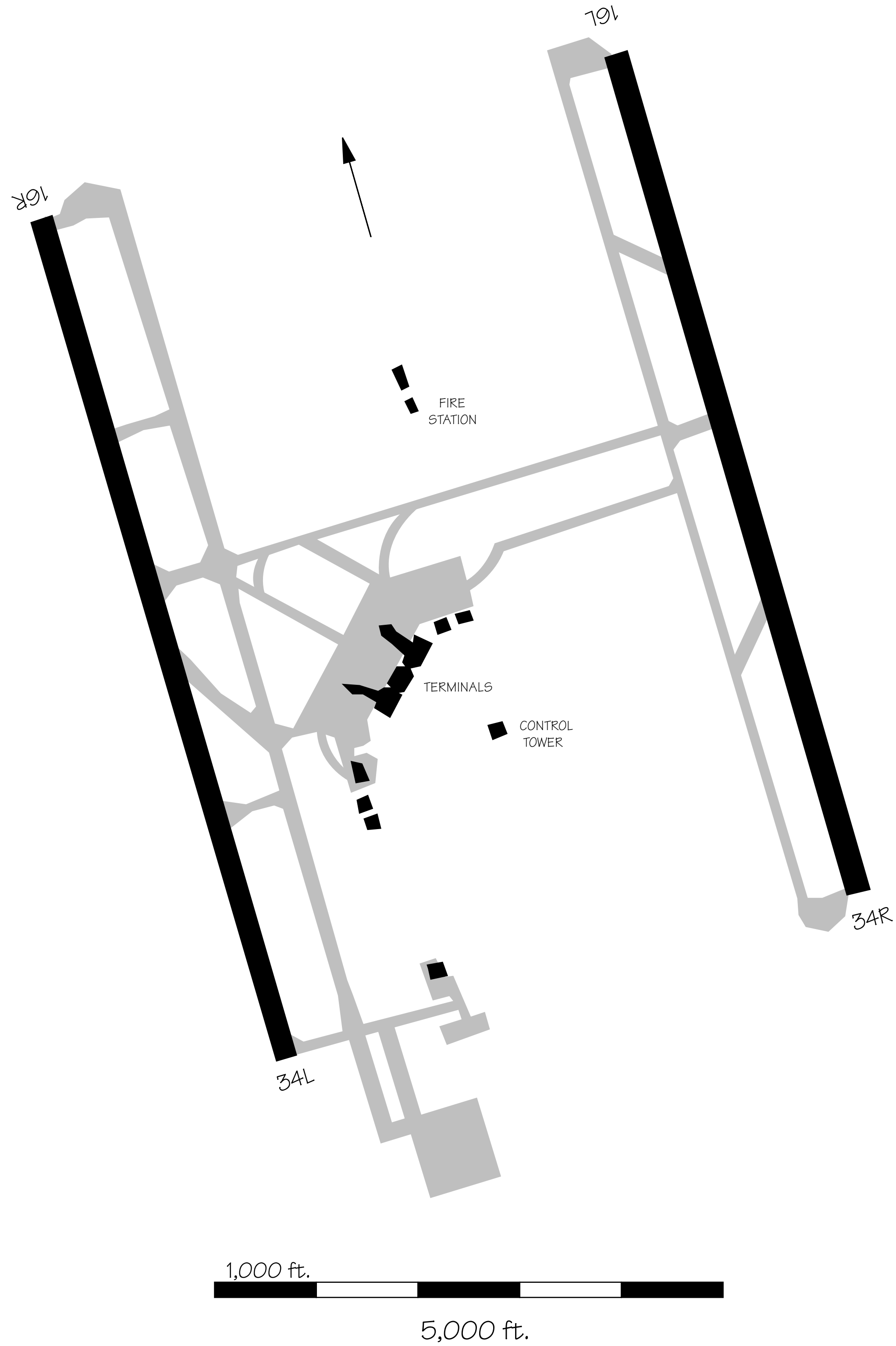
SJU — San Juan Luis Muñoz Marín International Airport



