Minneapolis – St. Paul International Airport (MSP)

2030 Long Term Comprehensive Plan Update

July 26, 2010

Minneapolis-St. Paul International Airport
Long Term Comprehensive Plan Update

July 26, 2010

Prepared by the Metropolitan Airports Commission
with assistance from HNTB Corporation

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Note

Minneapolis-St. Paul International Airport (MSP) is the only major airport in the United States to have two terminals – the Lindbergh and the Humphrey – located on entirely separate roadway systems. Highway signs and other way-finding aids related to MSP will be updated in 2010 in order to assist travelers in locating the terminals. Numeric designations will be added to the existing terminal names: Terminal 1-Lindbergh and Terminal 2-Humphrey. For the purposes of this document, however, the terminals are referred to by their original names.

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

E.1 PURPOSE

The Metropolitan Council adopted guidelines to integrate information pertinent to planning, developing, and operating the region's airports in a manner compatible with their surrounding environs. The process to ensure this orderly development is documented in a Long Term Comprehensive Plan (LTCP) for each airport. In recognition of the dynamic nature of the aviation industry, the plans are to be updated regularly. The previous LTCP for the Minneapolis-St. Paul International Airport (MSP) was completed in 1996. The 2009 update will be the first revision to that LTCP and reflects substantial changes for MSP and the aviation industry over the past 13 years.

E.2 NEED

The aviation industry has changed since the previous LTCP for MSP was published in 1996. Airline consolidation, shifts in the aircraft fleet, new technologies, and evolving security protocols stemming from the September 11, 2001 terrorist attacks have resulted in many changes to operations that require new approaches to airport planning. These changes have affected airline service patterns, passenger processing and behavior, and have resulted in some development at MSP that was not part of the 1996 LTCP.

Airports work best when the capacities of their various elements are balanced and work in harmony to provide a safe, efficient system of facilities with a high level of customer service. Over time, some of MSP's facilities have become less efficient and some have not been improved to meet the dynamic needs of today's travelers.

While MSP's airfield was dramatically improved with the addition of a fourth runway in 2005, portions of the terminal and landside facilities have become outdated and need improvement. MSP's two-terminal system could be utilized more efficiently to provide better service to airlines and passengers alike. Terminal facilities, including the international arrivals hall, bag-claim hall, passenger security screening, and some concourses, need improvement. Access roads, parking, and terminal curb areas are also in need of enhancements to serve increasing passenger levels into the future. Finally, even with the new runway, MSP's airfield may require additional taxiways to improve aircraft circulation, especially around the terminal areas. These issues are the primary focuses of this updated LTCP.

The LTCP is a 20-year plan for MSP focused on developing facilities to accommodate forecast growth in a safe and efficient manner with a high level of customer service. Proposed improvements are phased to reflect the gradual growth of demand at MSP and to reflect lead time required for detailed planning, environmental analysis, design, and implementation. The LTCP will be updated every five years, consistent with Metropolitan Council guidelines, to ensure planning activities address changes in the aviation industry, demand and local and national economic conditions.

E.3 PROCESS AND CONTENT

The LTCP consists of five primary tasks:

1. Assessing the condition and capacity of existing facilities
2. Forecasting long-range aviation demand
3. Determining future facility requirements

4. Identifying and evaluating various development options
5. Selecting a preferred comprehensive plan

The LTCP Update identifies the type and location of facility improvements needed to safely and efficiently accommodate aviation demand through the year 2030. The LTCP Update also provides guidance for phasing airport improvements during the development period. Noise contours were also generated for 2030 and are included in the full report.

The goals of this LTCP Update were established at the outset of the planning process and are listed here:

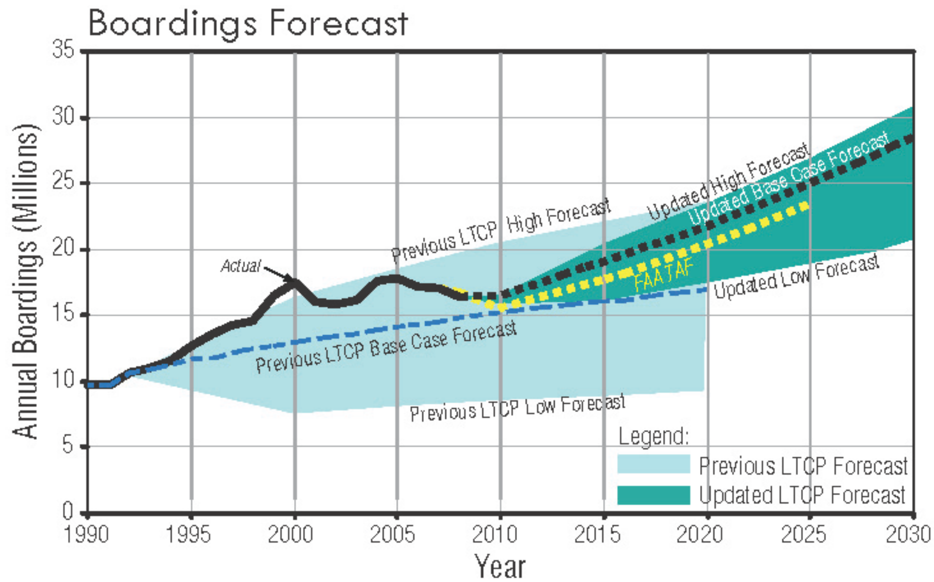
1. Provide sufficient, environmentally-friendly facilities to serve existing and future demand;
2. Provide improved energy efficiencies;
3. Encourage increased use of public transportation;
4. Minimize confusion associated with having two terminals and multiple access points;
5. Allow for flexibility in growth;
6. Utilize and maintain existing facilities to the fullest extent possible; and
7. Enhance aircraft operational safety and efficiency.

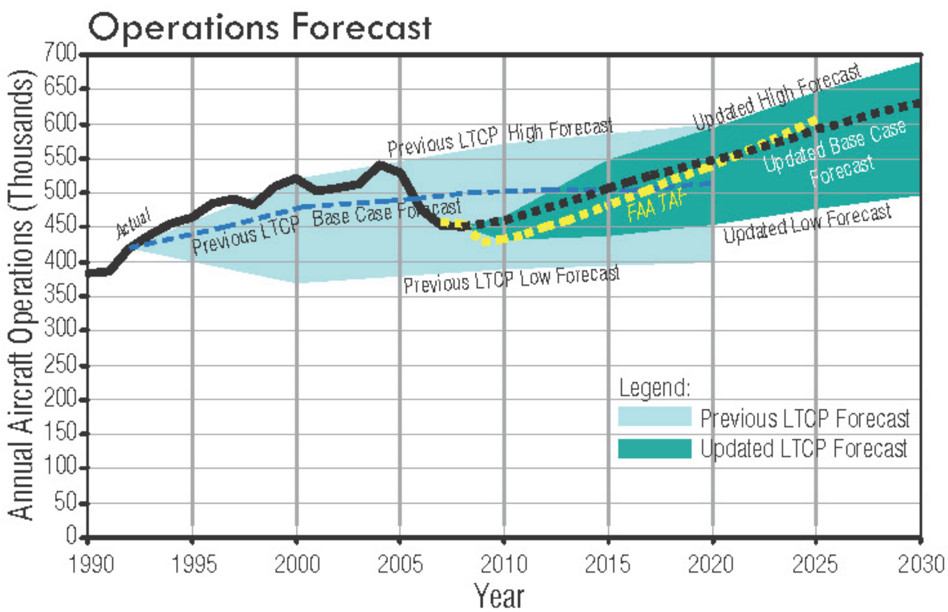
E.4 INVENTORY

Existing facilities at MSP were inventoried and their conditions and capacities assessed. The inventory shows that future plans for MSP will require consideration of balancing airfield capacity, terminal capacity, and landside capacity. In addition to properly balancing the capacities of these three functional elements of the airport, more efficient balance and utilization of the airport's two terminal complexes required consideration.

E.5 FORECAST

Forecasts of annual passenger boardings and aircraft operations (takeoffs and landings) were completed in June 2009. They show that passenger boardings are expected to increase by more than 73% by 2030, growing from 16.4 million to 28.4 million. Total aircraft operations at MSP are expected to grow by about 40% from 450,000 to 630,000 by 2030. While the current economic recession has resulted in declines in both boardings and operations at MSP since 2005, passenger boardings are expected to return to previous levels in 2013, and operations are expected to return to previous levels in 2019. Additionally, the MAC will initiate a capacity study two years in advance of when MSP is expected to have 540,000 annual operations and will incorporate the results into a future LTCP Update.


