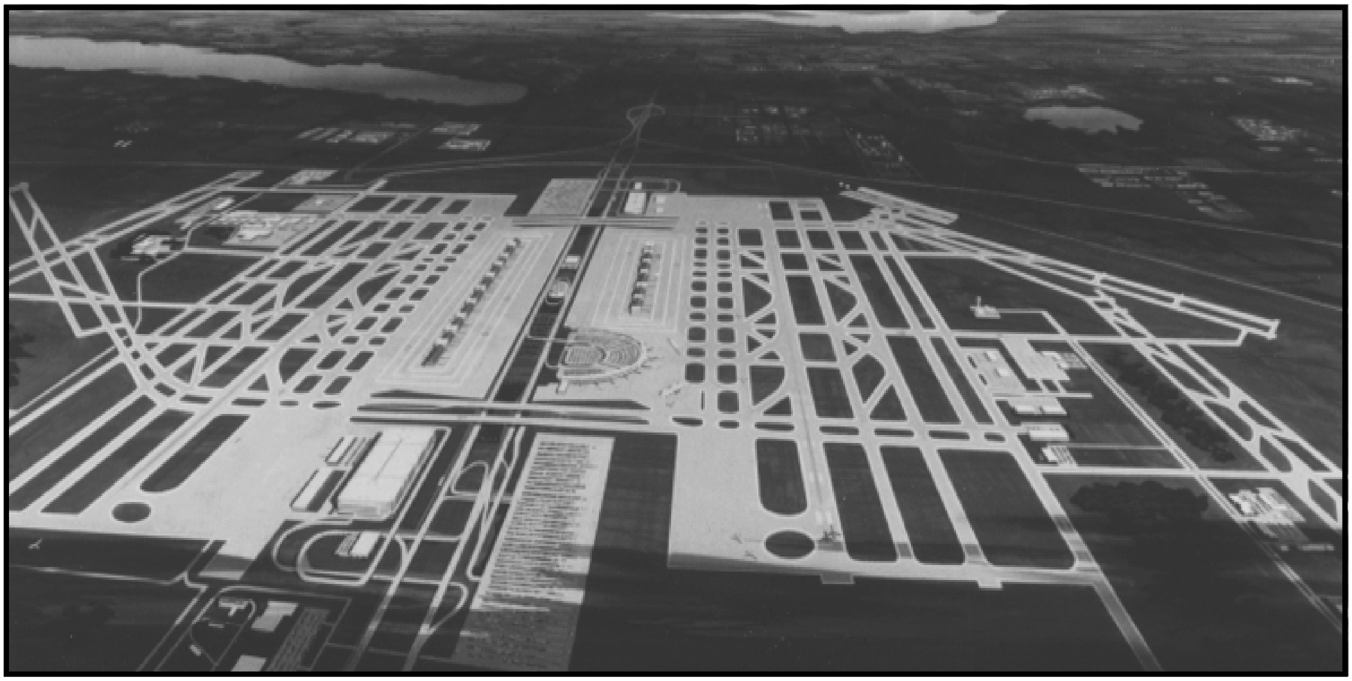
Dallas-Fort Worth International Airport

Short-Term
Capacity Enhancement Plan



Dallas-Fort Worth International Airport

Short-Term Capacity Enhancement Plan

September 1994

Prepared jointly by the U.S. Department of Transportation, Federal Aviation Administration, the Dallas-Fort Worth International Airport Board, and the airlines and general aviation serving the Dallas-Fort Worth Metroplex.

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Summary

Recognizing the problems posed by congestion and delay within the National Airspace System, the Federal Aviation Administration (FAA), airport operators, and aviation industry groups have initiated joint Airport Capacity Design Teams at various major air carrier airports throughout the U.S. Each Capacity Team identifies and evaluates alternative means to enhance existing airport and airspace capacity to handle future demand, decrease delays, and improve airport efficiency. The Team works to develop a coordinated action plan for reducing airport delay. Over 30 Airport Capacity Design Teams have either completed their studies or have work in progress.

The need for this program continues. Dallas-Fort Worth International Airport (DFW) is one of the 23 airports that exceeded 20,000 hours of airline flight delays in 1993 and, according to FAA forecasts, is one of the 32 airports that could exceed 20,000 hours of annual delay in 2003, if no improvements in capacity are made. Steady growth at DFW has made it one of the two busiest airports in the country and in the world. Activity at the airport has increased from 12,861,000 passenger enplanements in 1983 to 27,863,000 in 1993, an increase of 117 percent. In 1983, the airport handled 427,000 aircraft operations (takeoffs and landings), and, in 1993, 803,655 aircraft operations, an increase of 88 percent.

An Airport Capacity Design Team for Dallas-Fort Worth International Airport was formed in 1992. The DFW Capacity Team identified and assessed various actions that, if implemented, would increase DFW's capacity, improve operational efficiency, and reduce aircraft delays. The purpose of the process was to determine the technical merits of each alternative action and its impact on capacity. Additional studies will be needed to assess environmental, socioeconomic, or political issues associated with these actions.

Selected alternatives identified by the Capacity Team were tested using a computer model developed by the FAA to quantify the benefits provided. Different levels of activity were chosen to represent growth in aircraft operations in order to compare the merits of each action. These activity levels are referred to throughout this report as:

- Baseline — 764,243 annual operations
- Future 1 — 950,000 annual operations
- Future 2 — 1,200,000 annual operations
- Future 3 — 1,400,000 annual operations

The Airport Capacity Design Team Study at DFW is somewhat different, because large-scale improvement plans, like the need for new runways, have already been defined in the Airport Development Plan (ADP), which identifies facilities needed to accommodate forecast aviation demand at the Airport through the year 2010. The focus of this study has been on improvements to taxiways, airspace, navigation aids, and operational strategies that would most efficiently accommodate the existing and ultimate runway configurations.

This report documents the first phase of the study. In this first phase, only short-term improvements associated with the existing airfield and the new parallel Runway 16E/34E were evaluated, and only the Baseline and Future 1 activity levels were analyzed.

Based on the analysis completed during the first phase of the study, the Capacity Team recommended the capacity enhancement alternatives listed in the table below.

In addition, the Capacity Team recommended that more study be completed for the following capacity enhancement alternatives.

- Extend Runway 18L/36R by 2,000 feet to the north and construct the associated hold pad.
- Extend Runway 18R/36L by 2,000 feet to the north.
- Construct perimeter taxiways to reduce runway crossings.
- Assess alternative taxiway configurations for Runways 16E/34E and 16W/34W.