SLC — Salt Lake City International Airport

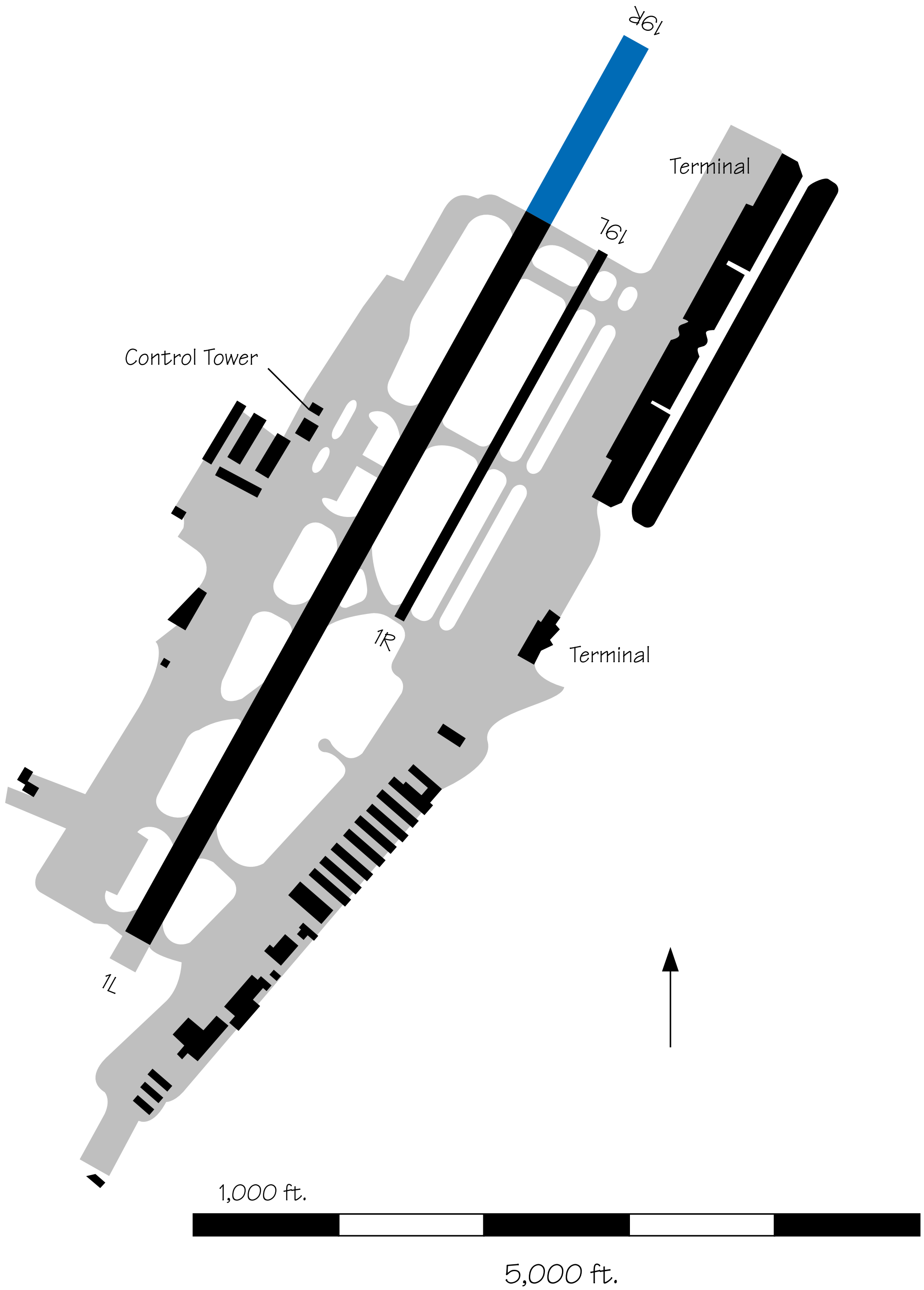


SMF — Sacramento Metropolitan Airport



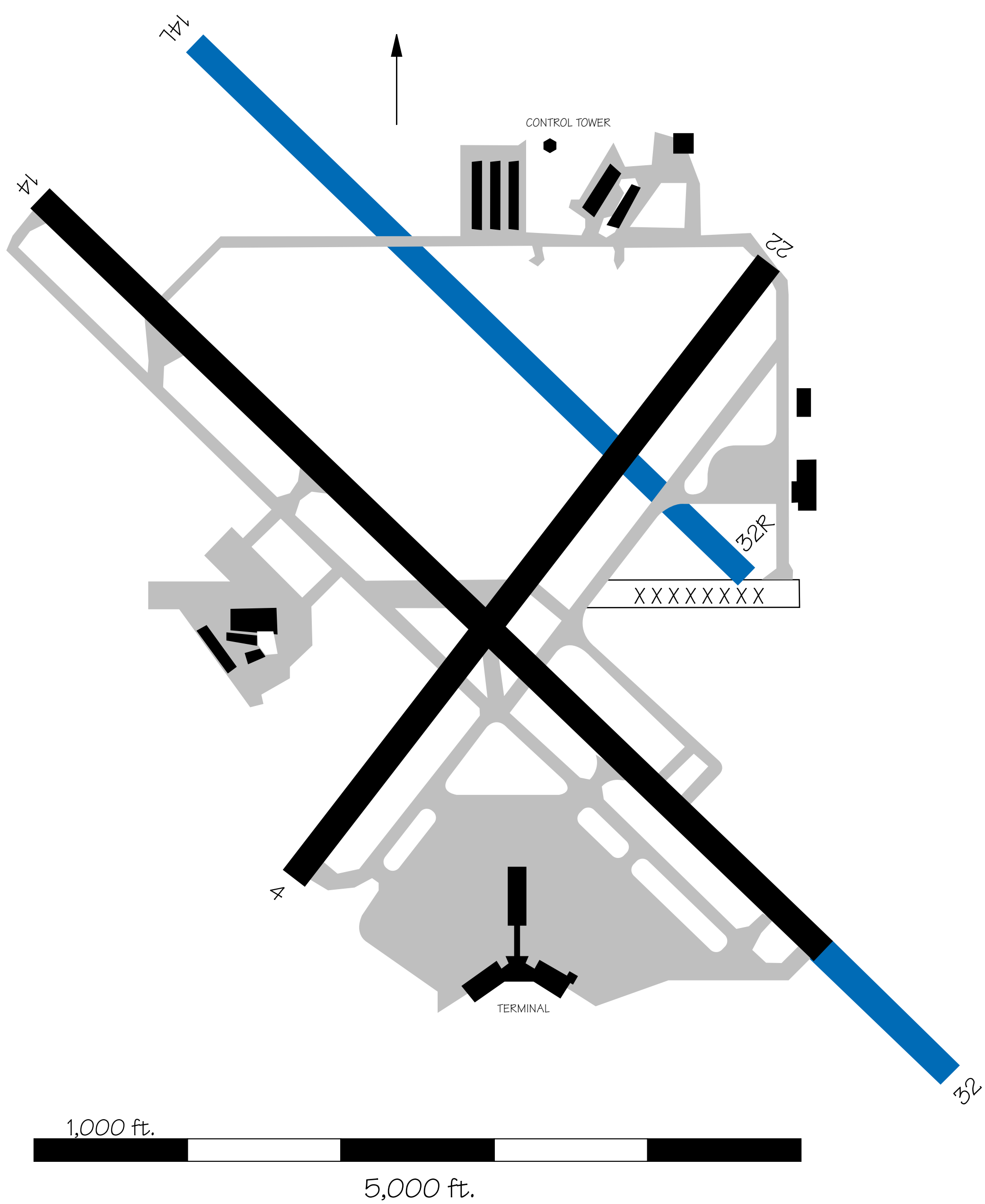
SNA — Santa Ana/John Wayne Airport - Orange County

An extension of Runway 1L/19R is under consideration.