Boardings Forecast
Annual Boardings (Millions)
35
30
25
20
15
10
5
0
1990
1995
2000
2005
2010
2015
2020
2025
2030
Year
Actual
Previous LTCP High Forecast
Previous LTCP Base Case Forecast
Previous LTCP Low Forecast
Updated High Forecast
Updated Base Case Forecast
FAA TAF
Updated Low Forecast
Legend:
Previous LTCP Forecast
Updated LTCP Forecast


Operations Forecast
Annual Aircraft Operations (Thousands)
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
1990
1995
2000
2005
2010
2015
2020
2025
2030
Year
Actual
Previous LTCP High Forecast
Previous LTCP Base Case Forecast
Previous LTCP Low Forecast
Updated High Forecast
Updated Base Case Forecast
FAA TAF
Updated Low Forecast
Legend:
Previous LTCP Forecast
Updated LTCP Forecast

E.6 FACILITY REQUIREMENTS

Growth in the number of passengers and aircraft operations will require airport facilities to be improved in order to continue operating in a safe and efficient manner.

The inventory of airport facilities and existing capacity evaluation identified 15 key focus areas for the LTCP Update to evaluate. Each of these focus areas identified existing facilities that are operating inefficiently today or that are expected to operate inefficiently with moderate increases in passenger numbers. The 15 focus areas are:

1. Balancing passenger demand between the two terminals
2. Reallocation of airlines between the two terminals
3. Arrival curbside capacity (Lindbergh Terminal)
4. Public parking (Both Terminals)
5. Way-finding / Signage for the airport roadways
6. Baggage claim facilities (Lindbergh Terminal)
7. Security Screening Check Points (Lindbergh Terminal)
8. International arrivals (Customs and Border Protection) facilities (Lindbergh Terminal)
9. Regional carrier aircraft gates (Lindbergh Terminal)
10. Refurbishing Concourses E and F (Lindbergh Terminal)
11. Rental car facilities (Both Terminals)
12. Airfield capacity and taxiways
13. The United States Post Office facility (Lindbergh Terminal)
14. Potential development of an airport hotel
15. Air Traffic Control Tower (ATCT) improvements

The analysis concluded that the existing passenger terminal complexes and their landside facilities are not able to accommodate planned forecast growth without expansion. Growth in passenger boardings will prompt additional aircraft gates, parking, roadway improvements and terminal space to allow passengers to enjoy a safe and comfortable airport environment. Balancing passenger demand between the Lindbergh and Humphrey Terminals will result in improved efficiency and customer service of both facilities. This balance can best be achieved by utilizing the Lindbergh Terminal to accommodate Delta Air Lines and its partner airlines while relocating all other airlines to the Humphrey Terminal. The aviation activity forecast suggests that this move should occur by 2015.

Though aircraft operations will be growing as well, the existing four-runway airfield is expected to be able to continue operating in a safe and efficient manner without the need for additional runways. Some improvements to taxiways are recommended to help aircraft move around the airfield as they taxi between the runways and the terminal complexes.

E.7 CONCEPTS

Though it is typical for an airport LTCP effort to provide a series of broad organizational concepts for airport development, the nature of this study was to focus on key facilities and develop concepts that would resolve existing and forecast facility deficiencies. A more detailed description, by subject area, is included in the full report and a summary of the recommendations is provided below and shown on **Figure E-1** located at the end of this Executive Summary.

Lindbergh Terminal

- *ADDITIONAL GATES* - Extending Concourse G would provide new gates capable of accommodating domestic or international flights.

- *EXPANDED INTERNATIONAL ARRIVALS (CBP) FACILITY* - New, larger facilities will be provided as part of the Concourse G expansion to accommodate forecasted growth in demand for international flights to MSP.

- *SECURITY SCREENING* - Reconfiguration of security screening areas would improve efficiency and reduce wait times.

- *BAGGAGE CLAIM* - The existing baggage claim hall would be reconfigured with larger, modern baggage claim systems.

- *PARKING* - Additional parking garages would be constructed adjacent to the existing garages to accommodate existing and future parking demand.

- *ARRIVALS CURB* - Enhancements to the curb area would improve capacity and efficiency for arriving passengers to reach shuttles, taxis, and private vehicles.

- *HOTEL* - A site has been identified that would be appropriate for hotel development.

Humphrey Terminal

- *ADDITIONAL GATES* - New gates would be added by extending the passenger concourses to the north and south accommodating up to 26 additional gates.

- *PASSENGER PROCESSING* - Ticketing and baggage claim facilities would be expanded to accommodate additional airlines and passengers.

- *PARKING* - Existing garages would be expanded to accommodate future parking demand.

- *RENTAL CAR FACILITIES* - Accommodations for rental cars would be provided by developing facilities in expanded existing parking garages.

- *ACCESS ROADS* - Post Road and 34th Avenue would be improved and signed to accommodate increasing traffic volumes and simplify circulation.

E.8 FACILITY IMPLEMENTATION SCHEDULE AND COSTS

Improvements must be phased and constructed in response to demand and with consideration for the Capital Improvement Program budget. A preliminary phasing plan prepared for the LTCP Update includes four 5-year phases along with very preliminary cost estimates. These costs are for new development only and do not include normal rehabilitation and maintenance efforts that will be required during this period. The costs are based upon planning concepts for the airport. Preliminary design has not been accomplished for any of these projects. The costs, therefore, represent the general order of magnitude of costs that could be expected for the proposed development. They are expressed in 2009 dollars, with no allowance for inflation.

- Phase I (2010-2015): Expand Humphrey Terminal and relocate airlines.
  Cost Range - $380 Million - $445 Million

- Phase II (2015-2020): Modernize and expand Lindbergh Terminal, including a new international arrivals facility.
  Cost Range - $810 Million - $960 Million

- Phase III (2020-2025): Complete expansion of Humphrey Terminal, balancing passenger loads between the two terminals.
  Cost Range - $665 Million - $783 Million

- Phase IV (2025-2030): Construct crossover taxiways and access road improvements at Lindbergh Terminal.
  Cost Range - $190 Million - $225 Million

This phasing plan allows improvements to be implemented over a 20-year period in response to gradual increases in demand. It also allows implementation of improvements to occur with minimal disruption to the day-to-day operation of the airport.

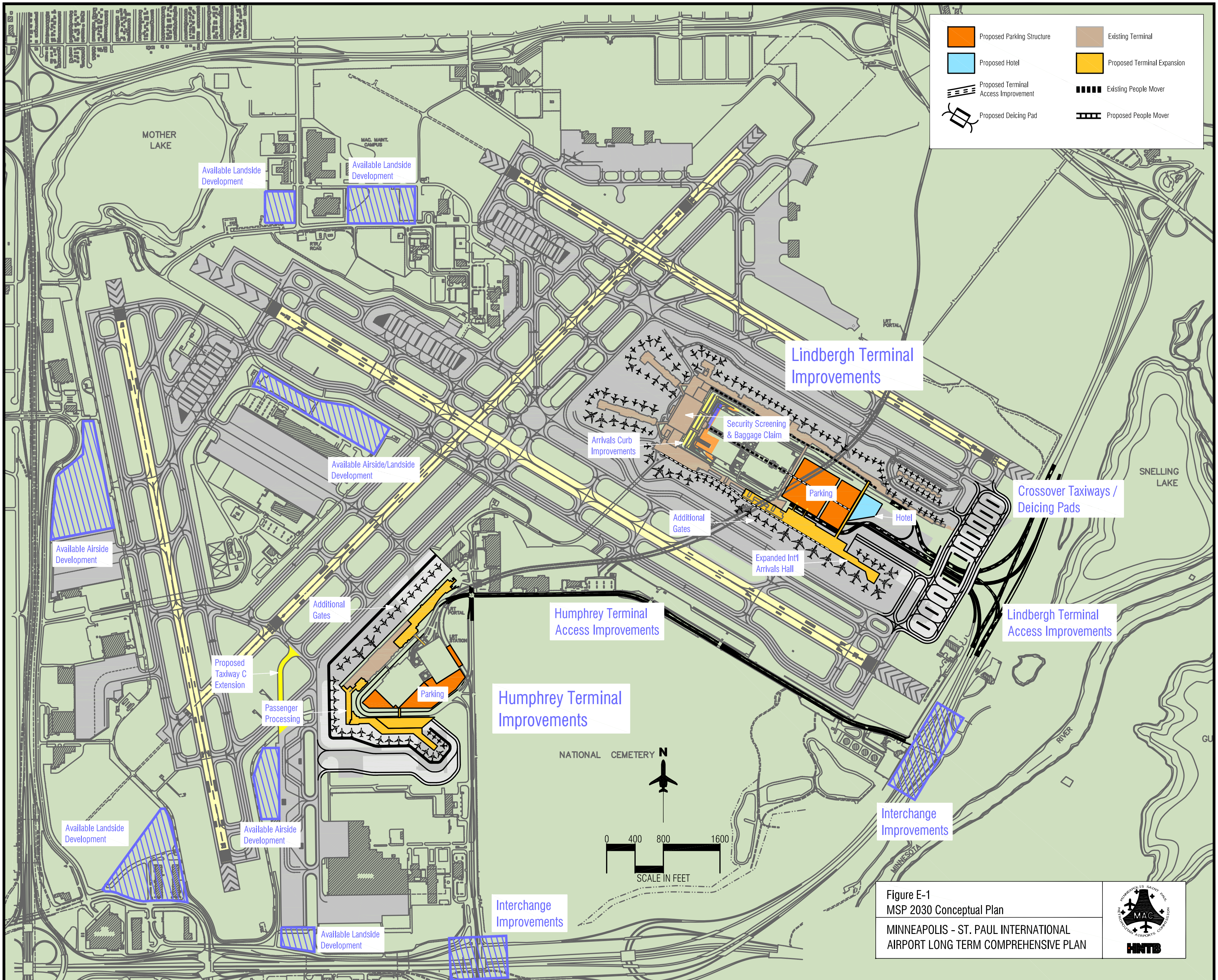


Figure E-1
MSP 2030 Conceptual Plan
MINNEAPOLIS - ST. PAUL INTERNATIONAL
AIRPORT LONG TERM COMPREHENSIVE PLAN

CHAPTER 1: INVENTORY

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1.1 INTRODUCTION

Minneapolis-St. Paul International Airport (MSP) is a commercial service airport located approximately seven miles south of downtown Minneapolis, Minnesota and seven miles southwest of downtown St. Paul. It is owned and operated by the Metropolitan Airports Commission (MAC) which was formed by the State Legislature in 1943 as a public corporation to provide and promote aviation services for the Minneapolis-St. Paul metropolitan area. In addition to MSP, the MAC operates six other airports in the Twin Cities region: Airlake, Anoka County-Blaine, Crystal, Flying Cloud, Lake Elmo, and St. Paul Downtown. **Figure 1-1** shows the location of MSP and the other airports in the MAC system.