Alternatives Recommended	Future 1 Annual Delay Savings Millions of 1993 Dollars
• Extend Runway 17L/35R by 2,000 feet to the north	$1.1
• Reduce converging approach weather minimums	$1.0
• Allow simultaneous jet departures on close parallel runways under VFR	$14.2
• Reduce in-trail separations for arrivals under IFR	$10.4
• Construct an additional high-speed exit from Taxiway 23 to Taxiway 25 for any extended runways	

Figure 1. Dallas-Fort Worth International Airport

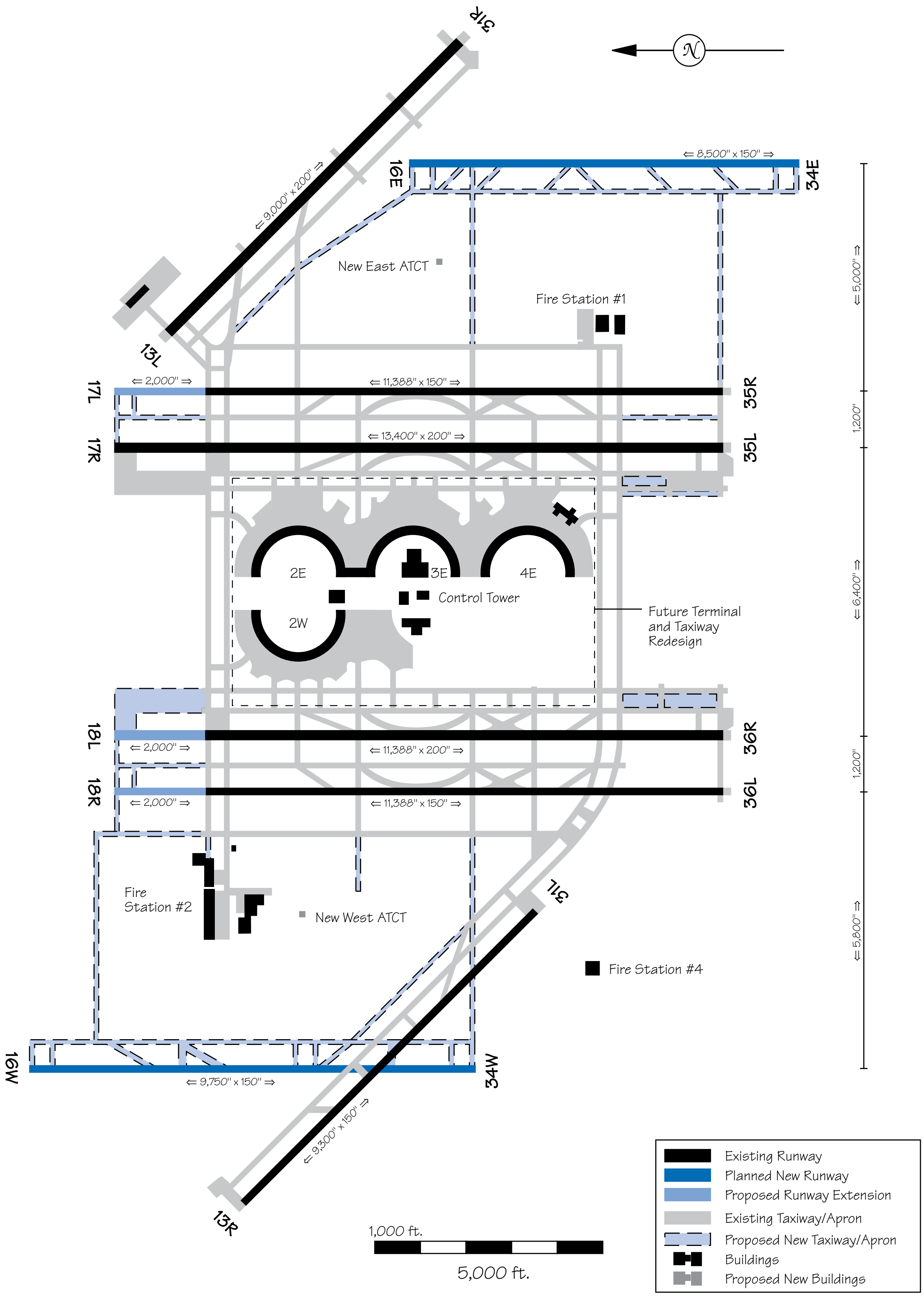


Figure 2. Capacity Enhancement Alternatives and Annual Delay Savings

Airfield Improvements	Estimated Annual Delay Savings* (in millions of 1993 $) Future 1 (950,000)
1. Extend runways 2,000 ft. to the north	
1a. Extend Runway 17L/35R	$1.1
1b. Extend Runway 18L/36R	-$4.3
1c. Extend Runway 18R/36L	$0.0
2. Construct perimeter taxiways	—
3 Construct additional high-speed runway exits	†
3a. To inboard taxiways — With existing airfield	
3b. To outboard taxiways — With existing airfield	
3c. To inboard taxiways — With extended runways	
3c. To outboard taxiways — With extended runways	
Operational Improvements	
4 Optimize use of existing high-speed exits	†
5. Reduce converging approach weather minimums	$1.0
6 Allow simultaneous jet departures on close parallel runways under VFR	$14.2
7 Reduce in-trail separations for arriving aircraft under IFR	$10.4
8. Implement demand management	†
9 Enhance reliever and GA airport system	†

* Delay savings based on B757 3 mile in-trail separation (old standard).

† These improvements were not simulated. Therefore, no dollar figures are available. There is a description of each of these items in Section 2 — Capacity Enhancement Alternatives.

Note: In comparing delay estimates for the Baseline and Future 1 demand levels, it should be noted that, in addition to the increase in demand, capacity has increased with the addition of Runway 16E/34E. Based on SIMMOD analysis for the ADP, it is estimated that average annual delays would be about 4.2 minutes higher per operation without Runway 16E/34E. The estimated annual savings in aircraft operating costs associated with Runway 16E/34E are $79 million.

SECTION 1

INTRODUCTION

Background

Recognizing the problems posed by congestion and delay within the National Airspace System, the Federal Aviation Administration (FAA) asked the aviation community to study the problem of airport congestion through the Industry Task Force on Airport Capacity Improvement and Delay Reduction chaired by the Airport Operators Council International.

By 1984, aircraft delays recorded throughout the system highlighted the need for more centralized management and coordination of activities to relieve airport congestion. In response, the FAA established the Airport Capacity Program Office, now called the Office of System Capacity and Requirements (ASC). The goal of this office and its capacity enhancement program is to identify and evaluate initiatives that have the potential to increase capacity, so that current and projected levels of demand can be accommodated within the system with a minimum of delay and without compromising safety or the environment.

In 1985, the FAA initiated a renewed program of Airport Capacity Design Teams at various major air carrier airports throughout the U.S. Each Capacity Team identifies and evaluates alternative means to enhance existing airport and airspace capacity to handle future demand and works to develop a coordinated action plan for reducing airport delay. Over 30 Airport Capacity Design Teams have either completed their studies or have work in progress.

The need for this program continues. In 1992, 23 airports each exceeded 20,000 hours of airline flight delays. If no improvements in capacity are made, the number of airports that could exceed 20,000 hours of annual aircraft delay is projected to grow from 23 to 33 by 2002. The challenge for the air transportation industry in the nineties is to enhance existing airport and airspace capacity and to develop new facilities to handle future demand. As environmental, financial, and other constraints continue to restrict the development of new airport facilities in the U.S., an increased emphasis has been placed on the redevelopment and expansion of existing airport facilities.

Dallas-Fort Worth International Airport

Dallas-Fort Worth International Airport (DFW) is, in fact, one of the 23 airports that exceeded 20,000 hours of annual aircraft delay in 1993, and, according to FAA forecasts, one of the 32 airports that could exceed 20,000 hours of annual aircraft delay by 2003, if no improvements in capacity are made. Even with the planned addition of two runways, the projected growth for the airport will result in delay levels that will be near or greater than the existing level of delays. In the past decade, DFW has been one of the Nation's busiest airports. Enplanements at DFW rose from 12,861,000 in 1983 to 27,863,000 in 1993, an increase of 117 percent. DFW's total aircraft operations (takeoffs and landings) reached 803,655 in 1993, an increase of 88 percent over the 427,000 aircraft operations the airport handled in 1983.

Dallas-Fort Worth International Airport is jointly owned by the cities of Dallas and Fort Worth. The Airport is managed and operated by the Dallas-Fort Worth Airport Board. DFW is located midway between the Dallas and Fort Worth central business districts, a distance of about 17 miles. There are about 17,600 acres within the Airport boundaries. The airfield has six runways (the short-takeoff-and-landing (STOL) runway was decommissioned early in 1994).

