THE NEW DENVER AIRPORT

Ginger Evans
City and County of Denver

The City and County of Denver is building a new airport northeast of the existing metropolitan area in a location somewhat more removed from the existing central business district than the present Denver Stapleton International Airport. This a relatively undeveloped part of the metropolitan area that lies just outside what has been a military preserve for the last 40 years and provides a suitably large open tract of land for a new airport to accommodate air commerce on a global scale. (Figure 1)

The environmental approval for the project was obtained on September 29, 1989. Construction started on September 30, 1989. The new airport, designated Denver International Airport (DIA) is scheduled to open in 1994, after a construction period of about four and one-half years. Concurrently, the existing Stapleton International Airport will be closed forever for aeronautical purposes.

Historically, Denver's air travelers are roughly 55 percent hubbing passengers and 45 percent origin-destination passengers. There has been a strong market for international air service to Mexico for the last 20 years, a market that is expected to increase (along with service to Canada) as a result of the North American Free Trade Agreement. Denver is well positioned to service these markets.

Denver's first nonstop service to continental Europe was initiated in December 1993 by Martin Air Holland using B767-300ER (extended range) aircraft. In addition, both British Airways and Lufthansa consider Denver to be their number one unserved market in the United States. With the advent of new long-range aircraft such as the B777 in the next five years, the expansion of overseas service into Denver becomes even more likely. Hawaii and Japan can be served with the B777. Denver intends to compete for increased international air service, both by foreign carriers and by two domestic hub carriers, Continental and United Airlines, each with a significant presence in the international market.

It may very well be that Denver's primary function will be as a base for very large feeder operations to other existing gateways for these two domestic carriers. The existing gateways are expensive to operate and develop, and United and Continental will probably be reluctant to make that type of investment in multiple locations. The new Denver airport is positioned to be a very large feeder for existing gateways and to provide direct international service. The intent is to compete for both.

The new airport has also been designed as a major air cargo facility. Cargo has been the highest area of growth, a minimum of 10 percent per year for the last five years, generally closer to 15 percent per year.

Denver sold airport development bonds on the strength of the historical passenger and air cargo service markets. The airline agreement provides for preferential, rather than exclusive, gate use. This was a major breakthrough. There are no majority-of-interest provisions that require airline approval of construction of new facilities for market entrance. This is a key provision that was very carefully negotiated. It took about four years to get United Airlines to sign an agreement without the majority-of-interest clause.

AIRPORT DESIGN

DIA was designed with three main objectives:

- Ease of growth and expansion in all the service areas,
- Elimination of noise impacts on the metropolitan area, especially in the residential neighborhoods that surround the existing Stapleton airport, and
- Reduction (ideally virtual elimination) of aircraft delays by providing a highly efficient ramp and runway configuration.

The new DIA facility has a fairly high level of base finishes that will minimize the investment required of new market entrants. Denver wants to encourage new carriers to come to DIA.

AIRFIELD AND AIRSPACE CONFIGURATION

The new airport has a four-quadrant airfield configuration to provide capacity in all four cardinal directions. (Figure 2) In visual meteorological conditions (VMC) the major traffic flow is north-south. In instrument meteorological conditions (IMC), because of the prevailing winds that accompany low visibility, operations are exclusively to the north. For these