In 2008, MSP ranked as the 16th busiest airport in the U.S. in terms of passengers, with 17 million enplanements (passenger boardings). MSP also handled about 234,000 metric tons of air cargo. That same year, about 450,000 aircraft operations (takeoffs or landings) occurred at the airport. The airport covers approximately 3,400 acres.

The Long Term Comprehensive Plan (LTCP) for MSP serves as a guide for the long-range facility development needed to meet the Twin Cities' forecast growth in commercial aviation demand safely and efficiently, and with minimal environmental consequences.

The MAC initiated an update to the LTCP in 2008. In the first phase, a general inventory of existing airport facilities was conducted and some initial concepts for expanding airport facilities were developed. In addition, activity forecasts were updated. This inventory chapter provides an overview of existing airport facilities. Chapter 2 documents the activity forecast update. Phase 2 of the study consisted of determining the capacity of the existing airport facilities, calculating long-range (Year 2030) facility requirements, identifying and evaluating alternative development concepts, selecting a preferred comprehensive plan, and providing a general approach for phasing the expansion.

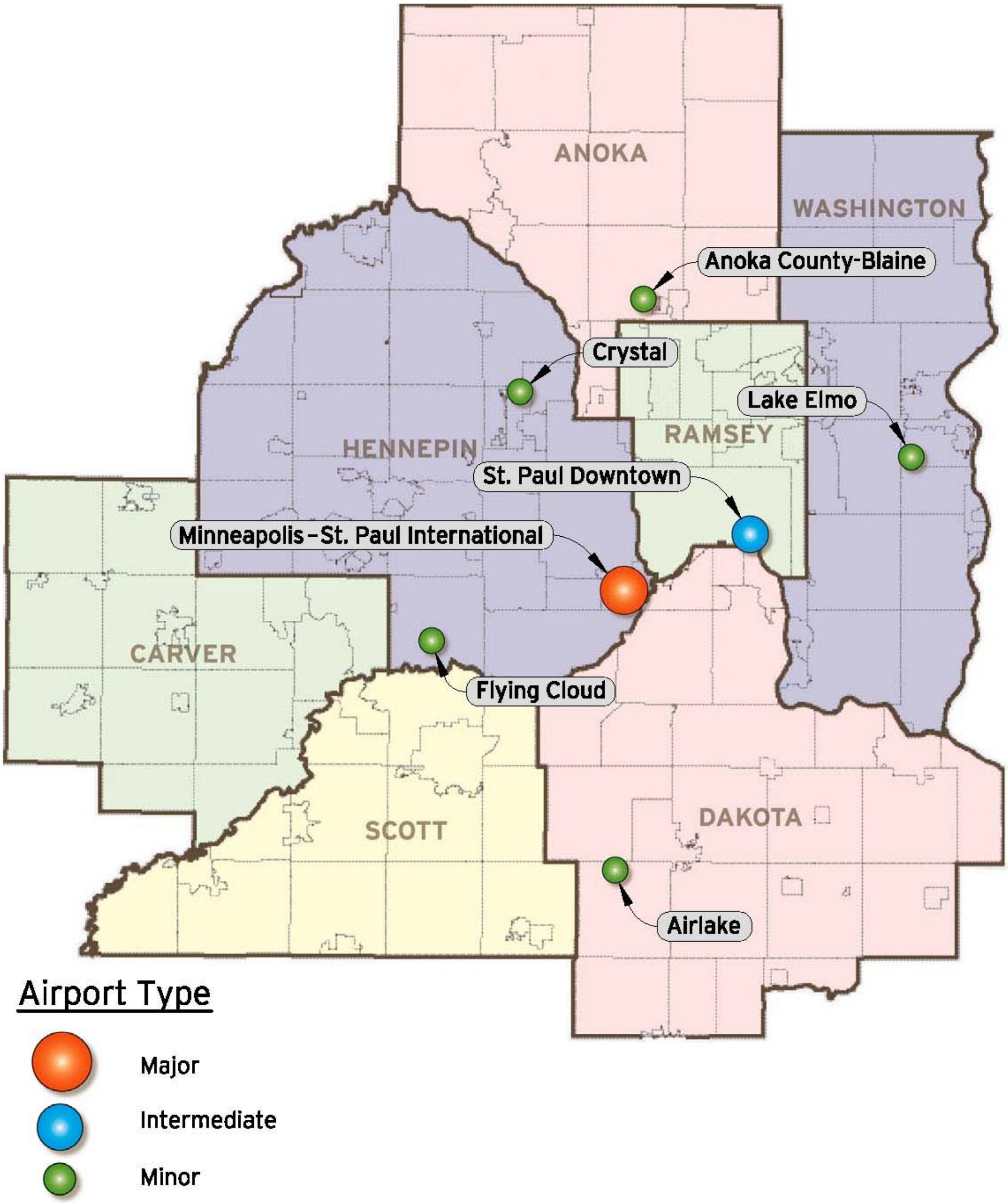
1.2 NEED FOR LTCP UPDATE

The Metropolitan Council adopted guidelines for the MAC to integrate information pertinent to planning, developing, and operating the region's airports in a manner compatible with their surrounding environs. In recognition of the dynamic nature of the aviation industry, the plans are to be updated regularly.

The aviation industry has changed significantly since the last LTCP was published in 1996. These changes include airline consolidation (including the recent merger of Delta Air Lines and Northwest Airlines), shifts in the aircraft fleet, new technologies, and evolving security protocols stemming from the September 11, 2001 terrorist attacks and other threats since that time. Combined, these changes have affected airline service patterns and passenger processing and behavior, and have resulted in some development at MSP that is different from the current LTCP.

The changes listed above, as well as variations in growth rates for different aviation activities, have resulted in some imbalances and deficiencies among various airport elements. In the terminal area, these near-term issues include bag claim facilities, public parking, the international arrivals hall, passenger security screening capacity, and a need for refurbishing

FIGURE 1-1: MAC AIRPORTS IN THE SEVEN COUNTY METROPOLITAN AREA



some concourses. On the airfield, consideration will be given to new taxiways to improve aircraft circulation. These near-term issues will be the primary focus of the LTCP Update.

The LTCP must examine not just immediate needs, but the long-range vision for MSP must be considered as well, especially given the long lead time for planning, environmental review, design, and actual construction. Key long-range issues include balancing airline activity between the Lindbergh and Humphrey terminals and enhancing the airport's ultimate capacity. To ensure the LTCP activities address changes in the aviation industry, demand and local and national economic conditions, the MAC will budget and update the LTCP every five years, consistent with Metropolitan Council guidelines. Based on this schedule, the next update will be completed in 2015.

1.3 AIRPORT HISTORY

Wold-Chamberlain Field flying activities date back to the formation of the Aero Club of Minneapolis, which leased land at an old concrete race track on the present MSP site in 1920. Government mail service began in 1921 but lasted only three months. In 1923, the airfield was named after two pilots killed in World War I, Ernest Groves Wold and Cyrus Foss Chamberlain. Air mail service was reinitiated by Northwest Airways in 1926, with service under government contract between Chicago and the Twin Cities.

In 1928, the airport was taken over by the Minneapolis Park Board and named Minneapolis Municipal Airport. Passenger service began in 1929 with Northwest Airways flying Ford Tri-motors to Chicago.

Airport facilities and service continued to expand through the 1930s, and in 1943, the Minnesota Legislature created the Minneapolis-St. Paul Metropolitan Airports Commission. The airport was designated Minneapolis-St. Paul International Airport—Wold-Chamberlain Field on August 23, 1948.

The Charles Lindbergh Terminal was built in 1962, and the original Hubert Humphrey Terminal opened in 1977, initially to accommodate international fights. It is now used by charter flights and a few scheduled airlines.