- Runway 17L/35R is 11,388 ft. long and 150 ft. wide.
- Runway 17R/35L is 13,400 ft. long and 200 ft. wide.
- Runway 18L/36R is 11,388 ft. long and 200 ft. wide.
- Runway 18R/36L is 11,388 ft. long and 150 ft. wide.
- Runway 13L/31R is 9,000 ft. long and 200 ft. wide.
- Runway 13R/31L is 9,300 ft. long and 150 ft. wide.

In March 1991, the Dallas-Fort Worth International Airport Board completed the Airport Development Plan (ADP) for the Airport. The ADP identifies facilities needed to accommodate forecast aviation demand at the Airport through the year 2010. The two most significant airfield recommendations included in the ADP are to construct two new north-south runways capable of accommodating air carrier aircraft. The new runways will be constructed parallel to the existing north-south runways, and the separation distances of the new runways from the existing runways will permit four simultaneous approaches under instrument flight rules (IFR).

Runway 16E/34E will be 8,500 feet long and 150 feet wide and will be located 5,000 feet east of and parallel to the existing Runway 17L/35R. Runway 16E/34E is currently under construction and is scheduled to be opened in December 1996.

Runway 16W/34W will be 9,750 feet long and 150 feet wide and will be located 5,800 feet west of and parallel to the existing Runway 18R/36L. It will intersect the existing west diagonal Runway 13R/31L. The length of the new runway is a function of the distance required south of the intersection to maximize north flow capacity in conjunction with takeoffs on Runway 13R/31L.

In order to ensure that adequate airspace capacity would be available to accommodate increasing demand in the Dallas-Fort Worth Metroplex and to prepare for future expansion at the Airport, the FAA Southwest Region undertook a study to develop the Dallas-Fort Worth Metroplex Air Traffic System Plan (Metroplex Plan). The objective of this effort was to prepare an expanded airspace structure that would serve the anticipated facilities at Dallas-Fort Worth International Airport, as well as the other airports in the Metroplex: Dallas Love Field, Naval Air Station (NAS) Dallas, and Fort Worth Meacham Field. NAS Dallas is slated to close in the near future, and most military functions will be transferred to Carswell AFB. The recommended Metroplex Plan includes an expanded terminal control area, additional navigational equipment, parallel arrival routes into the Airport area, additional departure routes, altitude separation for jet and propeller aircraft, and provisions for triple and quadruple simultaneous approaches to the Airport under instrument flight rules (IFR).

As the number of aircraft operations has increased since the completion of the ADP, the major carriers serving the Airport have reported that delays, particularly those to taxiing aircraft, have increased. In 1991, the Airport Board and the FAA decided to conduct an Airport Capacity Design Team study of potential short-term delay-reduction measures, because it would be several years before the new runways and associated taxiways recommended in the ADP would be constructed and ready for use.

Dallas-Fort Worth Airport Capacity Design Team

An Airport Capacity Design Team for Dallas-Fort Worth International Airport was formed in 1992. The DFW Capacity Team identified and assessed various actions that, if implemented, would increase capacity, improve operational efficiency, and reduce aircraft delays. The purpose of the process was to determine the technical merits of each alternative action and its impact on capacity. Additional studies will be needed to assess environmental, socioeconomic, or political issues associated with these actions.

In many respects, DFW has had a standing Capacity Team that has dealt with capacity issues since the early 1980s. The present Team is an outgrowth of earlier efforts. For instance, the Team was very active on the Airport Development Plan. Many members of the present Capacity Team participated, and were instrumental, in the recommendation for two new runways.

This report has established benchmarks for development based upon traffic levels and not upon any definitive time schedule, since actual growth can vary year to year from projections. As a result, the report should retain its validity until the highest traffic level is attained regardless of the actual dates paralleling the development.

A Baseline benchmark of 764,243 aircraft operations (takeoffs and landings) was established based on the annual traffic level for 1992. Three future traffic levels, Future 1, Future 2, and Future 3, were established at 950,000, 1,200,000, and 1,400,000 annual aircraft operations respectively, based on Capacity Team consensus of potential traffic growth at Dallas-Fort Worth.

The focus of the Capacity Design Team study at DFW is somewhat different from studies for other airports, because large-scale improvement plans, like the need for new runways, had already been defined in the ADP. This study evaluated specific refinements to the existing and planned facilities and operations at the Airport, such as improvements to taxiways, airspace, navigation aids, and operational strategies to accommodate the existing and ultimate runway configuration most efficiently. This report documents the first phase of the study, in which only short-term improvements associated with the existing airfield and the new parallel Runway 16E/34E were analyzed.

The following planned major improvements were considered as existing conditions rather than capacity enhancement alternatives:

- Construction of Runway 16E/34E.
- Construction of Runway 16W/34W.
- Construction of the new linear airside terminal to replace the existing terminals except for Terminal 4E.
- The terminal area airspace improvements documented in the *Metroplex Air Traffic System Plan.*

Runway 16E/34E was considered an existing condition beginning at the Future 1 demand level, and 16W/34W, at the Future 2 demand level. The two new linear terminals were considered an existing condition at the Future 3 demand level. The terminal airspace improvements were considered as existing conditions for all four demand levels.

The Capacity Team studied various proposals with the potential for increasing capacity and reducing delays at DFW. The improvements evaluated by the Capacity Team are delineated in Figure 2 and described in some detail in Section 2, Capacity Enhancement Alternatives.

Objectives

The major goal of the Capacity Team was to identify and evaluate proposals to increase airport capacity, improve airport efficiency, and reduce aircraft delays. In achieving this objective, the Capacity Team:

- Assessed the current airport capacity.
- Examined the causes of delay associated with the airfield, the immediate airspace, and the apron and gate-area operations.
- Evaluated capacity and delay benefits of alternative air traffic control (ATC) procedures, navigational improvements, airfield development, and operational improvements.

Scope

The Capacity Team limited its analyses to aircraft activity within the terminal area airspace and on the airfield. They considered the operational benefits of the proposed airfield improvements, but did not address environmental, socioeconomic, or political issues regarding airport development. These issues need to be addressed in future airport planning studies, and the data generated by the Capacity Team can be used in such studies.

Methodology

The Capacity Team, which included representatives from the FAA, the Dallas-Fort Worth International Airport Board, and various aviation industry groups (see Appendix A), met periodically for review and coordination. The Capacity Team members considered suggested capacity improvement alternatives proposed by the FAA's Office of System Capacity and Requirements, Technical Center, and Regional Aviation Capacity Program Manager, and by other members of the Team. Alternatives that were considered practicable were developed into experiments that could be tested by simulation modeling. A consultant team was responsible for performing the technical analyses to evaluate capacity enhancement options, as directed by the Capacity Team. The Capacity Team validated the data used as input for the simulation modeling and analysis and reviewed the interpretation of the simulation results. The data, assumptions, alternatives, and experiments were continually reevaluated, and modified where necessary, as the study progressed. A primary goal of the study was to develop a set of recommendations for capacity enhancement, complete with planning and implementation time horizons.

Initial work consisted of gathering data and formulating assumptions required for the capacity and delay analysis and modeling. Where possible, assumptions were based on actual field observations at DFW. Proposed improvements were analyzed in relation to current and future demands with the help of an FAA computer model, the Airport and Airspace Simulation Model (SIMMOD). Appendix B briefly explains the model.

The Capacity Team strongly recommended that SIMMOD be improved to allow runway crossing delays to be reported by selected time period, by runway, and by type of operation, and to quantify the effects of controller workload.