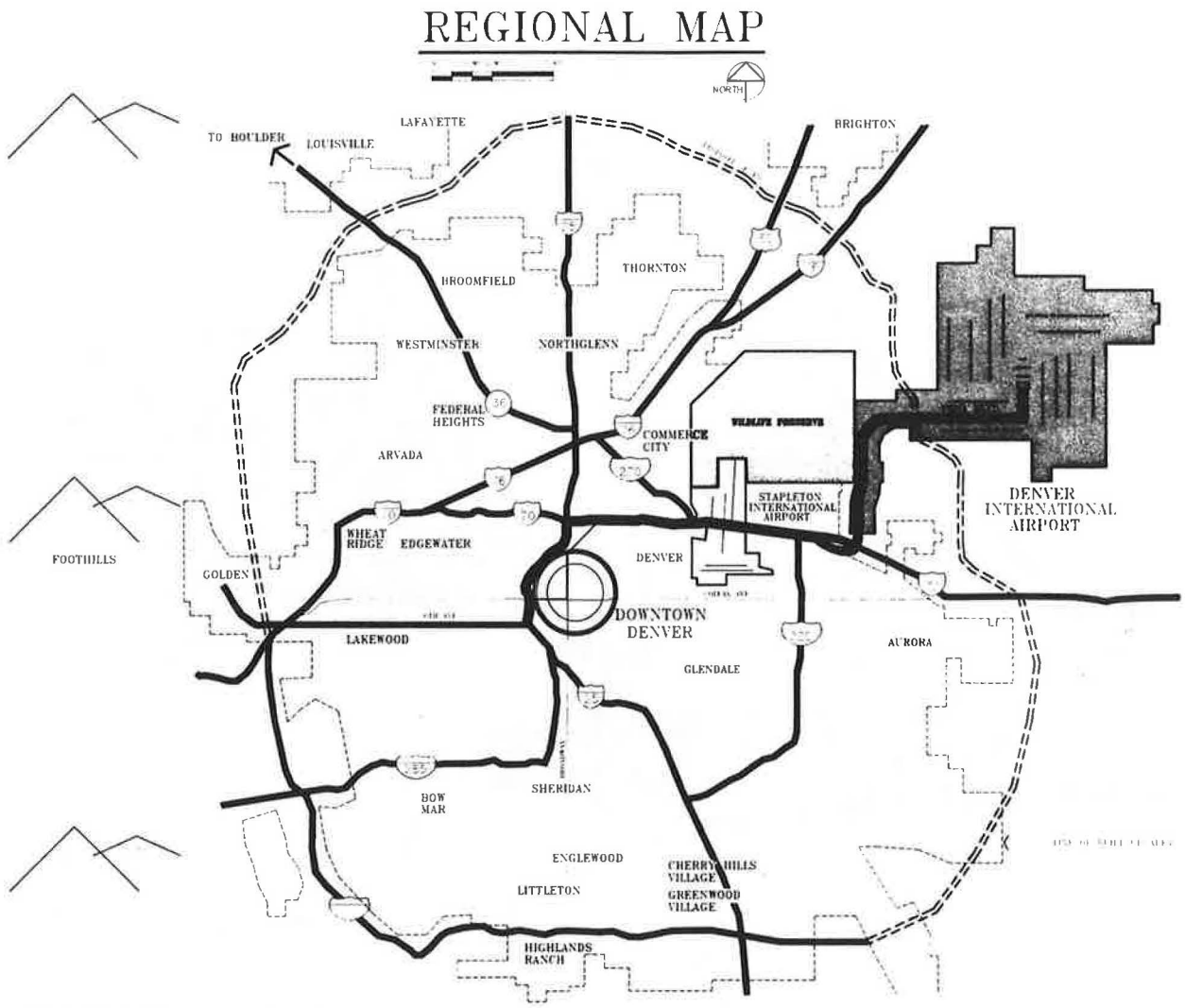

FIGURE 1 Denver regional map.

reasons the preponderance of the runways are north-south. However, there is a substantial crosswind (east-west) component at certain times. In the morning, because of Denver's location in the middle of the country there is an "east push", with a large number of aircraft inbound from New York and Chicago arriving from this direction The east-west set of runways allows these flights to make the transition from en route to a straight-in approach without changing direction and then to continue to landing, roll-out, and taxi to the ramp with maximum efficiency. Morning departures use the other side of the ramp and depart to the north and east.

This runway configuration also allows very efficient use of the 360 degrees of surrounding airspace. Oftentimes, designers rigidly apply the FAA advisory circulars, locating runway thresholds to avoid wake turbulence and to provide the required separation for independent IFR arrivals. All these criteria have to be met. However, if the airspace is viewed from the perspective of the air traffic controller in the tower, it is evident that many delays do not occur close in but at the 50-mile posts on the approach path. With all flights coming in from a single direction, traffic stacks up, and controllers must hold aircraft until they have spaces for them.