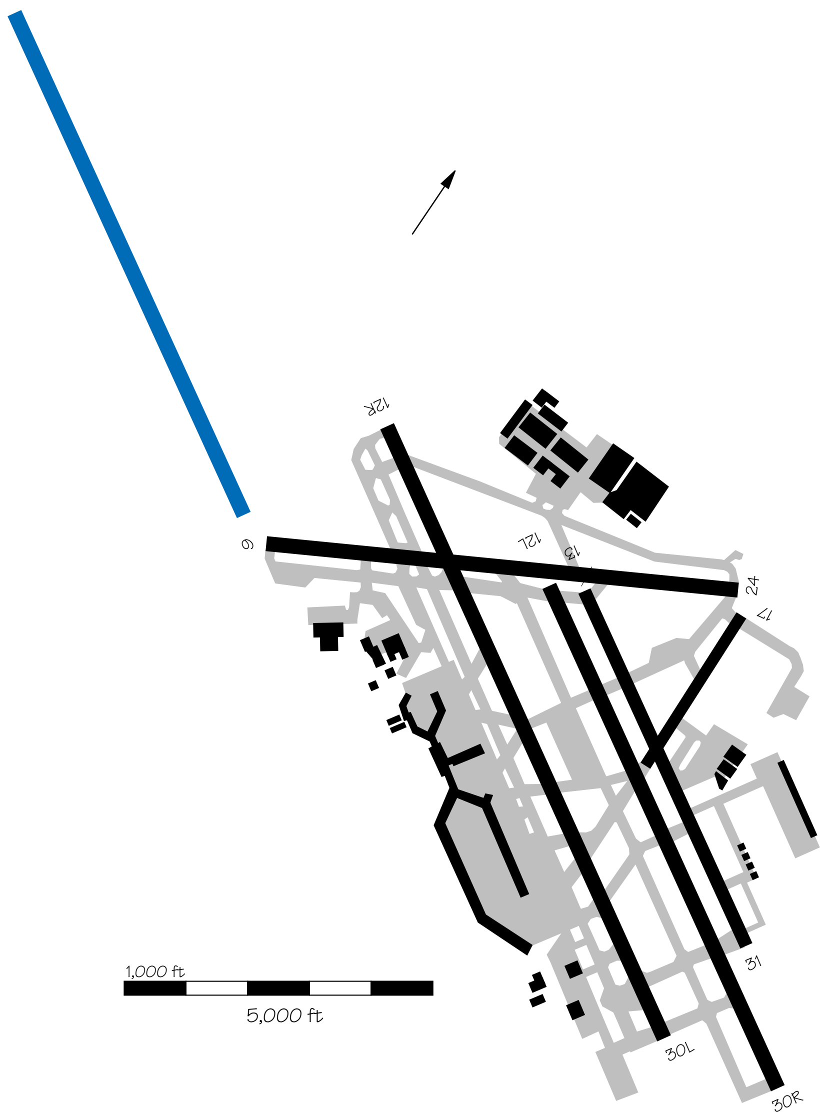
SRQ — Sarasota Bradenton Airport

A new parallel Runway 14L/32R 1,230 feet northwest of Runway 14/32 is being planned at an estimated cost of $10 million. It is expected to be operational beyond 2002. In addition, an extension of the existing Runway 14/32 is planned at a cost of $5.1 million. It is expected to be operational beyond 2002.

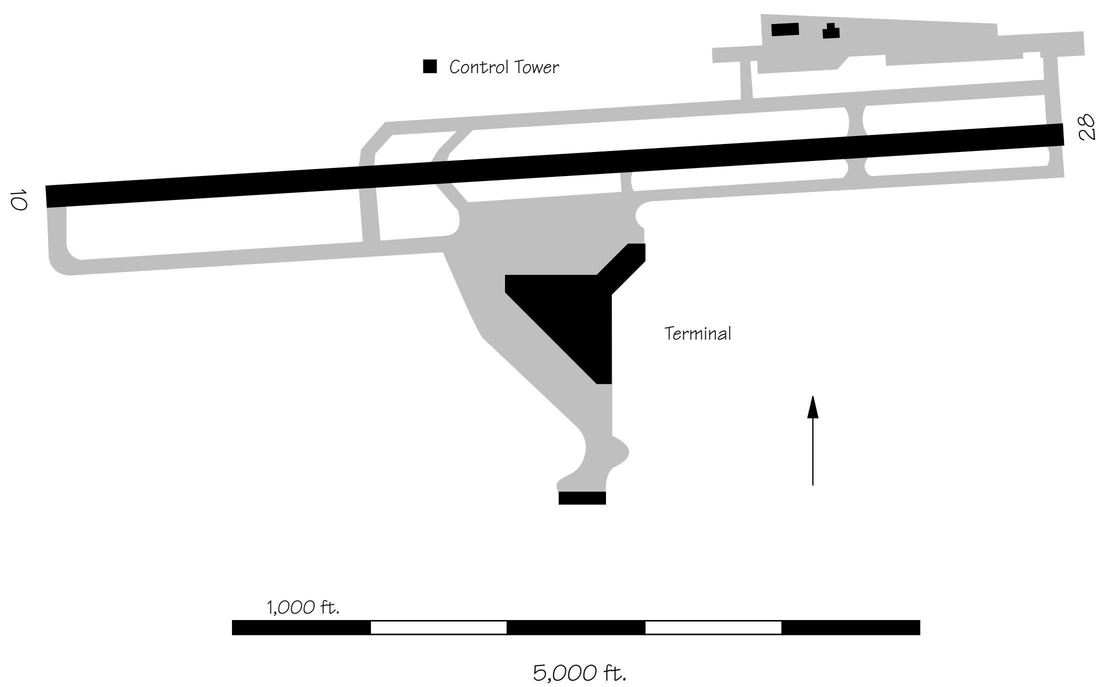


STL — Lambert St. Louis International Airport

A new parallel Runway 12R/30L has been recommended in the St. Louis Airport Master Plan Update. The new plan calls for a parallel runway supporting independent IFR operations. An EIS is also underway. The Master Plan Update and the EIS are anticipated to be completed in early 1997. The new Runway 12R/30L is planned as the first phase of the airport expansion. Construction of the runway could occur beginning in 1997, subject to environmental approval.