The simulation models considered air traffic control procedures, airfield improvements, and traffic demands. Airfield configurations were prepared from present and proposed airport layout plans. Various configurations were evaluated to assess the benefit of projected improvements. Air Traffic Control procedures and system improvements determined the aircraft separations to be used for the simulations under both visual flight rules (VFR) and instrument flight rules (IFR.) operations

Aircraft fleet mix and schedule assumptions were derived from *Official Airline Guide* data, historical data, and Capacity Team and other forecasts. Aircraft volume, mix, and peaking characteristics were considered for each of the four different demand forecast levels (Baseline, Future 1, Future 2, and Future 3). From this, annual delay estimates were determined based on implementing various improvements. These estimates took into account historic variations in runway configuration, weather, and demand. The annual delay estimates for each configuration were then compared to identify delay reductions resulting from the improvements. Following the evaluation, the Capacity Team developed a plan of recommended alternatives for consideration.

Section 2

Capacity Enhancement Alternatives

Background

The capacity enhancement alternatives are categorized and discussed under the following headings:

- Airfield Improvements.
- Operational Improvements.

Figure 1 shows the current layout of the airport, plus the airfield improvements considered by the Capacity Team.

Figure 2 lists the capacity enhancement alternatives evaluated by the Capacity Team and presents the estimated annual delay savings benefits for selected improvements. The annual savings are given for the Future 1 activity level, which corresponds to annual aircraft operations of 950,000.

Figure 3 presents the recommended action and suggested time frame for each capacity enhancement alternative considered by the Capacity Team.

Conditions for the various demand levels were defined as follows:

- Baseline — Includes all airport facilities in use at the end of 1992 plus major improvements completed in 1993, including the extension of Runway 17R/35L by 2,000 feet to the north, the associated northeast hold pad, and the southwest hold pad.
- Future 1 — Includes the Baseline airfield plus Runway 16E/34E and the associated supporting taxiways as described in the ADP.
- Future 2 and Future 3 — Includes Runways 16E/34E and 16W/34W and the associated supporting taxiways as described in the ADP and recommended capacity enhancement alternatives from the previous phases of the study.

The focus of this study has been the need for improvements to taxiways, airspace, navigation aids, and operational strategies that would most efficiently accommodate the existing and ultimate runway configuration. In this first phase, only short-term improvements associated with the existing airfield and the new parallel Runway 16E/34E were analyzed. To facilitate the focus of this first phase of the study on short-term strategies for enhancing airport capacity, SIMMOD runs for were only prepared for the Baseline and Future 1 demand levels.

Figure 3. Capacity Enhancement Alternatives Studied and Recommended Actions

Airfield ImprovementsAlternatives	Action	Time Frame
1. Extend runways 2,000 ft. to the north		
1a. Extend Runway 17L/35R	Recommended*	Baseline-Future 1
1b. Extend Runway 18L/36R	Further Study**	
1c. Extend Runway 18R/36L	Further Study**	
2. Construct perimeter taxiways	Further Study**	
3. Construct additional high-speed runway exits		
3a. To inboard taxiways — with existing airfield	Not Recommended	
3b. To outboard taxiways — with existing airfield	Not Recommended	
3c. To inboard taxiways — with extended runways	Recommended*	As Required
3d. To outboard taxiways — with extended runways	Not Recommended	

Operational Improvements		
4. Optimize use of existing high-speed exits	Recommended*	As Required
5. Reduce converging approach weather minimums	Recommended*	Baseline
6. Allow simultaneous jet departures on close parallel runways during VFR operations	Recommended*	Baseline-Future 1
7. Reduce in-trail separation standards for arriving aircraft during IFR conditions	Recommended*	Baseline
8. Implement demand management	Not Recommended	
9. Enhance reliever and GA airport system	Recommended*	Baseline

* The Capacity Team recognizes that additional planning and investigation would be required to implement the recommended capacity enhancement alternatives. For example, alternatives 5, 6, and 7 would require a significant FAA evaluation and approval process for implementation.

** "Further Study" suggests that a specific study be conducted or that it becomes part of a larger planning effort. These proposals require further investigation at a level of detail beyond the scope of this effort.

Airfield Improvements

1. Extend runways 2,000 ft. to the north.

Extending the north-south runways and their associated parallel taxiways northward by 2,000 feet would increase available takeoff lengths, provide more holding pad area for staging and sequencing departures, and increase the potential to use procedures for landing and holding short of runway crossing points. The additional runway length would permit heavier aircraft to takeoff from the runways, particularly for departures on long-haul routes during hot weather.

1a. Extend Runway 17L/35R.

Recommended

Under the intersection departure rule with the existing runway configuration, a departure cannot be released from Runway 17L/35R for 3 minutes after a heavy jet aircraft departs from the extended Runway 17R/35L. With Runway 17L/35R extended to the same length as Runway 17R/35L, the intersection departure rule would no longer apply.

Estimated 1993 project cost is $7.6 million.*

Annual savings at the Future 1 activity level would be $1.1 million. The extension of Runway 17L/35R is estimated to reduce overall travel time and delay by 0.1 minutes per operation. The Boeing 757, which makes up a significant and increasing share of operations at DFW, was reclassified as a heavy aircraft after modeling was complete, therefore, the number of instances in which the intersection departure rule will have to be applied will increase, and the delay savings associated with the extension of Runway 17L/35R will be even greater.

The Capacity Team recommended this project between the Baseline and Future 1 level of operations prior to or along with the opening of Runway 16E/34E so that the intersection rule would no longer apply.

1b. Extend Runway 18L/36R.

Further Study

The extension of Runway 18L/36R 2,000 feet to the north would include the construction of a hold pad to enable air traffic controllers to more effectively stage and sequence aircraft departures on the west side of the airfield. The ability to sort aircraft prior to departure queuing and choose the next aircraft for departure from three different departure queues would help controllers to minimize wake turbulence separations, thus reducing overall ground delays, and avoid sending

* Note: Construction cost estimates are conceptual (order-of-magnitude) in nature and are for planning purposes only. The estimates do not include costs for federal facilities and equipment.

aircraft back-to-back on the same route or to the same departure fix, thus reducing airspace delays. The hold pad would also prevent congestion that occurs on (and south of) Taxiways 18 and 19 by moving taxiing aircraft north of these taxiways. This would reduce taxiing delays for aircraft traveling in the east-west direction across the northern end of the airfield and on the taxiways in front of the passenger terminal apron areas.

Estimated 1993 project cost is $24.4 million.

Annual cost penalty at the Future 1 activity level would be $4.3 million. The extension of Runway 18L/36R and the associated hold pad were estimated to increase overall taxi travel time. This was attributed in part to the intersection departure rule that would result from the extension of only one of the runways in a close-parallel complex. After a heavy jet aircraft departed from the extended runway, a departure could not be released from the other runway for 3 minutes. This effect will be intensified due to the fact that the Boeing 757, which makes up a significant and increasing share of operations at DFW, has been reclassified as a heavy aircraft.

The Capacity Team recommended this project for further study based, in part, on comments from pilots and air traffic controllers concerning the benefits of the recently completed extension and associated hold pad on Runway 17R/35L. The construction and use of a hold pad would improve the overall operation of the Airport, however, due to limitations in the present SIMMOD capability, other benefits could not be captured using the simulation model .

1c. Extend Runway 18R/36L.