In planning DIA an attempt was made to sort out the traffic efficiently by minimizing what is called "flying the trombone", which involves getting approaching aircraft lined up for the runway in an orderly stream as early as possible. In a climate like Denver's where the winds are known to shift abruptly, controllers have to be able to redirect traffic flow very quickly.

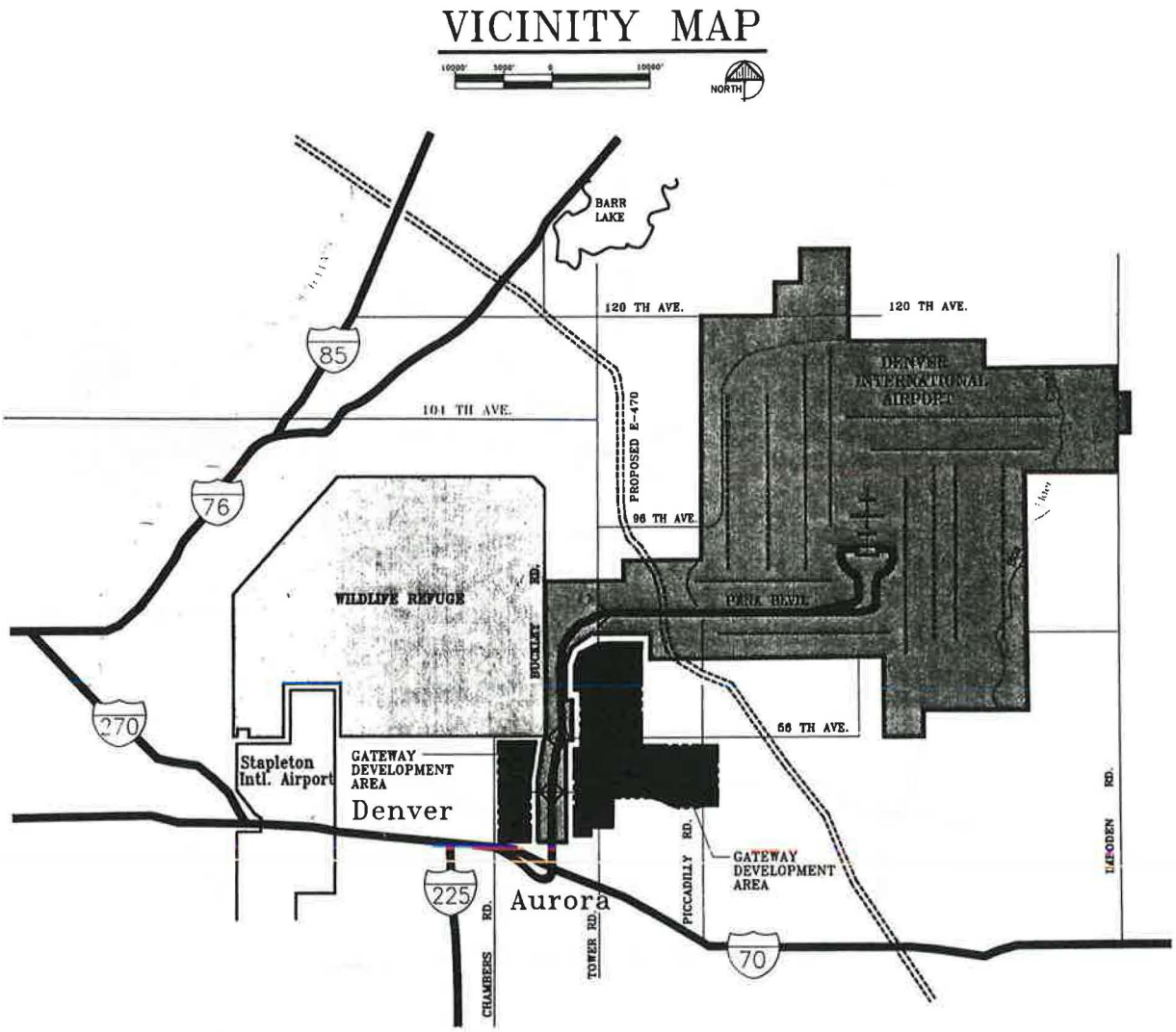

FIGURE 2 Vicinity map, Denver International Airport.