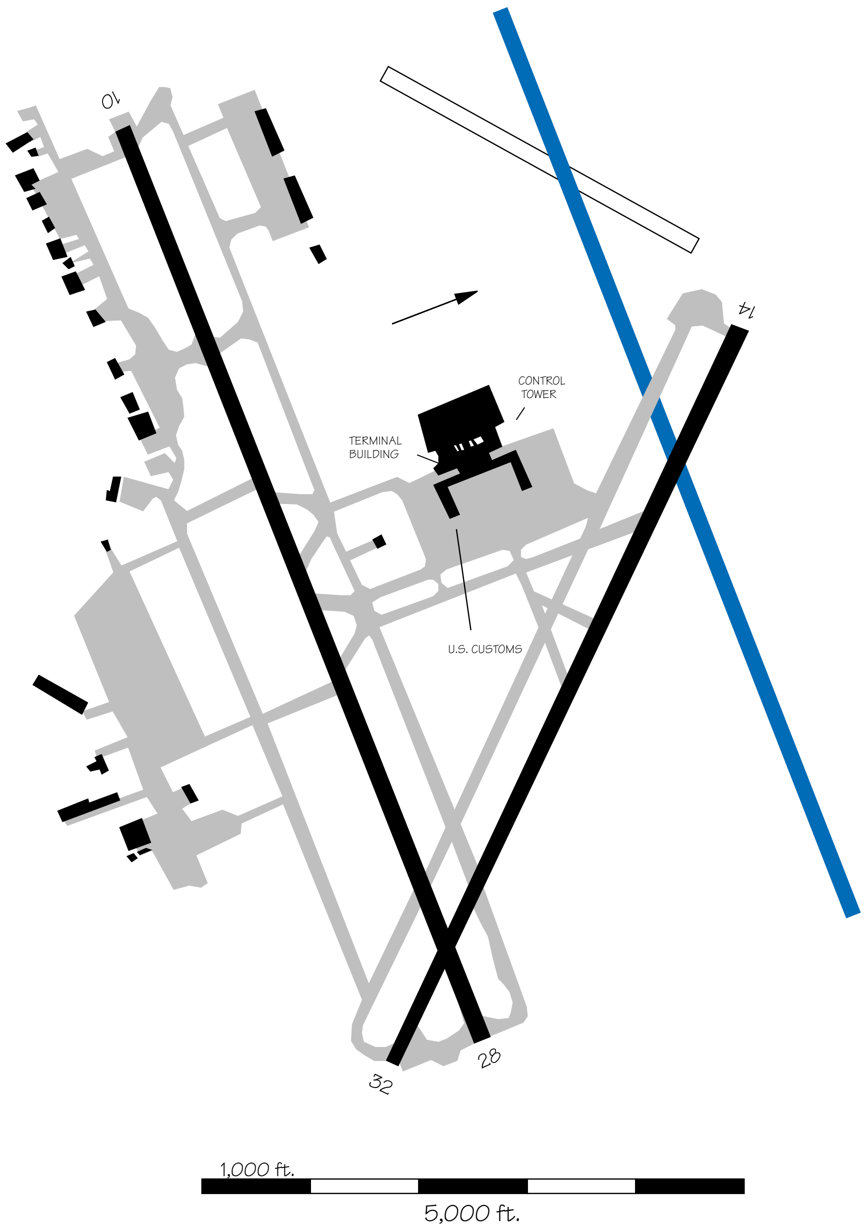


STT — Charlotte Amalie St. Thomas, Virgin Islands



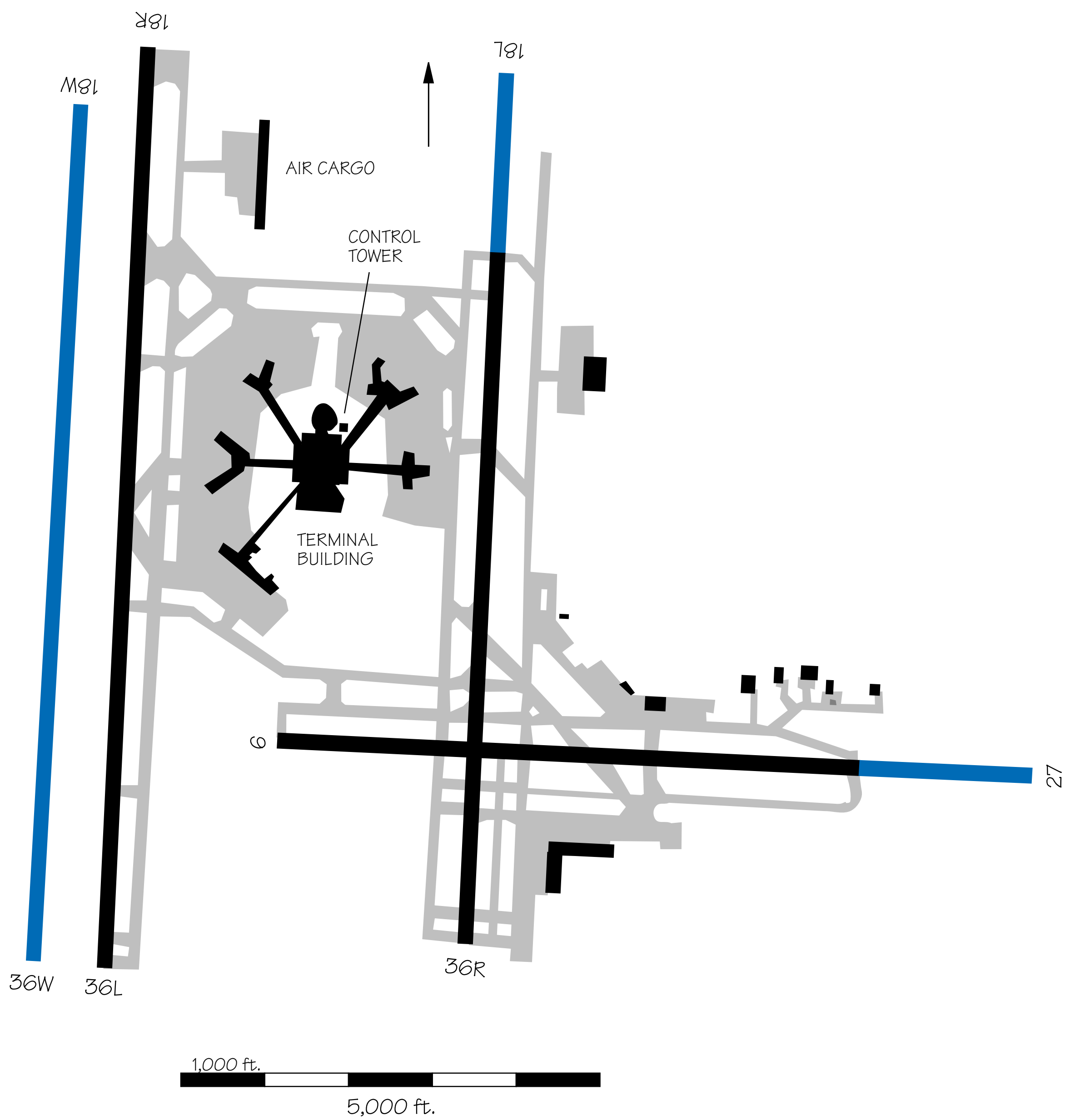
SYR — Syracuse Hancock International Airport