Further Study

Land-and-hold-short procedures are currently used at the Airport to allow aircraft taxiing to or from Runway 13R/31L to cross the north-south runways independent of arriving aircraft. To minimize crossing delays, aircraft arriving on Runway 18R can be instructed to land and hold short of Taxiway 31. This procedure allows aircraft arriving on Runway 13R to taxi nonstop across Runway 18R/36L. However, the distance from the Runway 18R arrival threshold to the intersection is not sufficient to allow this procedure to be used for a DC-10, DC-8, Boeing-747, or similar size aircraft. Extending Runway 18R by 2,000 feet to the north (or at least by 300 feet) would allow the land-and-hold-short procedure to be used for all aircraft which arrive on that runway under the required conditions.

Estimated 1993 project cost is $7.6 million.

Annual operating costs at the Future 1 activity level were estimated to remain unchanged. The Capacity Team recommended this project for further study. One reason for this is that the extension only slightly increases the number of opportunities for using the land-and-hold-short procedures because the additional aircraft types allowed to land and hold short as a result of the runway extension make up a very small share of the total operations.

2. Construct perimeter taxiways.

Further Study

Runway crossings not only require extra coordination between the ground controller and local controller, but can also result in delays between successive arrivals or departures. The construction of perimeter taxiways north and south of each of the main north-south runway complexes would allow aircraft to taxi to and from the diagonal runways and the planned outboard runways without crossing an active runway and without being stopped at each runway crossing location. Perimeter taxiways have the potential to reduce controller workload, enhance safety with fewer opportunities for runway incursion, increase departure capacity, and reduce taxiing delays.

The perimeter taxiways were evaluated using SIMMOD. The Capacity Team acknowledged that SIMMOD would not be able to capture the benefits of reduced controller workload and that the reduction in arrival ground delays and in departure queue delays estimated by SIMMOD would be lower than the actual reductions because of this inability to account for the effects of reduced controller workload. Perimeter taxiways will provide a number of benefits in addition to capacity enhancement and delay reduction. These include greatly reducing the number of runway crossings, which is proportionally related to the number of ground controller transmissions to pilots. Further, frequency congestion should be reduced. Not all of these benefits are easily quantified.

The Capacity Team recommended that analysis of perimeter taxiways be included in a later study, after improvements in the Airport and Airspace Simulation Model (SIMMOD) are available and planning requirements have been refined.

3. Construct additional high-speed runway exits.

High-speed exits are designed to facilitate aircraft exiting the runway. Right-angle exits require aircraft to come to almost a complete stop before exiting the runway. High-speed exits enable aircraft to exit the runway at speeds ranging from 35 to 60 knots. The design and location of runway exits affect aircraft arrival runway occupancy times (ROTs). For arrivals, poorly placed exits can result in longer ROTs and larger arrival-to-arrival separations than would otherwise be required for normal airspace or wake turbulence considerations. Poorly placed runway exits can also reduce the departure capacity of runways used for both arrivals and departures because excessive arrival ROTs decrease the number of opportunities for releasing departures.

3a. To inboard taxiways — With existing airfield.

Not Recommended

Most of the runways at DFW have at least two high-speed exits to the inboard taxiways for arrivals, with the exception of Runway 13R/31L, which has only one high-speed exit in each direction. Data collected during October 1991 and February 1992 show that over 90 percent of all aircraft are able to land and exit the runways using the first two high-speed exits on any of the runways.

According to the DFW Airport Traffic Control Tower (ATCT), the runway exits (both high-speed and right-angle) on the existing airfield have been adequate for expediting aircraft runway exits and have allowed for reasonable average ROTs. However, if in-trail separation standards for arriving aircraft under IFR are reduced, there may be a need for additional high-speed exits to the inboard taxiways.

Estimated 1993 project cost for constructing each high-speed exit is about $3.0 million.

The Capacity Team did not recommend this project since no additional high-speed exits are needed to accommodate existing airfield conditions and in-trail separation standards. The Capacity Team recommended that this be reevaluated if in-trail separation standards under IFR are reduced.

3b. To outboard taxiways — With existing airfield.

Not Recommended

Currently there are no high-speed exits to the outboard taxiways. Cargo aircraft arriving on Runways 17L, 18R, 35R, or 36L must either slow down significantly to execute a 90-degree exit to the outboard taxiway or exit to the inboard taxiway. When aircraft slow down to use the 90-degree exit, in-trail separations must often be increased to accommodate the higher ROT. When cargo aircraft exit to the inboard taxiways, congestion on these taxiways increases and additional runway crossings may be required. If high-speed exits were added to the outboard taxiways (Taxiways C and N), ROTs, congestion on the inboard taxiways, and controller workload could be reduced.

As of January, 1994, all-cargo airlines average about 46 arrivals per day at the Airport, with about 16 arrivals occurring during daytime hours. These traffic levels were not considered sufficient by the Capacity Design Team to justify construction of high-speed exits to the outboard taxiways.

Estimated 1993 project cost for constructing each high-speed exit is about $3.0 million.

The Capacity Team did not recommend this project since high-speed exits to the outboard taxiways are not needed to accommodate all-cargo aircraft traffic as of January 1994. If all-cargo traffic increases significantly, one high-speed exit each would be recommended from Runways 17L, 18R, 35R, and 36L to the outboard taxiways. The exits should be located at the same distance from the arrival threshold as the second high-speed exit to the inboard taxiways on the same runway.

3c. To inboard taxiways — With extended runways.

Recommended

If Runways 17L/35R, 18R/36L, and 18L/36R were extended 2,000 feet to the north, the first high-speed exits for south flow operations would then be located 2,000 feet further from the arrival runway threshold, unless the thresholds were displaced. New high-speed exits north of the existing high-speed exits would allow pilots to expedite their egress from the runways. In addition, without new high-speed exits, aircraft would tend to use the same exit (the existing high-speed Exit 1S) and would add to the congestion near that exit. Adding new high-speed exits would achieve better distribution of exiting aircraft and lower ROTs.

For Runway 17L, the estimated 1993 project cost for constructing a high-speed exit between Taxiways 23 and 25 is $2.3 million and for extending Taxiway 25 from Taxiway K to Taxiway L, $1.6 million. For Runway 18R, the estimated 1993 project cost for constructing a high-speed exit between Taxiways 23 and 25 is $2.3 million and for extending Taxiway 25 from Taxiway E to the terminal area, $1.6 million.

The Capacity Team recommended that, with extended runways, high-speed exits be constructed from extended Runways 17L and 18R to the inboard taxiways beginning near Taxiway 23 and ending at Taxiway 25. If high-speed exits were added for any of the runways between Taxiways 23 and 25, Taxiway 25 would need to be extended from the terminal area out to the runways. Also, if there is a significant increase in the percentage of non-jet aircraft operations, additional high-speed exits to the inboard taxiways should be constructed, beginning near Taxiway 21 and ending at Taxiway 23.

The runway extensions would not affect exiting characteristics during north flow operations. Therefore, new high-speed exits are not recommended for Runways 35L, 35R, 36L, and 36R.

3c. To outboard taxiways — With extended runways.

Not Recommended

Currently, there are no high-speed exits to the outboard taxiways. Cargo aircraft arriving on Runways 17L, 18R, 35R, or 36L must either slow down significantly to an outboard taxiway using a 90-degree exit or exit to the inner taxiways. When aircraft slow down to use a 90-degree exit, in-trail separations must often be increased because of increased ROT. When cargo aircraft exit to the inner taxiways, congestion on these taxiways may increase, and an additional runway crossing may be required.

Although the level of all-cargo traffic is projected to increase, the amount of traffic is not considered sufficient to justify the construction of high-speed exits to the outboard taxiways. However, if all-cargo traffic increases significantly beyond these projections and Runways 17L and 18R are extended 2,000 feet to the north, one high-speed exit to the outboard taxiways should be constructed on each of these runways. The exits should be located at the same distance from the arrival threshold as the second high-speed exit on the same runway.