Today at Stapleton, which is basically a big L, it takes 90 minutes to change the direction of arrivals. DIA will be able to do it in less than 2 minutes. This will be accomplished by having four VORs instead of two. At any particular time two VORs will be in operation, permitting aircraft to arrive in two quadrants of the compass and to depart in the other two. How this works is shown in Figure 2.

In the afternoon, traffic flow reverses at Denver. The eastside VORs are turned off, and the two westside VORs are turned on. Aircraft coming in from San Francisco and Seattle land on the west side of the airport, and the departures to the east coast move out south and east on the other side of the airport.

This configuration facilitates departures as well. Air traffic controllers fan aircraft out from a particular takeoff path (or stick), and each of these sticks requires a cone of airspace. The cones of airspace are so widely separated at DIA that they are, in fact, independent, which lets controllers shoot flights out as quickly as individual aircraft performance will allow.

RAMP LAYOUT

The DIA terminal configuration was likewise planned to make aircraft movement efficient. The design is a modification of that used at Atlanta. The Atlanta arrangement is by far the most efficient airfield model in use, but it has some problems. One was that the concourses were too closely spaced to allow dual taxiways and independent push-backs from both

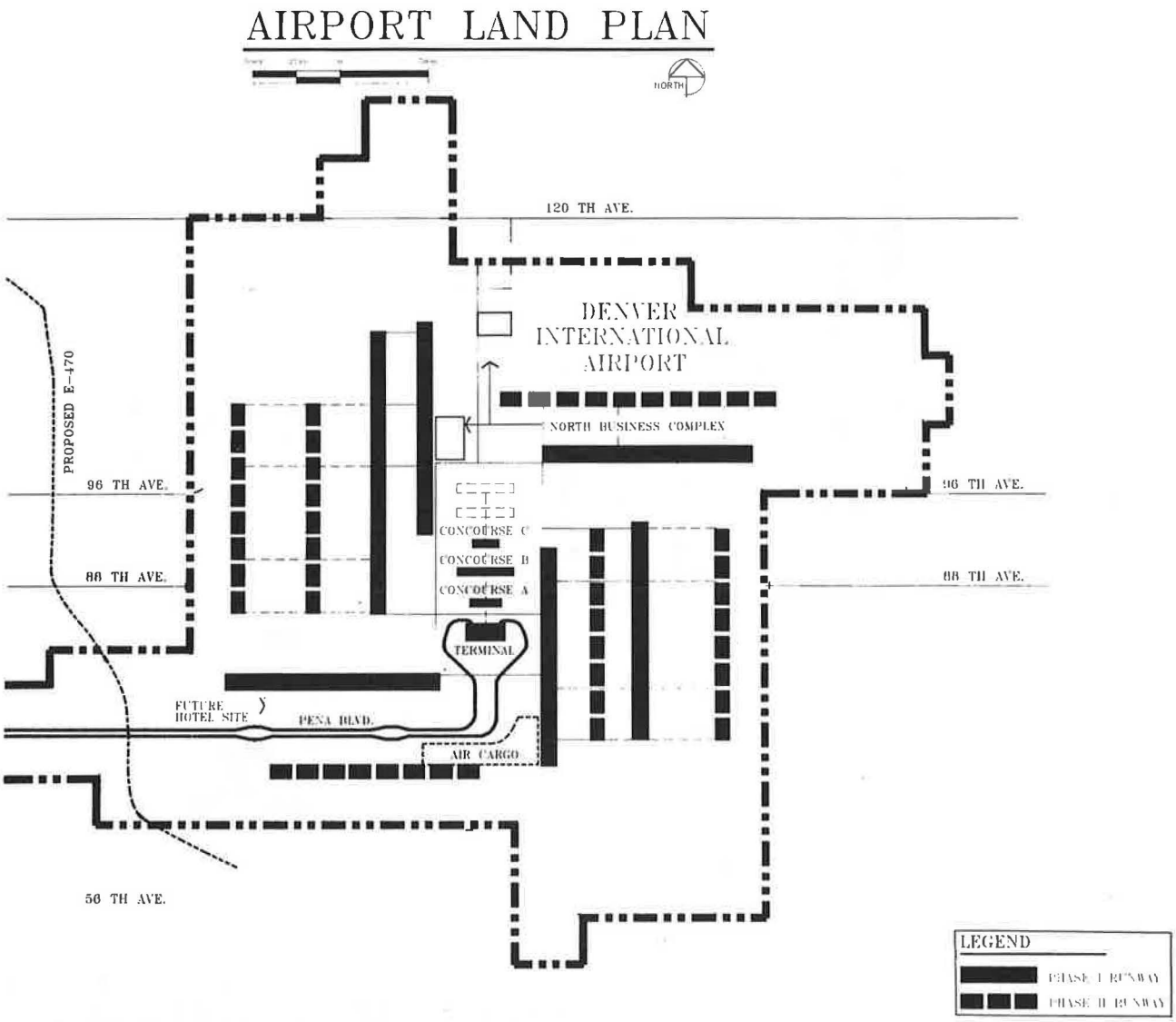

FIGURE 3 Denver International Airport land plan.

concourses at the same time. At DIA spacing was increased so that aircraft can push back, taxi out, and leave without coming into conflict with the ground movements of other aircraft.

DIA has three airside concourses, A, B, and C. The north side of concourse B is designed for Group 5 plus aircraft like the B777, which requires an additional 142 feet of ramp width beyond traditional Group 5 requirements. The north side of concourse A, where international flights will come in, is designed to Group 6 criteria. This is intended to achieve a smooth flow of aircraft through the ramp area. (I have a master's degree in hydraulics, so I call this the laminar flow theory of aircraft movement.)

The ramp is controlled by two towers on concourses A and B, staffed by airline personnel with a city observer, to make sure that parity of precedence is given to aircraft movements on the two concourses. At one time it was contemplated that FAA would control the ramp because it is so large, but the final decision was that it would be better to hand off to FAA at the ramp perimeter. DIA has the space to have a triple perimeter taxiway system around that ramp.

The deicing pads are on the west of the ramp, basically on the departure side, where aircraft take off during IFR conditions. The deicing pads are located immediately adjacent to the runway threshold, as close as FAR Part 77 criteria permit.