A new parallel Runway 10L/28R, 9,000 feet long and separated from the existing Runway 10/28 by 3,400 feet is being considered. It would provide independent parallel IFR operations, doubling hourly IFR arrival capacity. The expected operational date is 2000. The cost of construction is estimated to be $55 million for the first phase of the new runway, which would be 7,500 feet long, including a parallel taxiway and connections to the ramp. The final length of the runway will be 9,000 feet.



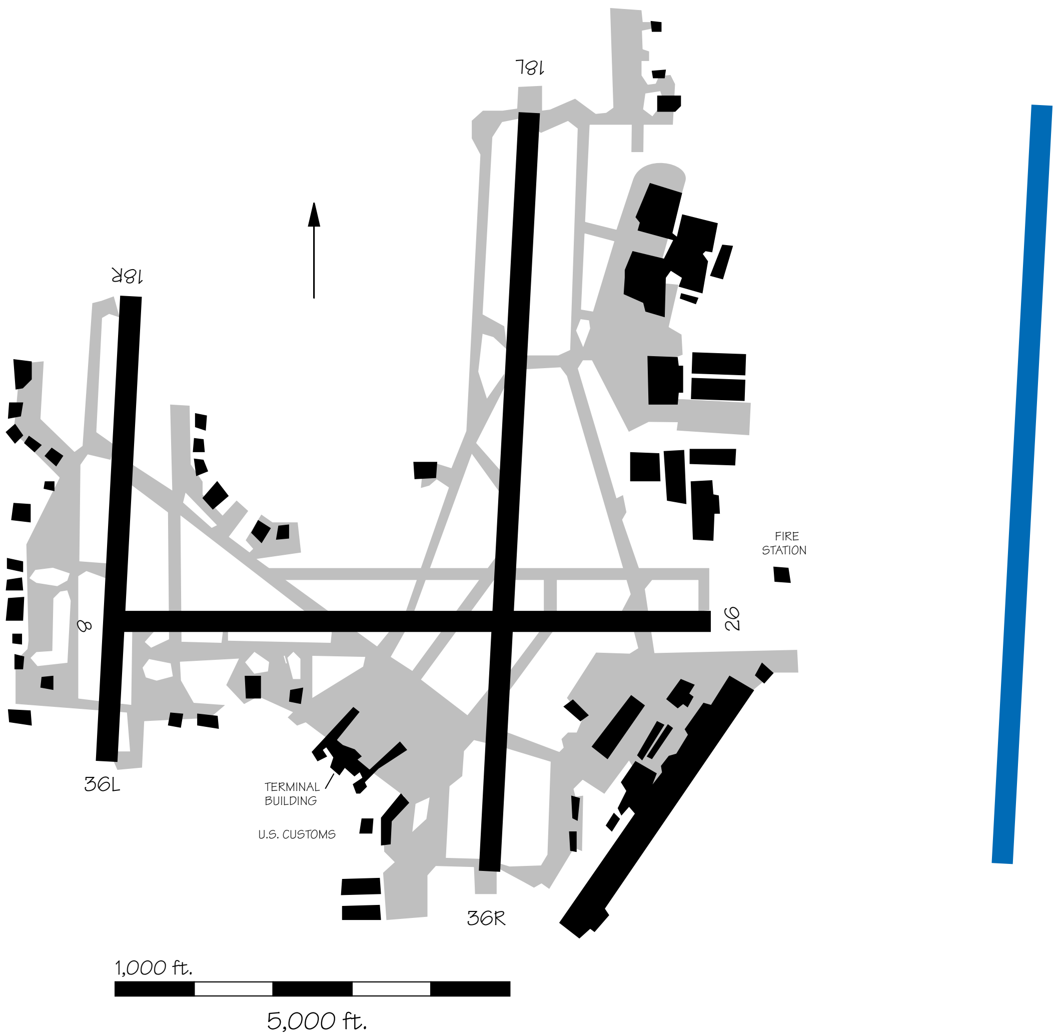
TPA — Tampa International Airport

A third parallel Runway 18W/36W 9,650 feet long and 700 feet west of Runway 18R/36L is being considered. An extension of Runway 18L is also being considered for the time frame beyond 2005, and reconstruction and extension of Runway 27, for the time frame beyond 2010.