In 1989, the Minnesota Legislature adopted the Metropolitan Airport Planning Act. This legislation required the MAC and the Metropolitan Council (Met Council) to complete a comprehensive and coordinated program to plan for major airport development in the Twin Cities. The planning activities were designed to compare the option of future expansion of Minneapolis-St. Paul International Airport (MSP) with the option of building a new airport.

The analysis was completed in 1996, and the MAC and the Met Council formally submitted their recommendations to the Legislature on March 18, 1996. On April 2, 1996, legislation was passed by both the House and Senate, and subsequently signed by Governor Arne Carlson, stopping further study of a new airport and directing the MAC to implement the MSP 2010 Long Term Comprehensive Plan. This plan led to an over $3 billion expansion program including gate and automobile parking expansion and rental car facility consolidation and expansion, culminating in 2005 with the opening of the new Runway 17-35.

1.4 INVENTORY OF EXISTING FACILITIES

1.4.1 OVERVIEW

This section summarizes the major functional elements of the airport, including the airfield, passenger terminal, roadways and parking, cargo facilities, general aviation (GA) facilities, and support functions. **Table 1.1** found on the following page summarizes the major airport components.

1.4.2 AIRFIELD

MSP's airfield consists of four runways, a network of taxiways, and deicing pads.

Runways

Figure 1-2 shows the general airport layout for MSP. The airfield consists of two parallel runways, one north-south runway and one crosswind runway. Runway 4-22 is 11,006 feet long (with environmental approvals for an extension to 12,000 feet); Runway 12R-30L is 10,000 feet long; Runway 12L-30R is 8,200 feet long; and Runway 17-35 is 8,000 feet long.

Taxiways

Each runway is served by at least one full-length parallel taxiway. In addition, a network of taxiways connects each runway with the terminal areas (described in the next section) and other airport facilities.

Deicing Pads

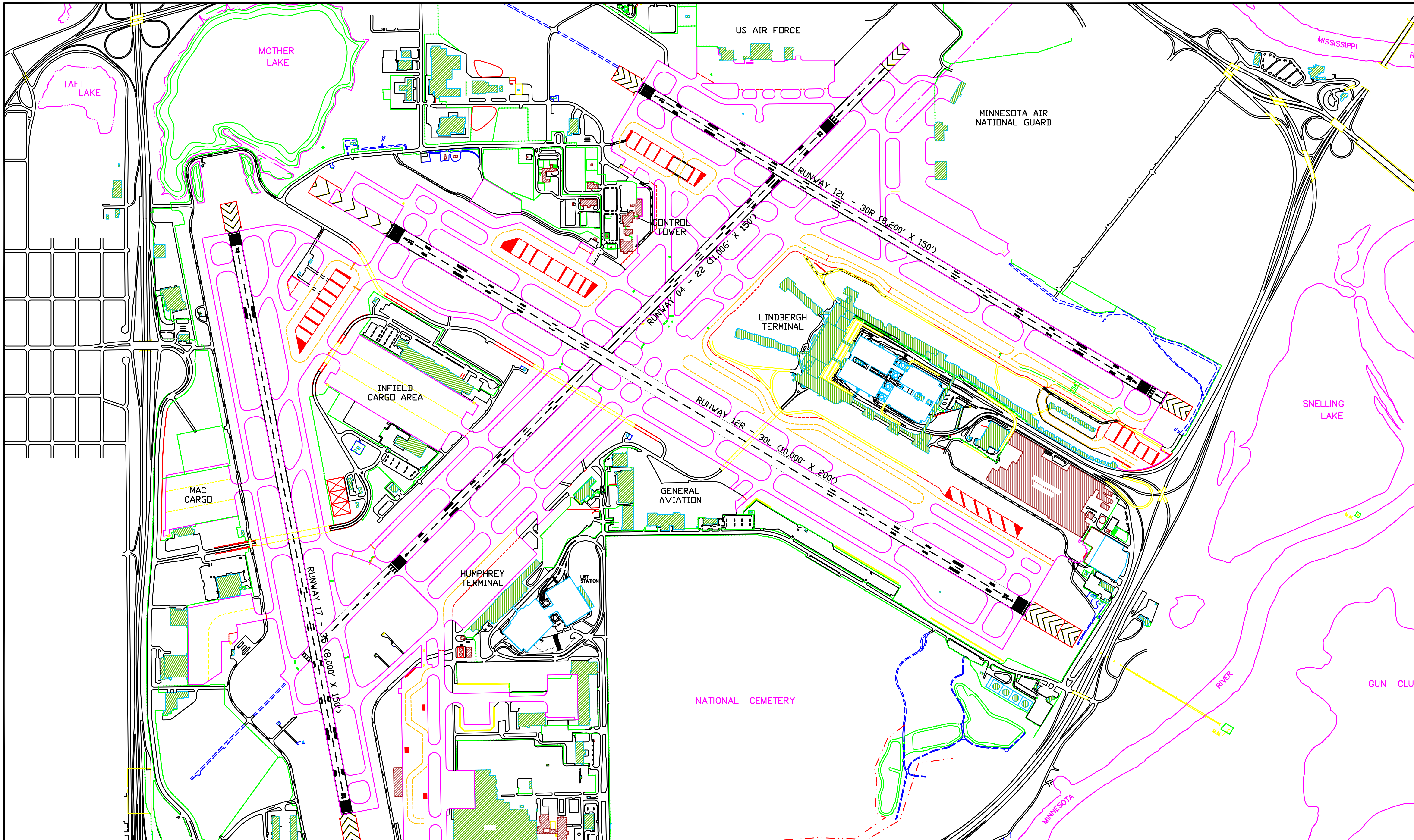
The parallel runways have deicing pads at each end sized to maintain runway departure rates during deicing conditions. Runway 17-35 has a 7-position deicing pad at the north end only because current operating restrictions normally preclude departures to the north over Minneapolis. All the deicing pads have adjacent facilities to recharge the deicing trucks and rest the deicing crews. A combined deicing operations and maintenance facility adjacent to the 12L deicing pad provides the capability to coordinate deicing operations on all pads.

TABLE 1.1: EXISTING AIRPORT FACILITIES

Airport Facility		Quantity
Runways		
East-West Parallel (12L-30R)		8,200 x 150 linear ft.
East-West Parallel (12R-30L)		10,000 x 200 linear ft.
North-South (17-35)		8,000 x 150 linear ft.
Crosswind (4-22)[1]		11,006 x 150 linear ft.
Terminals		
Lindbergh Terminal		2.8 sq. ft. (millions)
Humphrey Terminal		0.4 sq. ft. (millions)
	Total	3.2 sq. ft. (millions)
Gates		
Lindbergh Terminal		117 gates
Humphrey Terminal		10 gates
	Total	127 gates
Auto Parking Spaces (Public)		
Lindbergh Terminal		14,400 spaces
Humphrey Terminal		9,200 spaces
	Total	23,600 spaces
Cargo		
Warehouse/Office Space		480,000 sq. ft.
Aircraft Apron		229,000 sq. yds.
General Aviation Facility		18,500 sq. ft.

Notes: (1) Runway 4-22 has environmental approval to be extended to 12,000 feet.

Source: 2008 Legislative Report and MAC Analysis



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Note: Scale sized for 22x34 print. If printed on 11x17 double scale factor.

0' 600' 1200'

SCALE: 1" = 1200'

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SOURCE:
BASE MAPPING - TKDA

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2900 SOUTH QUINCY STREET,
SUITE 200
ARLINGTON, VIRGINIA 22206
PH (703) 824-5100
FAX (703) 671-6210

EXISTING AIRPORT LAYOUT

MINNEAPOLIS - ST. PAUL
MINNEAPOLIS, MN

DATE:
Jan 20, 2010

FIGURE
1-2

1.4.3 TERMINAL FACILITIES

Two terminals serve MSP: the Lindbergh Terminal and the Humphrey Terminal. Together, they provide a total of 2.4 million square feet of terminal facilities and 127 aircraft gate positions.

Lindbergh Terminal

The Lindbergh Terminal is located between the two parallel runways, east of the crosswind runway. As shown in **Figures 1-3 through 1-5**, the terminal is laid out with single-loaded and double-loaded concourses that provide 117 gate positions. The gates are distributed among seven concourses labeled A through G. Ten gates can support international arrivals into the International Arrival Facility. A concourse tram and moving sidewalks assist passenger travel along Concourse C. Moving sidewalks also facilitate passenger movement on Concourses A, B, G and through the connector bridge between Concourses C and G. Domestic bag claim functions are located on the lower level where there are 12 sloped-plate carousels, of which 10 are the older circular-shaped devices that have the capacity of 1.2 bags per linear foot. The size of each of these units is 90 linear feet, or a total capacity of 108 bags each. The remaining two sloped-plate units are similar to the carousels that are in the Humphrey Terminal, with a capacity of 1.5 bags per linear foot. The claim frontage of these units in the Lindbergh Terminal is 218 and 306 linear feet, or a total capacity of 327 and 459 bags respectively.