Estimated 1993 project cost for constructing each high-speed exit is about $3.0 million.

The Capacity Team did not recommend this project under the anticipated levels of traffic. If the levels of all-cargo aircraft traffic increase significantly, one high-speed exit each would be recommended from Runways 17L, 18R, 35R, and 36L to the outboard taxiways.

Operational Improvements

4. Optimize use of existing high-speed runway exits.

Recommended

High-speed exits are designed to facilitate aircraft runway exits. The design and location of runway exits affect aircraft arrival runway occupancy times. According to DFW ATCT personnel, pilots typically use the first high-speed exit that their speed will allow. On the basis of this and an analysis of runway exit use, recommendations to increase the use of existing high-speed exits or to use the existing exits more efficiently are not necessary.

The Capacity Team recommended that present utilization of high-speed runway exits continue and, if in-trail separation standards under IFR were reduced, the use of existing high-speed exits should be reevaluated.

5. Reduce converging approach weather minimums.

Recommended

The current weather minimums for conducting three simultaneous ILS approaches (two parallel and one converging) at the Airport are as follows:

- South flow — ceiling at least 800 feet and visibility at least 2.25 miles (usually Runways 13R, 18R, and 17L)
- North flow — ceiling at least 975 feet and visibility at least 2.5 miles (usually Runways 31R, 35R, and 36L)

Available weather data indicates that weather conditions are below these minimums about 3.6 percent of the time. Reducing the minimums to the ILS Category I minimums of a 200 foot ceiling and 0.5 mile visibility would mean that the converging approach procedure could be conducted in IFR 1 conditions and increase its availability by about 3 percent.

Annual savings at the Baseline activity level would be $2.4 million, and, at Future 1, $1.0 million. The annual delay cost savings are lower for the Future 1 demand level because of the benefits are offset with the new Runway 16W/34W operational.

The Capacity Team recommended this alternative, but recognized that it depends on improvements in air traffic control procedures that will likely require the application of new technology. The FAA is studying the potential application of improved radar and communications technologies to multiple simultaneous converging instrument approaches.

6. Allow simultaneous jet departures on close parallel runways during VFR operations.

Recommended

Simultaneous (independent) jet departures are currently not conducted at the Airport on the close parallel runways (Runways 17L/35R and 17R/35L and Runways 18L/36R and 18R/36L) during any conditions. However, jet and not-jet aircraft are cleared to depart simultaneously.

The Capacity Team noted that there will be more need for increasing departure capacity than arrival capacity as traffic increases, because the new runways will be used primarily for arrivals. An effective operating strategy during peak departure periods would be to have simultaneous jet departures on the four inboard runways and arrivals on the diagonal runways and the new outboard runway. Perimeter taxiways would allow the arrivals to taxi to the gate area without incurring a runway crossing.

Annual savings at the Future 1 activity level would be about $14.2 million.

The Capacity Team recommended this project for the Future 1 level of operations along with the opening of Runway 16E/34E. The project cannot be implemented without FAA investigation. Conducting simultaneous jet departures on the close parallel runways under VFR would provide needed departure capacity and an effective operating strategy when the new runways open.

7. Reduce in-trail separations for arriving aircraft during IFR conditions.

Recommended

The minimum in-trail separation under IFR for aircraft within the terminal area is 2.5 nm when wake turbulence is not a factor. When wake turbulence is a factor (e.g., when a small aircraft trails a heavy jet), separations can be as high as 6 nm within the terminal area. This option would reduce minimum in-trail separations under IFR to 2.0 nm unless wake turbulence separation requirements dictate otherwise. Aircraft separations observed under VFR when wake turbulence is not a factor are about 1.9 nm.

Reduced in-trail separations would increase arrival runway capacity because more aircraft would be able to land on a runway during any given time period. The Capacity Team noted, however, that if in-trail separations are reduced, it may be necessary to construct new high-speed exits and make more efficient use of existing high-speed exits so that runway occupancy times (ROTs) are reduced to a level that does not restrict departure flow and an excessive number of missed approaches do not occur. Again, perimeter taxiways would allow the arrivals to taxi to the gate area without incurring a runway crossing.

Annual savings at the Future 1 activity level would be about $10.4 million.

The Capacity Team recommended this project for the Baseline level of operations. It cannot be accomplished without FAA investigation of the feasibility of reducing minimum in-trail separation to 2.0 nm under IFR. Implementation of this alternative would increase the need to optimize the use of existing high-speed exits (alternative 4).

8. Implement demand management.

Not Recommended

The two most commonly discussed methods of implementing demand management are differential pricing and auctioning landing rights. By requiring airlines to schedule arrivals and departures to be less "peaked," a more efficient flow of traffic could be maintained. Such peak flattening could reduce arrival and departure delays while also reducing ground control congestion.

This is only a temporary solution, however, because as traffic increases at a given airport, there will be fewer off-peak hours into which flights might be shifted. In addition, distributing operations more uniformly throughout the day would not be consistent with the hub operations of the primary air carriers serving the Airport. Demand management would impose higher costs on airlines and passengers, because airlines would not be able to provide as much service to passengers at the most convenient time, would likely have to charge a premium to travel during peak periods, and may need to use larger aircraft, which would be less economical on many routes and would produce longer turn-around times.

Airlines are also concerned with minimizing aircraft delays. In maximizing profits, airlines must balance the cost of delays due to scheduling practices with the need to provide flights at time when passengers want to travel. Demand management would likely impose higher costs on airlines and passengers and may not significantly reduce aircraft delays.

The Capacity Team recommended that the Airport not implement demand management because of the cost imposed on airlines and airline passengers. Airlines will naturally depeak their schedules in a manner that minimizes overall costs.

9. Enhance reliever and general aviation (GA) airport system.

Recommended

Reliever and GA airports can ease capacity constraints by attracting small/slow aircraft away from primary airports, especially where small/slow aircraft constitute a significant portion of operations. The segregation of aircraft operations by size and speed increases effective capacity because required time and distance separations are reduced between planes of similar size and speed.

Because DFW has a high proportion of large and heavy jet operations and no provisions for basing GA aircraft, GA operations comprise only about 2 percent of all operations at the Airport.

The Capacity Team recommended that the Airport Board, in coordination with the FAA, encourage the continuing development and enhancement of the reliever and GA airport system. The Capacity Team also recommended that no actions be taken to divert small/slow aircraft to other airports in the region because there are relatively few small/slow aircraft operations at the Airport, and these operations are often delivering passengers or freight to connect with commercial flights.

Section 3

Summary of Technical Studies

Overview

The Dallas-Fort Worth International Airport Capacity Team evaluated the efficiency of the existing airfield and the proposed future configurations. A brief description of the computer model and methodology used can be found in Appendix B. Certain standard inputs were used to reflect the operating environment at DFW. Details can be found in the data packages produced by the consultant team during the study. The potential benefits of various improvements were determined by examining airfield capacity, airfield demand, and average aircraft delays.

Figure 4 shows current airfield weather conditions. Figure 5 shows the fleet mix by aircraft class for the aircraft operating at DFW at each of the four demand levels. Figure 6 breaks down the annual traffic distribution by aircraft category for each demand level. Figure 7 shows the distribution by direction of DFW arrivals and departures into and out of the DFW TRACON airspace. Figure 8 illustrates the runway use configurations used for modeling purposes for the north and south flow at the Future 1 demand level with the new Runway 16E/34E in place.