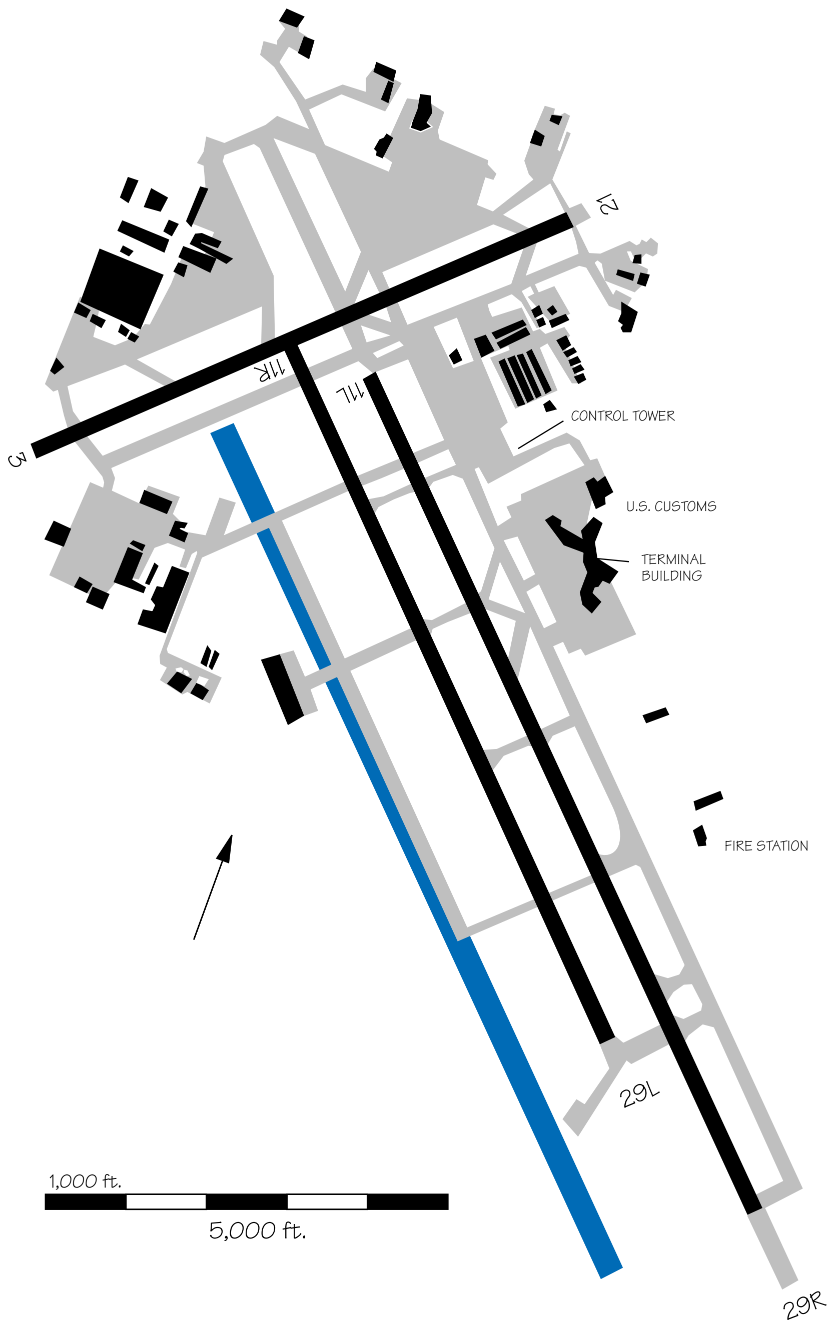
TUL — Tulsa International Airport

A new parallel runway, Runway 18L/36R, located 6,400 feet east of the present 18L/36R and 9,600 feet long, is being considered. The new runway would permit IFR triple independent approaches, if approved, to Runways 18L, 18C, and 18R.

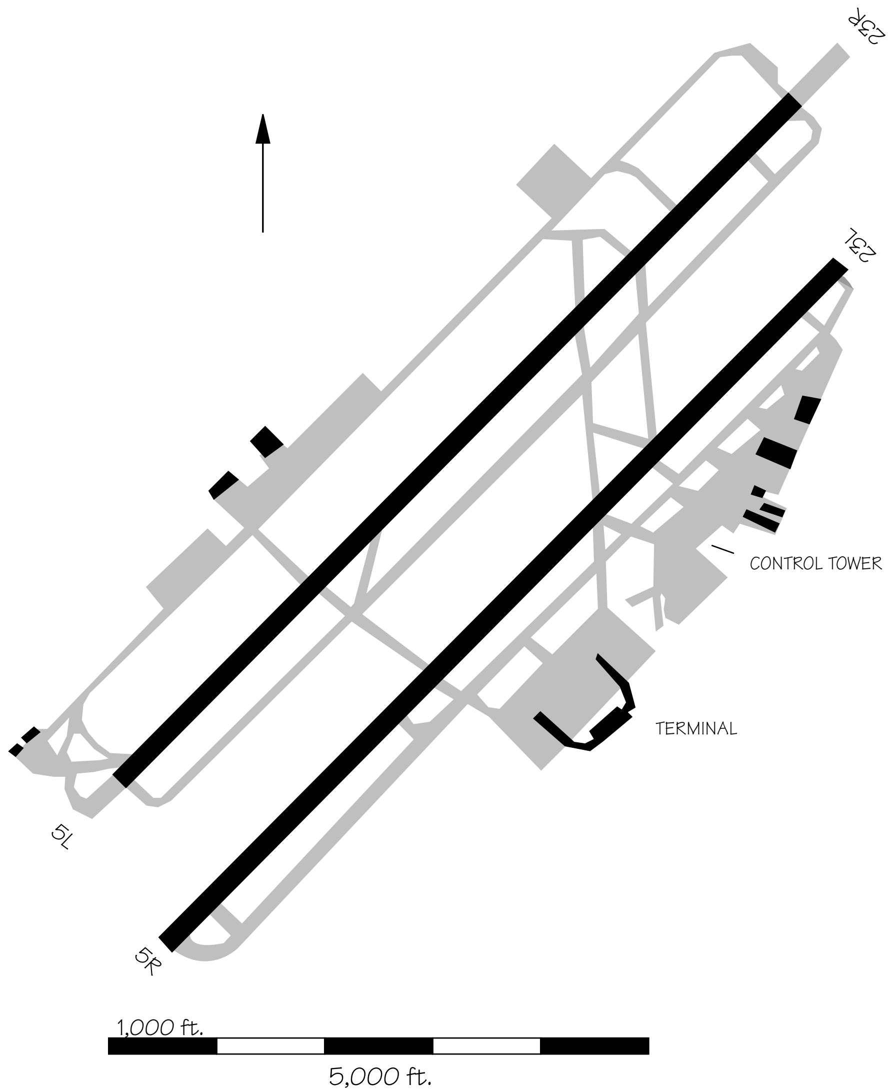


TUS — Tucson International Airport

An additional parallel air carrier runway, Runway 11R/ 29L, has been proposed. Upon completion of the new runway, the current Runway 11R/29L, a general aviation runway, will revert to its original taxiway status. It is not anticipated that the sponsor will proceed before 1998. Current plans call for construction to start in 2003 to be operational in 2005. The cost of construction is estimated to be $30 million.