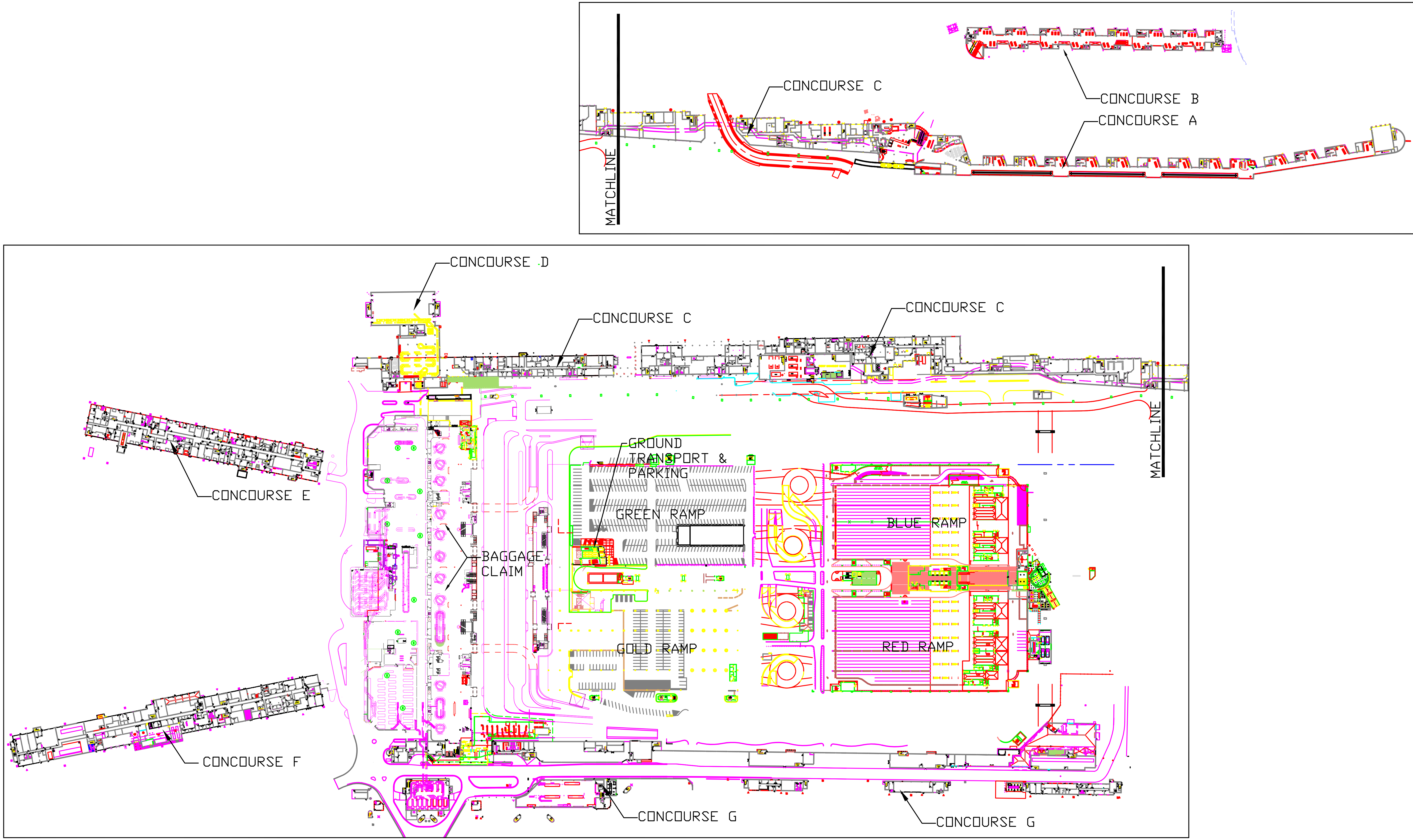
Ticketing/check-in, passenger security screening, gate hold rooms, and a wide array of concessions are located on the second level. A ground transportation center, located directly across from the terminal and accessed by a tunnel and skyway, serves as a focal point for multi-modal access. The MAC also has office space and a conference center on the Mezzanine Level of the Lindbergh Terminal.

At the time of this writing, the following airlines are currently located at the Lindbergh Terminal: Air Canada, Alaska Airlines, American Airlines, Continental Airlines, Delta Air Lines, Frontier Airlines, KLM Royal Dutch Airlines, United Airlines, and US Airways.

Humphrey Terminal

The Humphrey Terminal, shown in **Figures 1-6 through 1-8**, provides 10 gates (with four of those serving the International Arrivals Facility) used by Air Tran Airways, Iceland Air, Midwest Airlines, Southwest Airlines, Sun Country Airlines, and several charter airlines. The lower level features the ticketing/check-in area, international arrivals processing, and the bag claim area which has four sloped-plate carousels that are oval-shaped, and have the capacity of 1.5 bags per linear foot. The overall size of each of these units is 145 linear feet, or a total capacity of 218 bags per device.

The second floor of the terminal includes the security screening checkpoint and gate hold rooms. The Humphrey Terminal also features a ground transportation center for commercial vehicle service. The Humphrey Terminal is served by a single-level curb facility serving both departing and arriving passenger functions.



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LINDBERGH TERMINAL - LEVEL 1

MINNEAPOLIS - ST. PAUL
MINNEAPOLIS, MN

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FIGURE
1-3

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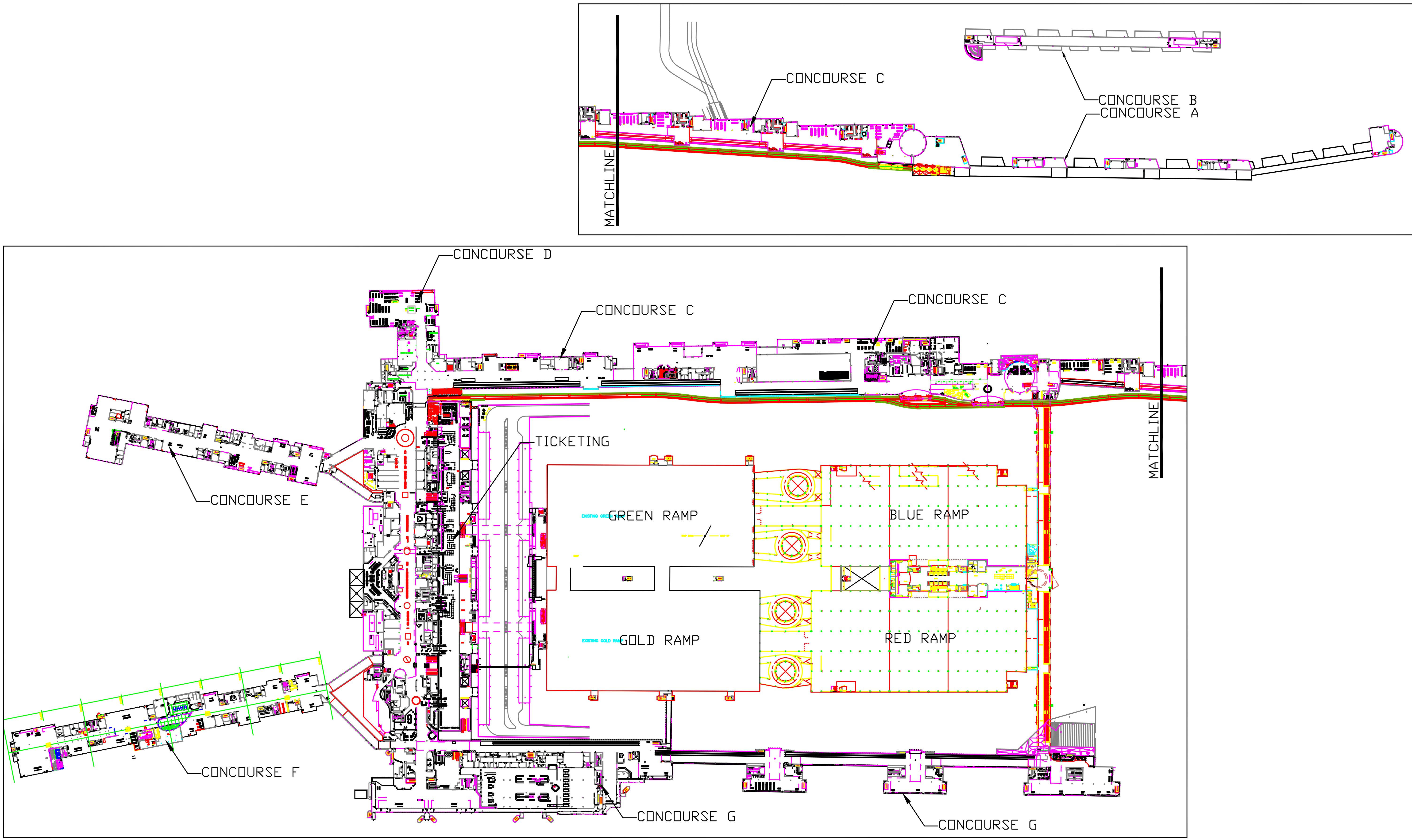

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LINDBERGH TERMINAL - LEVEL 2