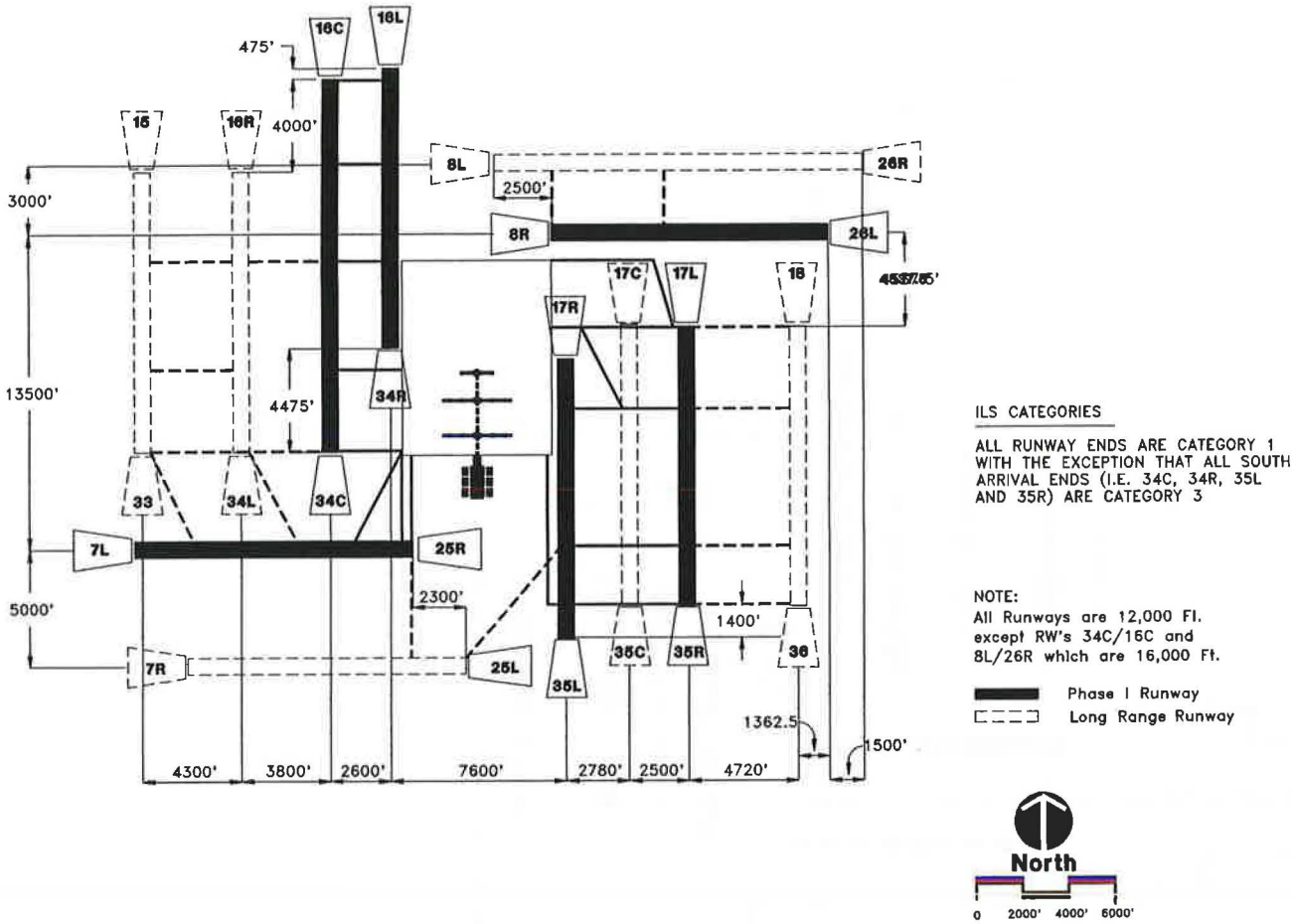

FIGURE 4 Denver International Airport runway layout plan.

TERMINAL LAYOUT

One special feature of the terminal is the way international arriving passengers are handled. Passengers come off the aircraft and stay high within Concourse A, moving through the central core portion of the building. The international passengers will use the upper level of the pedestrian bridge linking Concourse A with the terminal building and then go down two levels for processing through the FIS facility. That was a critical master planning decision, and there are some pros and cons. DIA is the only airport in the world where aircraft will pass under a pedestrian bridge. This was carefully negotiated with FAA. On opening day DIA will have the capacity for two widebody international flights on the north side of concourse A. This space can also be used for four domestic gates, if desired.

The terminal has three curbside levels. The upper level is for dropping off passengers. The next level is for commercial vehicles only. It includes a very wide roadway on the same level with baggage claim, so passengers can retrieve their bags, walk out the door, and catch a bus, van, or a taxi — an extremely efficient arrangement. On the lowest level is passenger pick-up. This segregates passenger vehicles from commercial vehicles, chiefly for reasons of air quality. With three curbside levels instead of two, DIA's curbside frontage has been increased by 50 percent, alleviating potential problems in what historically has been a highly congested area at airports.

Aircraft service areas and air cargo facilities have also been designed on a large scale. The United hangar at DIA is larger than the Phase I MOCII hangar in Indianapolis. It has the capacity to house two B747 and seven B737 aircraft under one roof simultaneously, with capacity for further expansion on the existing site.

The cargo area is located along the entrance boulevard to facilitate package delivery operation. Cargo operations need immediate access to make their stem times from their pickup points. The facilities were

FIGURE 5 Denver International Airport terminal.

FIGURE 6 Main concourse, Denver International Airport terminal.

carefully located to meet that requirement and assure that hubbing operations are not delayed.

DIA also has a very large area reserved for additional cargo operations or related development on the north side of the airport. The airport is built on 47 square miles of land, about 25 square miles of which are currently developed. Obviously there is real estate available for later airport-related activities and facilities. Key to this expansion are several large open tracts of land directly adjacent to the runways, which is the waterfront in airport terminology. The infrastructure — water, sewer, gas, electrical lines, and roadways — is all in place, which will make entrance by new carriers and new development very easy.