TYS — Knoxville McGhee-Tyson Airport



Appendix C: Glossary

AAC .... Advanced AERA Concepts
AAF .... Army Airfield
AAP .... Advanced Automation, FAA
AAS .... Advanced Automation System
ACARS .... ARINC Communications Addressing and Reporting System
ACCC .... Area Control Computer Complex
ACD .... Engineering, Research and Development Service, FAA
ACE .... Airport Capacity Enhancement
ACF .... Area Control Facility
ADR .... Automated Demand Resolution
ADS .... Automatic Dependent Surveillance
ADSIM .... Airfield Delay Simulation Model
AERA .... Automated En Route Air Traffic Control
AEX .... Automated Execution
AF .... Airway Facilities
AFB .... Air Force Base
AGFS .... Aviation Gridded Forecast System
AGL .... Above Ground Level
AIP .... Airport Improvement Program
AIRNET .... Airport Network Simulation Model
AIV .... Aviation Impact Variable
ALP .... Airport Layout Plan
ALS .... Approach Lighting System
ALSF-II .... Approach Light System with Sequenced Flashers and CAT II modification
AMASS .... Airport Movement Area Safety System
AMSS .... Aeronautical Mobile Satellite Service
ANA .... Program Director for Automation, FAA
AND .... Associate Administrator for NAS Development, FAA
ANG .... Air National Guard
ANN .... Program Director for Navigation and Landing, FAA
ANR .... Program Director for Surveillance, FAA
ANS .... NAS Transition Implementation Service, FAA
ANW .... Program Director for Weather and Flight Service Stations, FAA
AOC .... Aeronautical Operational Control
AOR .... Operations Research Service, FAA
APO .... Office of Aviation Policy and Plans, FAA
APP .... Office of Airport Planning and Programming, FAA
ARD .... Research and Development Service, FAA
ARF .... Airport Reservation Function
ARINC .... Aeronautical Radio Incorporated
ARSA .... Airport Radar Surface Area
ARTCC .... Air Route Traffic Control Center
ARTS .... Automated Radar Terminal System
ASC .... Office of System Capacity and Requirements, FAA
ASCP .... Aviation System Capacity Plan
ASD .... Aircraft Situation Display
ASDE .... Airport Surface Detection Equipment

ASE .... NAS System Engineering Service, FAA
ASOS .... Automated Surface Observation System
ASP .... Arrival Sequencing Program
ASQP .... Airline Service Quality Performance
ASR .... Airport Surveillance Radar
ASTA .... Airport Surface Traffic Automation
ATC .... Air Traffic Control
ATCAA .... Air Traffic Control Assigned Airspace
ATCSCC .... Air Traffic Control System Command Center
ATIS .... Automated Terminal Information Service
ATN .... Aeronautical Telecommunications Network
ATMS .... Advanced Traffic Management System
ATO .... Air Traffic Operations Service, FAA
ATOMS .... Air Traffic Operations Management System
AWDL .... Aviation Weather Development Laboratory
AWOS .... Automated Weather Observing System
AWPG .... Aviation Weather Products Generator
CAA .... Civil Aviation Authority
CAEG .... Computer Aided Engineering Graphics
CARF .... Central Altitude Reservation Function
CASA .... Controller Automated Spacing Aid
CASTWG .... Converging Approach Standards Technical Working Group
CAT .... Category
CDTI .... Cockpit Display of Traffic Information
CFWSU .... Central Flow Weather Service Unit
CIP .... Capital Investment Plan
CNS .... Communication, Navigation, and Surveillance
CODAS .... Consolidated Operations and Delay Analysis System
CONDAT .... CONUS National Airspace Data Access Tool
CONUS .... Continental United States
CRDA .... Converging Runway Display Aid
CRS .... Computer Reservation System
CSD .... Critical Sector Detector
CTAS .... Center–TRACON Automation System
CTMA .... Center Traffic Management Advisor
CTR .... Civil Tilt Rotor
CVFP .... Charted Visual Flight Procedures
CW .... Continous Wave
CWSU .... Center Weather Service Unit
CY .... Calendar Year
DA .... Descent Advisor
DDAS .... Daily Decision Analysis System
DEMVAL .... Demonstration/Validation
DGPS .... Differential GPS
DH .... Decision Height
DLP .... Data Link Processor
DME .... Distance Measuring Equipment
DME/P .... Precision Distance Measuring Equipment

DOD .... Department of Defense
DOT .... Department of Transportation
DOTS .... Dynamic Ocean Tracking System
DSB .... Double Sideband
DSP .... Departure Sequencing Program
DSUA .... Dynamic Special-Use Airspace
DVOR .... Doppler VOR
ECVFP .... Expanded Charted Visual Flight Procedures
EDP .... Expedite Departure Path
EDPRT .... Expert Diagnostic, Predictive, and Resolution Tool
EFF .... Experimental Forecast Facility
EIS .... Environmental Impact Statement
EOF .... Emergency Operations Facility
ESP .... En Route Spacing Program
ETMS .... Enhanced Traffic Management System
EVAS .... Enhanced Vortex Advisory System
F&E .... Facilities and Equipment
FAA .... Federal Aviation Administration
FAATC .... Federal Aviation Administration Technical Center
FADE .... FAA-Airline Data Exchange
FAF .... Final Approach Fix
FANS .... Future Air Navigation System
FAST .... Final Approach Spacing Tool
FBO .... Fixed Base Operator
FDAD .... Full Digital ARTS Display
FL .... Flight Level
FLOWALTS...... Flow Generation Function
FLOWSIM .... Traffic Flow Planning Simulation
FMA .... Final Monitor Aid
FMS .... Flight Management System
FSD .... Full-Scale Development
FSM .... Flight Simulation Monitor
FT .... Feet
FTMI .... Flight Operations and Air Traffic Management Integration
FY .... Fiscal Year
GA .... General Aviation
GAO .... General Accounting Office
GDP .... Gross Domestic Product
GLONASS........ Global Orbiting Navigational Satellite System
GNSS............... Global Navigation Satellite System
GPS .... Global Positioning System
GRADE .... Graphical Airspace Design Environment
HARS .... High Altitude Route System
HIRL .... High Intensity Runway Lights
HUD .... Heads-Up Display
HF................... High Frequency