MINNEAPOLIS - ST. PAUL
MINNEAPOLIS, MN

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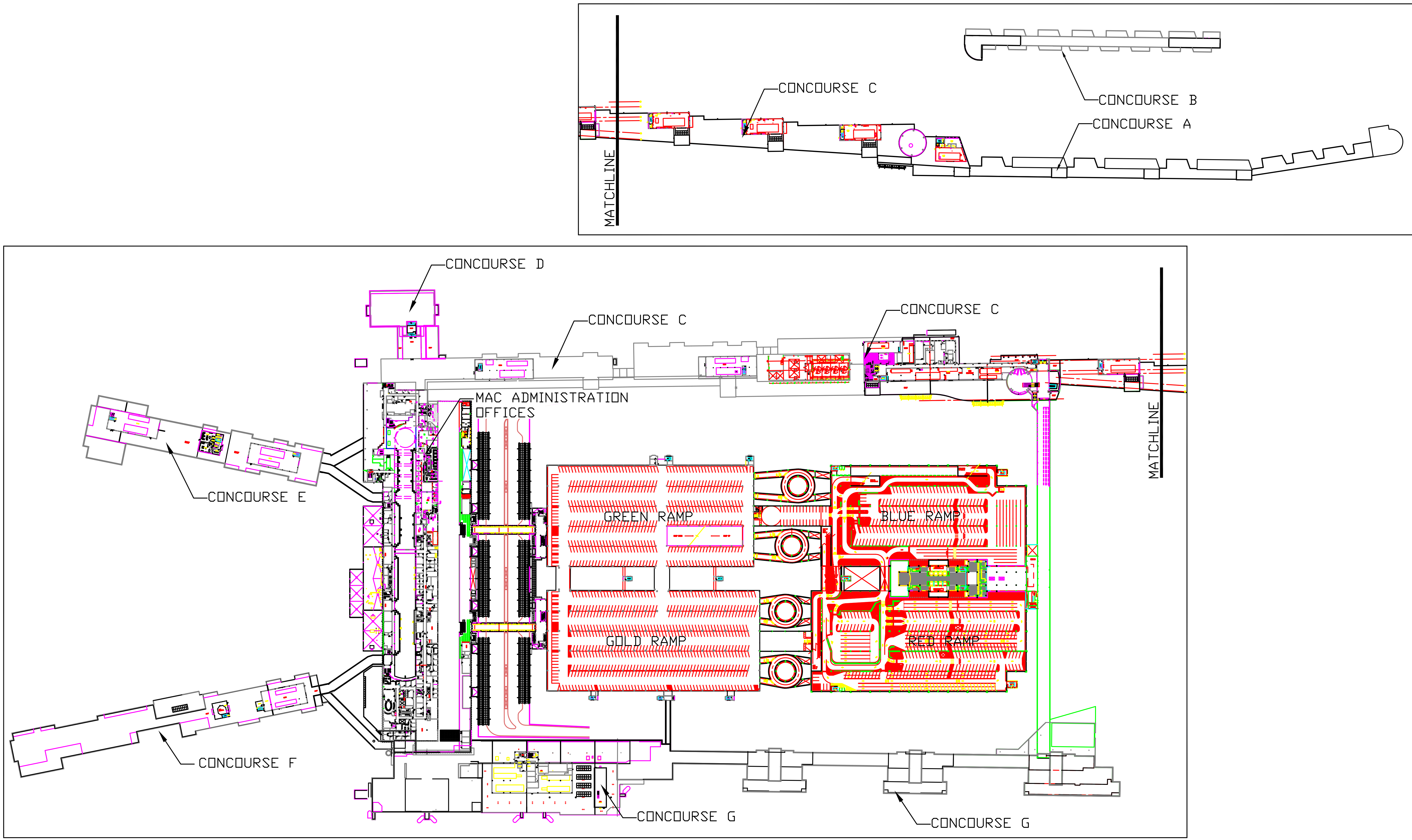
FIGURE
1-4



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LINDBERGH TERMINAL - LEVEL 3

MINNEAPOLIS - ST. PAUL
MINNEAPOLIS, MN

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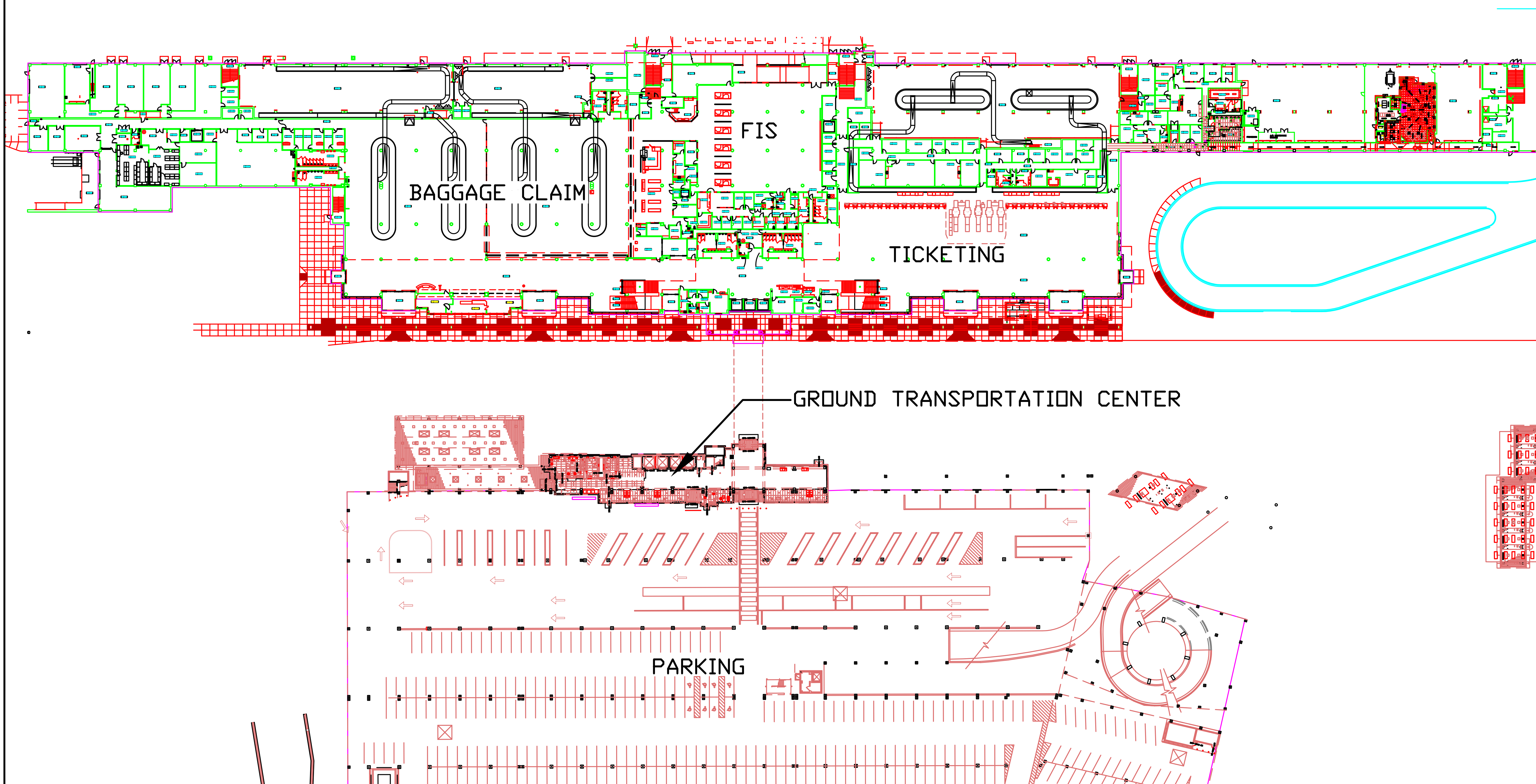
Jan 20, 2010