Listed below are unit costs, derived from 1993 data and presented in 1993 dollars, which were used to estimate annual direct operating cost changes for capacity enhancement alternatives:

These figures represent the costs for operating the aircraft and include such items as fuel, maintenance, and crew costs, but they do not consider lost passenger time, disruption to airline schedules, or any other intangible factors.

Daily operations corresponding to an average day in the peak month were used for each of the forecast periods. The Airport and Airspace Simulation Model (SIMMOD) was used to determine aircraft delays during peak periods. Delays were calculated for current and future conditions. Daily delays were annualized to measure the potential economic benefits of the proposed improvements. The annualized delays provided a basis for comparing the benefits of the proposed changes. The benefits associated with various runway use strategies were also identified. The cost of a particular improvement was measured against its annual delay savings. This comparison indicated which improvements would be the most effective.

For expected increases in demand, a combination of improvements can be implemented to allow airfield capacity to increase while aircraft delays are minimized.

• For ground delay and travel time	$17.86 per minute	$1,072 per hour
• For airborne delay and travel time	$30.25 per minute	$1,815 per hour
• For gate delay	$12.36 per minute	$742 per hour
• Overall delay and travel time	$20.58 per minute	$1,235 per hour

Figure 4. Airfield Weather

Ceiling/Visibility		Occurrence
VFR 1	3,500 feet and above / 5 sm and above	81.4%
VFR 2a	1,000 to 3,500 feet / 3 to 5 sm	12.6%
IFR 1a	700 to 1,000 feet / 2 to 3 sm	2.4%
IFR 1	200 to 700 feet / 0.5 to 2 sm	3.1%
IFR 2	100 to 200 feet / 0.25 to .5 sm	0.2%
IFR 3	Below 100 feet / below 0.25 sm	0.3%
	Total	100%

Figure 5. Aircraft Fleet Mix by Aircraft Class

Aircraft Class	Aircraft Types	Baseline (764,243)	Future 1 (950,000)	Future 2 (1,200,000)	Future 3 (1,400,000)
Heavy	Jet aircraft over 300,000 lbs.	8.5%	8.9%	10.0%	10.7%
757	Boeing-757 aircraft	6.4%	10.6%	11.8%	12.7%
Jet	Jet aircraft not in heavy or 757 classes	60.3%	58.5%	60.2%	61.4%
Large Turboprop	Turboprop aircraft over 12,500 lbs.	16.5%	14.2%	11.5%	9.6%
Small Turboprop	Turboprop aircraft 12,500 lbs. or less	7.8%	6.7%	5.4%	4.5%
Twin	Small twin-engine propeller aircraft	0.5%	1.0%	1.0%	1.0%
Small	Small single-engine propeller aircraft	0.0%	0.1%	0.1%	0.1%

Figure 6. Annual Operations by Aircraft Category

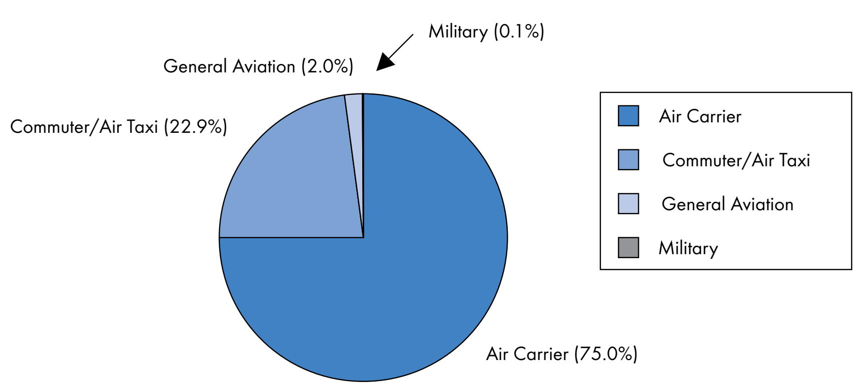


Figure 7. Aircraft Flow Distribution

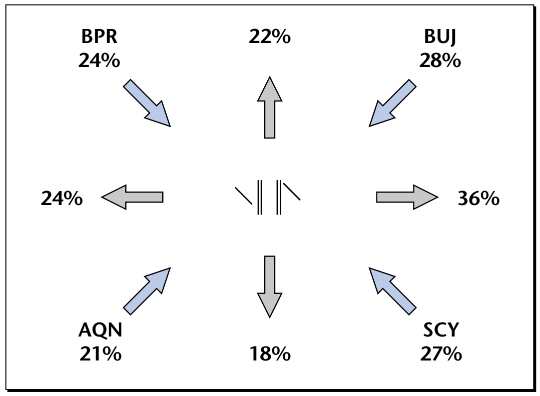
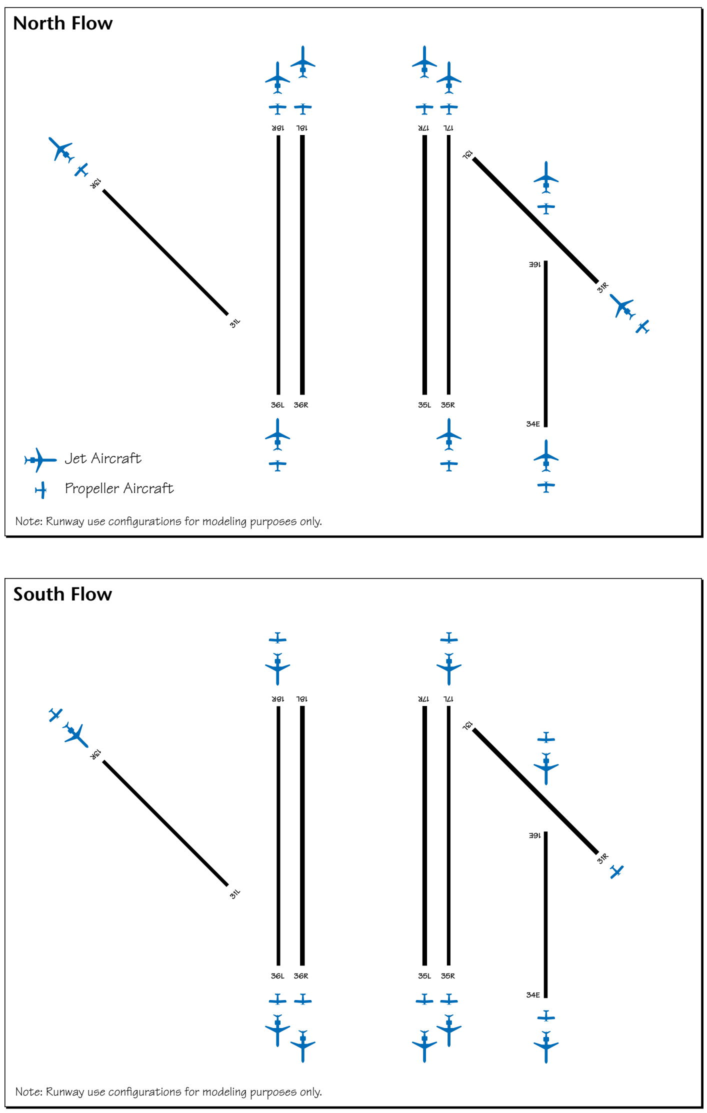


Figure 8. Runway Use Configurations — Future 1 Demand With Runway 16E/34E



Airfield Capacity

The DFW Capacity Team defined airfield capacity to be the maximum number of aircraft operations (landings or takeoffs) that can take place in a given time. The following conditions were considered:

- Airspace constraints.
- Ceiling and visibility conditions.
- Runway layout and use.
- Aircraft mix.
- Percent arrival demand.