ICAO .... International Civil Aviation Organization
IFCN .... Inter-Facility Flow Control Network
IFR .... Instrument Flight Rules
I-LAB .... Integration and Interaction Laboratory
ILS .... Instrument Landing System
IMC .... Instrument Meteorological Conditions
INMARSAT ...... International Maritime Satellite
IOC .... Initial Operational Capability
ISSS .... Initial Sector Suite System
ITS .... Intelligent Tutoring System
ITWS .... Integrated Terminal Weather System
LDA .... Localizer Directional Aid
LIP .... Limited Implementation Program
LLWAS .... Low Level Wind Shear Alert System
LORAN .... Long Range Navigation
MA .... Monitor Alert
MALSR .... Medium Intensity Approach Lighting System with RAIL
MAP .... Military Airport Program
MAP .... Missed Approach Point
MASPS .... Minimum Aviation System Performance Standards
MCAS .... Marine Corps Air Station
MCF .... Metroplex Control Facility
MDCRS .... Meteorological Data Collection and Reporting System
MIT .... Miles In Trail
MLS .... Microwave Landing System
MNPS .... Minimum Navigation Performance Specifications
MOA .... Military Operations Area
MOPS .... Minimum Operations Performance Standards
MRAD .... Milli-Radian
MWP .... Meteorologist Weather Processor
NAS .... Naval Air Station
NAS .... National Airspace System
NASP .... NAS Plan
NASPAC .... NAS Performance Analysis Capability
NASPALS .... NAS Precision Approach and Landing System
NASSIM .... NAS Simulation Model
NATSPG .... North Atlantic Special Planning Group
NAVAID .... Navigational Aid
NCF .... National Control Facility
NCP .... NAS Change Proposal
NEXRAD .... Next Generation Weather Radar
NFDC .... National Flight Data Center
NMC .... National Meteorological Center
NMCC .... National Maintenance Coordination Complex
NM .... Nautical Mile
NOAA .... National Oceanic and Atmospheric Administration
NPIAS .... National Plan of Integrated Airport Systems
NSC .... National Simulation Capability
NTP .... National Transportation Policy

NTZ .... No Transgression Zone
NWS .... National Weather Service
OAG .... *Official Airline Guide*
ODALS .... Omni-Directional Approach Lighting System
ODAPS .... Oceanic Display and Planning System
ODF .... Oceanic Development Facility
ODL .... Oceanic Data Link
OMB .... Office of Management and Budget
OPTIFLOW ..... Optimized Flow Planning
ORD .... Operational Readiness Date
ORD .... Operational Readiness Demonstration
OST .... Office of the Secretary of Transportation
OTFP .... Operational Traffic Flow Planning
OTPS .... Oceanic Traffic Planning System
PADS .... Planned Arrival and Departure System
PAPI .... Precision Approach Path Indicator
PCA .... Positive Control Airspace
PDC .... Pre-Departure Clearance
PRM .... Precision Runway Monitor
R&D .... Research and Development
RE&D .... Research, Engineering, and Development
RAIL .... Runway Alignment Indicator Lights
RDSIM .... Runway Delay Simulation Model
REIL .... Runway End Identifier Lights
RFP .... Request for Proposal
RGCSP .... Review of General Concepts of Separation Panel
RMM .... Remote Maintenance Monitoring
RMP .... Rotorcraft Master Plan
RNAV .... Remote Area Navigation
RNP .... Required Navigation Performance
RNPC .... Required Navigation Performance Capability
ROT .... Runway Occupancy Time
RSLS .... Runway Status Light System
RTCA .... Radio Technical Commission for Aeronautics
RVR .... Runway Visual Range
SAR .... System Analysis Recording
SARPS .... Standards and Recommended Practices
SATCOM .... Satellite Communications
SCIA .... Simultaneous Converging Instrument Approaches
SDAT .... Sector Design Analysis Tool
SDRS .... Standardized Delay Reporting System
SE .... Strategy Evaluation
SID .... Standard Instrument Departure
SIMMOD .... Airport and Airspace Simulation Model
SM .... Statute Mile
SMARTFLOW .. Knowledge-Based Flow Planning
SMGC .... Surface Movement Guidance and Control
SMS .... Simulation Modeling System
SOIR .... Simultaneous Operations on Intersecting Runways

SOIWR .... Simultaneous Operations on Intersecting Wet Runways
STAR .... Standard Terminal Arrival Route
SUA .... Special Use Airspace
TACAN .... Tactical Air Navigation —
UHF omnidirectional course and distance information
TASS .... Terminal Area Surveillance System
TATCA .... Terminal ATC Automation
TAVT .... Terminal Airspace Visualization Tool
TCA .... Terminal Control Area
TCAS .... Traffic Alert and Collision Avoidance System
TCCC .... Tower Control Computer Complex
TDP .... Technical Data Package
TERPS .... Terminal Instrument Procedures
TFM .... Traffic Flow Management
TIDS .... Tower Integrated Display System
TMA .... Traffic Management Advisor
TMCC .... Traffic Management Computer Complex
TMS .... Traffic Management System
TMU .... Traffic Management Unit
TRACON .... Terminal Radar Approach Control
TSC .... Volpe Transportation Systems Center
TSO .... Technical Standard Order
TTMA .... TRACON Traffic Management Advisor
TVOR .... Terminal VOR
TWDR .... Terminal Weather Doppler Radar
USWRP .... U.S. Weather Research Program
VASI .... Visual Approach Slope Indicators
VF .... Vertical Flight
VFR .... Visual Flight Rules
VHF .... Very High Frequency
VMC .... Visual Meteorological Conditions
VOR .... VHF Omnidirectional Range — course information only
VORTAC .... Combined VOR and TACAN Navigational Facility
VOT .... VOR Test
WAAS .... Wide Area Augmentation System

Appendix D: Index

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* A note concerning airport names and locations:

This index does not reference the occurrences of airports that appear in any Tables or Figures. For a listing of Tables and Figures, please see the Table of Contents. For a listing of airport layouts, please refer to Appendix B.

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