FIGURE
1-5



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HUMPHREY TERMINAL - LEVEL 1

MINNEAPOLIS - ST. PAUL
MINNEAPOLIS, MN

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FIGURE
1-6

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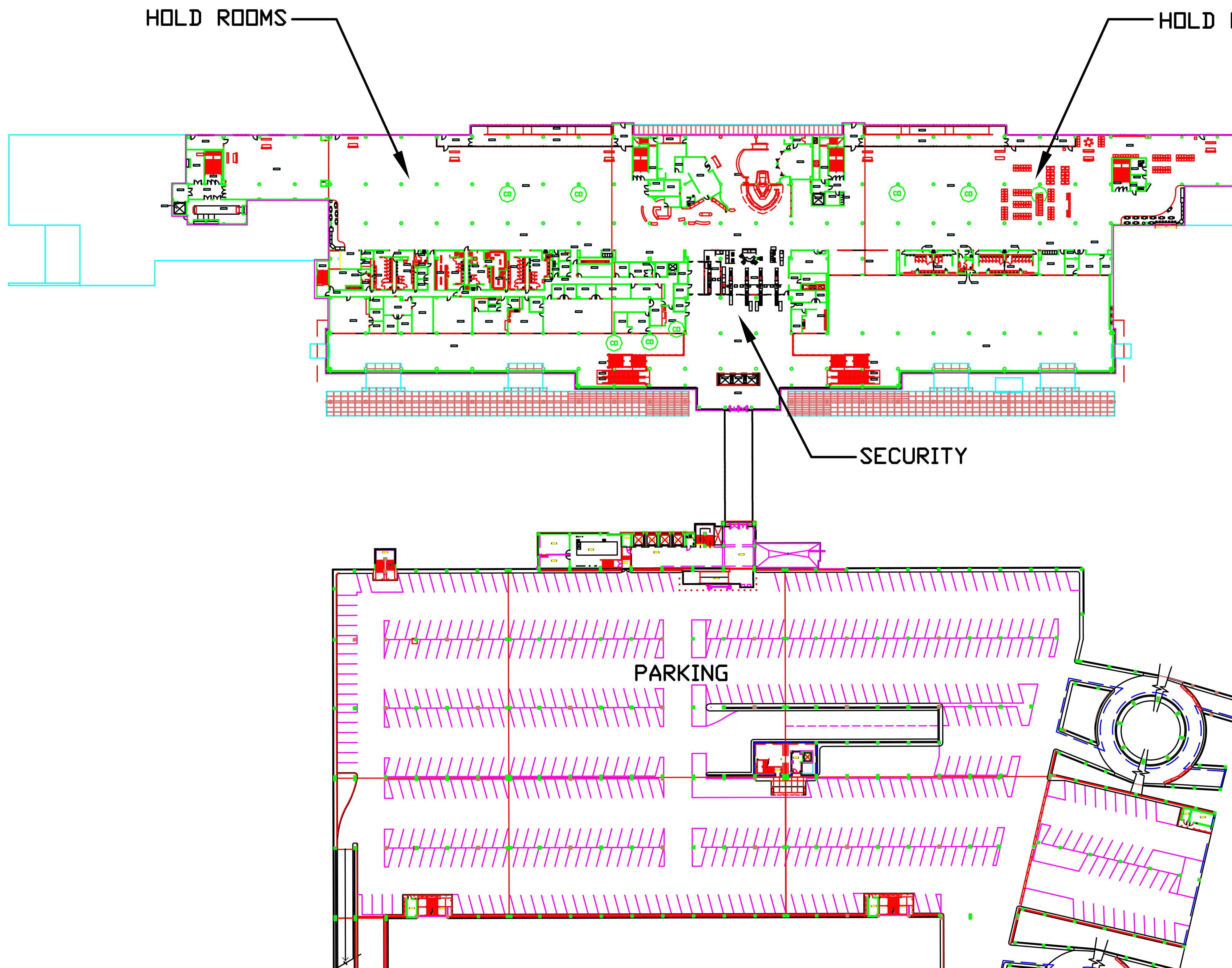

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HUMPHREY TERMINAL - LEVEL 2

MINNEAPOLIS - ST. PAUL
MINNEAPOLIS, MN

DATE:
Jan 20, 2010

FIGURE
1-7

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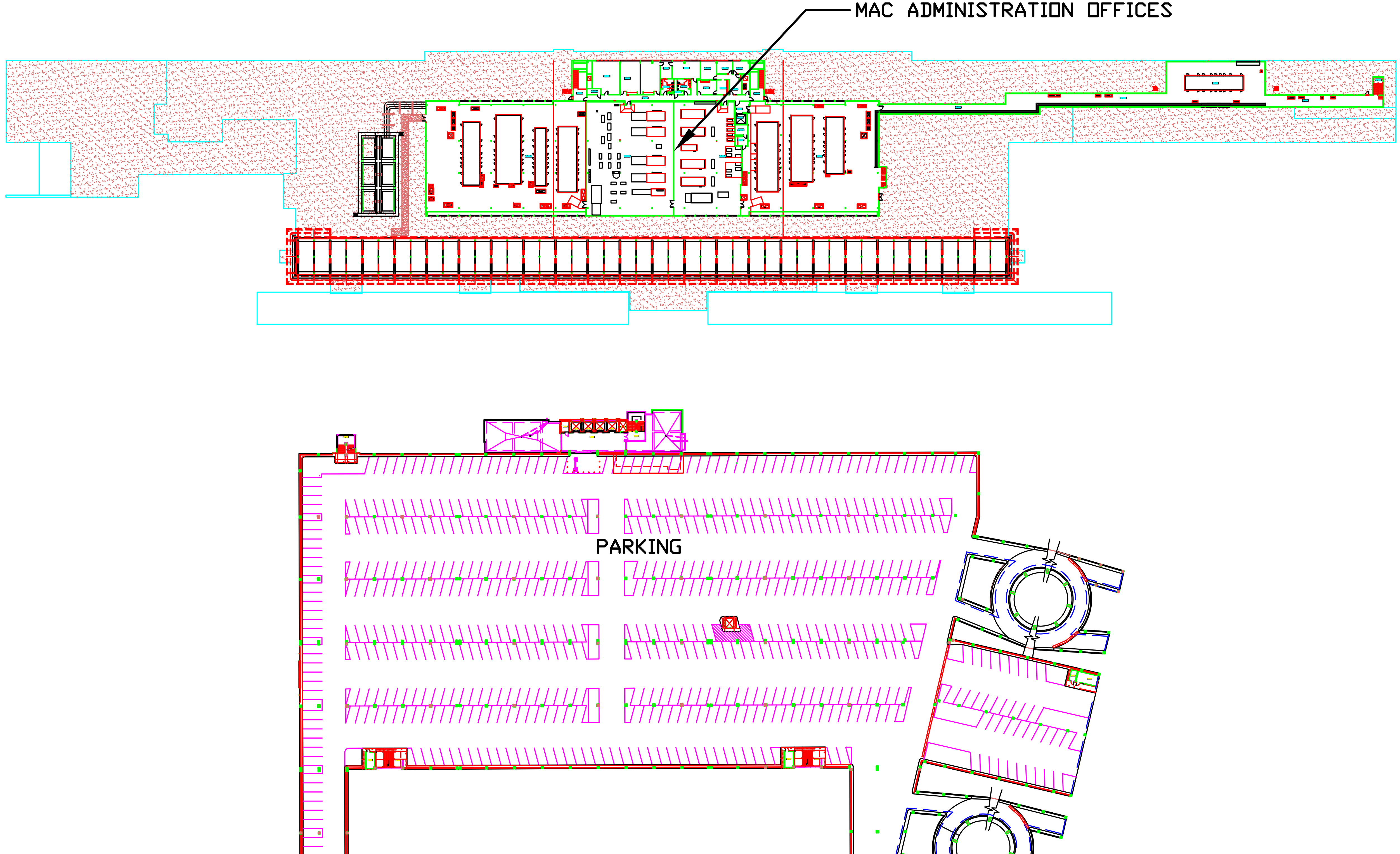

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2900 SOUTH QUINCY STREET,
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HUMPHREY TERMINAL - LEVEL 3

MINNEAPOLIS - ST. PAUL
MINNEAPOLIS, MN

DATE:
Jan 20, 2010

FIGURE
1-8

1.4.4 GROUND ACCESS AND PARKING

Highway Access

Minneapolis-St Paul International Airport (MSP) is surrounded by a comprehensive highway network. The Crosstown Highway (State Highway 62) is located directly north of MSP, while Interstate 494 lies directly south of the airport; both run in an east-west direction. State Trunk Highways 55 and 77 are located directly east and west of the airport, respectively, and run in a north-south direction. The Lindbergh Terminal is accessed directly off of Highway 5 via Glumack Drive. The Humphrey Terminal is accessed directly off of 34th Avenue from I-494, Highway 5, or Post Road (East 70th Street), via Humphrey Drive/East 72nd Street. The airport has a network of internal roads providing access to general aviation, cargo and other facilities.

MSP is the only major airport in the United States to have two terminals – the Lindbergh and the Humphrey – located on entirely separate roadway systems. Highway signs and other way-finding aids related to MSP will be updated in 2010 in order to assist travelers in locating the terminals. Numeric designations will be added to the existing terminal names: Terminal 1-Lindbergh and Terminal 2-Humphrey.

Transit

MSP has direct access to downtown Minneapolis and the Mall of America via the region's light rail transit (LRT). Currently, two stations serve the airport; the first is located directly east of the Humphrey Terminal and the second is below ground in the tunnel at the southeast end of the Lindbergh Terminal parking garage. Trains run every seven or eight minutes during peak hours and every 10 to 15 minutes off-peak. Metro Transit provides public bus service to the airport. The bus station is located in the Lindbergh Terminal's Transit Center.

Parking

There are approximately 23,600 public parking spaces at MSP, split between the Lindbergh and Humphrey parking ramps. At the Lindbergh Terminal, four parking ramps designated Green, Gold, Red and Blue provide short-term and general parking for passengers and space for rental cars. Short-term parking is located on Level 1 and the Mezzanine Level of the Green Ramp and rental car parking is provided on Levels 2 and 3 of the Red and Blue Ramps. Valet parking is also available in the lower level of the Lindbergh Terminal. There are a total of 14,400 public parking spaces in the areas described above. A tram assists passenger movements to the Red and Blue parking ramps that are located furthest from the Lindbergh Terminal.