Figure 9 illustrates the average-day, peak-month demand levels for DFW for each of the four annual activity levels used in the study, Baseline, Future 1, Future 2, and Future 3. Figure 10 illustrates the hourly profile of daily demand for the Baseline activity level. For comparison, it also includes a curve that depicts the profile of daily operations for the Future 1 activity level.

Figure 9. Airfield Demand Levels

	Annual Operations	24-Hour Day*	Peak Hour
Baseline	764,243	2,177	177
Future 1	950,000	2,707	222
Future 2	1,200,000	3,419	
Future 3	1,400,000	3,989	

* Average day, peak month.

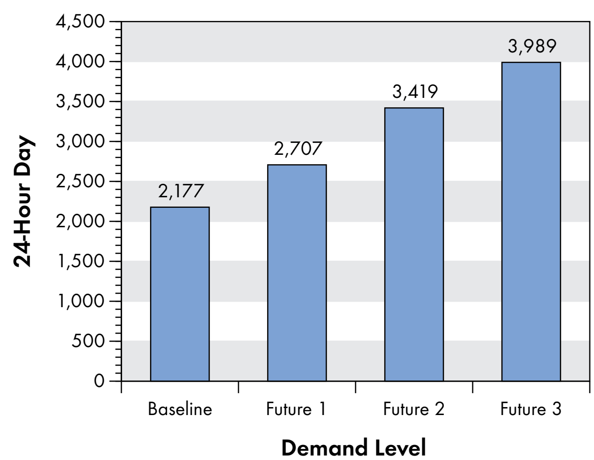
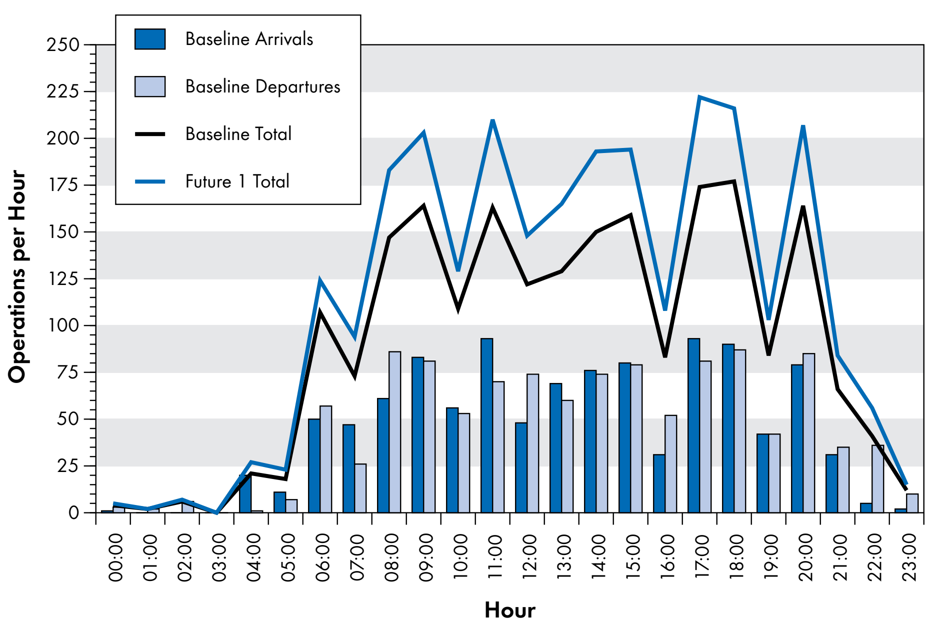


Figure 10. Profile of Daily Demand — Hourly Distribution



Aircraft Delays

Aircraft delay is defined as the time above the unimpeded travel time for an aircraft to move from its origin to its destination. Aircraft delay results from interference from other aircraft competing for the use of the same facilities.

The major factors influencing aircraft delays are:

- Ceiling and visibility conditions.
- Airfield and ATC system demand.
- Airfield physical characteristics.
- Air Traffic Control procedures.
- Aircraft operational characteristics.

Average delay in minutes per operation was generated by the Airport and Airspace Simulation Model (SIMMOD). A description of this model is included in Appendix B.

Conclusions

Based on the analysis completed during the first phase of the study, the Capacity Team recommended the following capacity enhancement alternatives.

- Extend Runway 17L/35R 2,000 feet to the north.
- Construct additional high-speed exit from Taxiway 23 to Taxiway 25 for extended runways.
- Reduce converging approach weather minimums.
- Allow simultaneous jet departures on close parallel runways under VFR.
- Reduce in-trail separations for arrivals under IFR.

In addition, the Capacity Team recommended that further study be completed for the following capacity enhancement alternatives:

- Extend Runway 18L/36R 2,000 feet to the north and construct the associated hold pad.
- Extend Runway 18R/36L 2,000 feet to the north.
- Construct perimeter taxiways.

APPENDIX A

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Appendix B

Computer Model and Methodology

Computer Model

The Dallas-Fort Worth Capacity Team studied the effects of various improvements proposed to reduce delay and enhance capacity. The options were evaluated considering the anticipated increase in demand. The analysis was performed using computer modeling techniques. A brief description of the model and the methodology employed follows.

Airport and Airspace Simulation Model (SIMMOD)

SIMMOD is a fast-time, event-step model that simulates the real-world process by which aircraft fly through air traffic controlled en route and terminal airspace and arrive and depart at airports. SIMMOD traces the movement of individual aircraft as they travel through the gate, taxiway, runway, and airspace system and detects potential violations of separations and operation procedures. It simulates the Air Traffic Control actions required to resolve potential conflicts to insure that aircraft operate within procedural rules. Aircraft travel time, delay, and traffic statistics are computed and provided as model outputs. The model was calibrated for this study against field data collected at DFW to ensure it was site specific. Inputs for the simulation model were also derived from empirical field data. The model repeated each experiment 10 times using Monte Carlo sampling techniques to introduce system variability. The results were then averaged to produce output statistics.

Methodology

Model simulations included present and future air traffic control procedures, various airfield improvements, and traffic demands for different times. To assess the benefits of proposed airfield improvements, different airfield configurations were derived from present and projected airport layouts. The projected implementation time for Air Traffic Control procedures and system improvements determined the aircraft separations used for IFR and VFR weather simulations.

For the delay analysis, agency specialists developed traffic demands based on the *Official Airline Guide,* historical data, and various forecasts. Aircraft volume, mix and peaking characteristics were developed for four demand periods, Baseline, Future 1, Future 2, and Future 3. The estimated annual delays for the proposed improvement options were calculated from the experimental results. These estimates took into account the yearly variations in runway configurations, weather, and demand based on historical data.

The potential delay reductions for each improvement were assessed by comparing the annual delay estimates with the Do Nothing case.

Appendix C

Abbreviations

ARTCC	Air Route Traffic Control Center
ASC	Office of System Capacity and Requirements, FAA
ATC	Air Traffic Control
ATCT	Airport Traffic Control Tower
CAT	Category — of instrument landing system
DFW	Dallas-Fort Worth International Airport
FAA	Federal Aviation Administration
GA	General Aviation
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
LBS	Pounds
NM	Nautical Miles
ROT	Runway Occupancy Time
RVR	Runway Visual Range
SIMMOD	Airport and Airspace Simulation Model
SM	Statute Miles
SMGCS	Surface Movement Guidance and Control System
TRACON	Terminal Radar Approach Control
VFR	Visual Flight Rules
VHF	Very High Frequency
VMC	Visual Meteorological Conditions

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