There are two parking ramps – designated the Orange and Purple ramps – at the Humphrey Terminal that provide a total of 9,200 public parking spaces. The LRT provides access to the Lindbergh Terminal from the Humphrey parking ramps.

There is also a cell phone lot located off of Post Road between the two terminals.

1.4.5 CARGO FACILITIES

Cargo activity occurs at three locations at MSP. FedEx and UPS operate in a 100-acre "infield" area which provides 269,000 square feet of warehouse/office space and 154,000 square yards of apron space, including the center taxiway.

Second, there is a 30-acre "west" cargo area, west of Runway 17-35, that provides a 26,000 square foot cargo building and a 75,000 square yard apron (including the center taxi lane).

Lastly, on the southwest side of the airfield, there are two 40,000 square-foot cargo buildings (for a total of about 80,000 square feet). This site, known as the “air cargo center” does not provide direct aircraft access.

1.4.6 GENERAL AVIATION FACILITIES

General aviation (GA) facilities are located on a 37-acre site off East 70th Street. Fixed Base Operator (FBO) services are provided by Signature Flight Support. In 2002, Signature built a new GA facility, which now provides 18,500 square feet of facilities featuring a lobby, office space, conference rooms, private phone suites, pilot lounge, showers, lockers, a game room and a quiet room. A 3,700 square-foot garage provides indoor storage for ground equipment. There are also about 185 public automobile parking spaces. The site includes about 267,000 square feet of hangar/storage/shop space and 88,000 square yards of apron. The FBO also provides aircraft maintenance.

1.4.7 SUPPORT FACILITIES

Support facilities (which include airline maintenance, airport maintenance, Aircraft Rescue & Fire Fighting (ARFF) facilities), Federal Aviation Administration facilities, and miscellaneous facilities are in various locations of the airport.

Delta Air Lines (which acquired Northwest Airlines) occupies two maintenance complexes and a cargo facility on the south side of the airport. Most of the old Northwest Building B maintenance facility (adjacent to the Lindbergh Terminal inbound/outbound roadway) has been demolished. Two hangars, an engine test cell and associated facilities that remain (approximately 751,000 sq. ft.), are used by Delta for aircraft maintenance, shops and repairs.

Three additional airline maintenance hangars are sited on the western edge of the airfield and provide a total of approximately 247,000 square feet of floor space for hangars, shops, and offices.

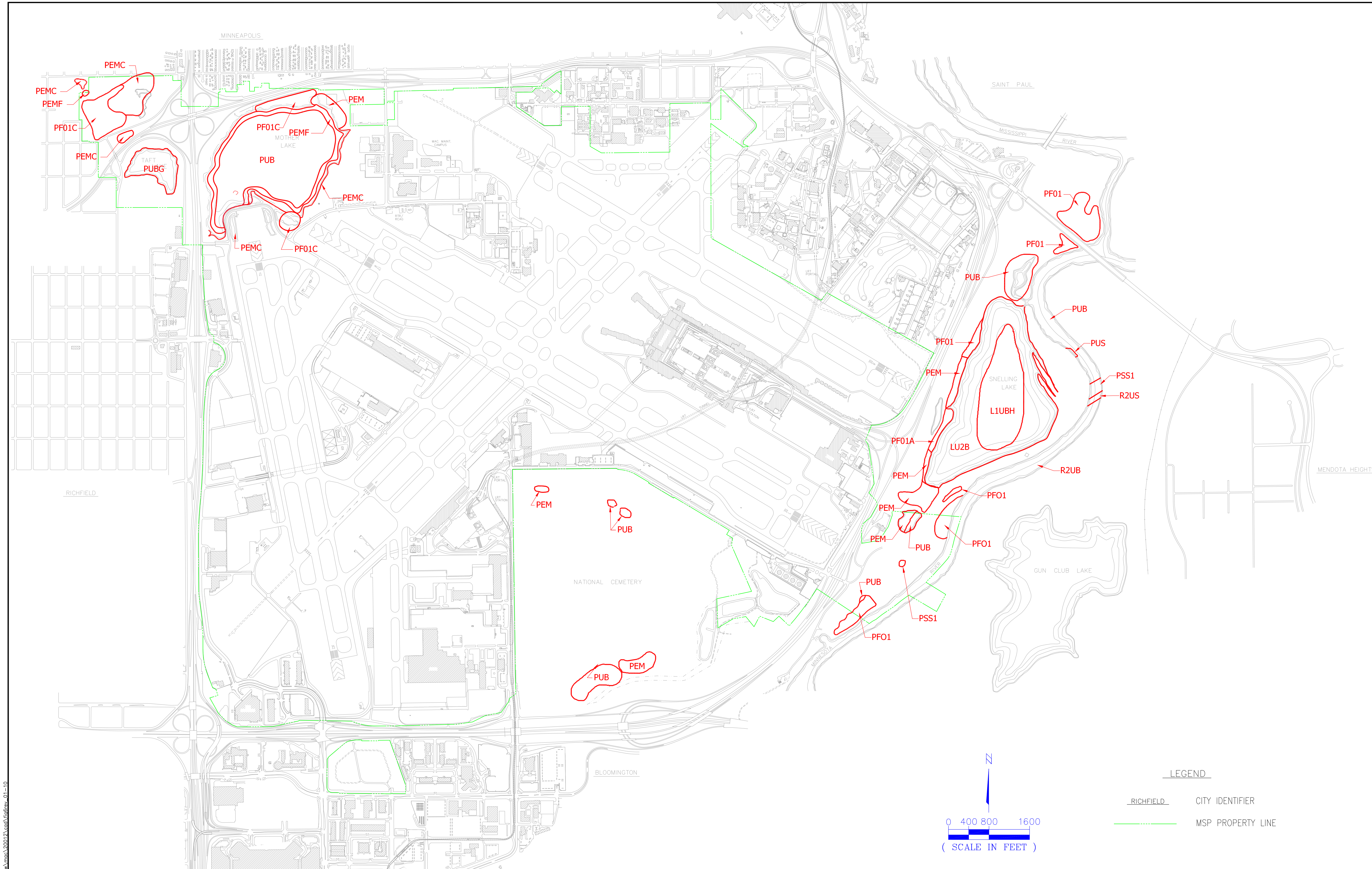
The main Aircraft Rescue & Fire Fighting (ARFF) facility is located near the center of the airfield on the south side of the runways; a satellite ARFF facility is located on the north side of the airfield between the parallel runways.

1.5 AIRPORT ENVIRONMENT

1.5.1 WETLANDS

In the now completed MSP 2010 Airport Expansion Program, impacted wetlands were mitigated through various means in conjunction with the appropriate regulatory agencies. Only a couple of minor remnant wetlands, at the north end of Runway 17, adjacent to the Mother Lake area, are still in existence on the airfield.

The wetlands were mitigated through permits granted by the US Army Corps of Engineers and the Minnesota Department of Natural Resources and in accordance with federal and state laws. The MAC serves as its own local government unit for any Wetland Conservation Act (WCA) jurisdictional wetlands. The Department of Natural Resources would have jurisdiction over any remnants that qualify under its authority. **Figure 1-9** depicts the National Wetlands Inventory within the airport property.



MINNEAPOLIS – ST. PAUL INTERNATIONAL AIRPORT
MSP WATERSHED MANAGEMENT PLAN

NATIONAL WETLANDS INVENTORY

Figure 1–9

1.5.2 WATER QUALITY AND DRAINAGE

Water Quality

Issues of concern at MSP that have the potential for environmental impact on water resources and that are associated with the airport facility and operations are biochemical oxygen demand (glycol products used for aircraft de/anti-icing operations); total suspended solids in storm water runoff; and oil and grease associated with aviation fueling facilities and operations.

The MAC has a National Pollutant Discharge Elimination System (NPDES) permit from the Minnesota Pollution Control Agency (MPCA) for storm water discharges from MSP. The MAC also maintains a construction NPDES permit from the MPCA and a Special Discharge permit from the Metropolitan Council Environmental Services (MCES) for construction dewatering activities.

Deicing activities at airports have the potential to effect receiving bodies of water. The MSP Glycol Management Program - a combination of capital improvements and Best Management Practices (BMP) implemented by both the airport and airlines - has been and may continue to be the most effective means to minimize the five-day carbonaceous biochemical oxygen demand ($CBOD_5$) discharges to the Minnesota River.

The basic objective of the Program is to control the runoff of Aircraft Deicing Fluid (ADF) so that glycol (and therefore $CBOD_5$) discharges to the river are minimized. The source control program seeks to minimize ADF application consistent with safety mandates, and to maximize glycol capture at the location of ADF application. Contained glycol-impacted storm water (GISW) with significant enough glycol content is recycled. Contained GISW with glycol content insufficient for recycling is routed to MCES for treatment.

The key components of the MSP Glycol Management Program are five dedicated deicing pads, a plug and pump network adjacent to both terminals, enhanced or new storm water ponds, snow melters, glycol recovery vehicles, runway/pavement BMPs and sophisticated equipment for ADF application.

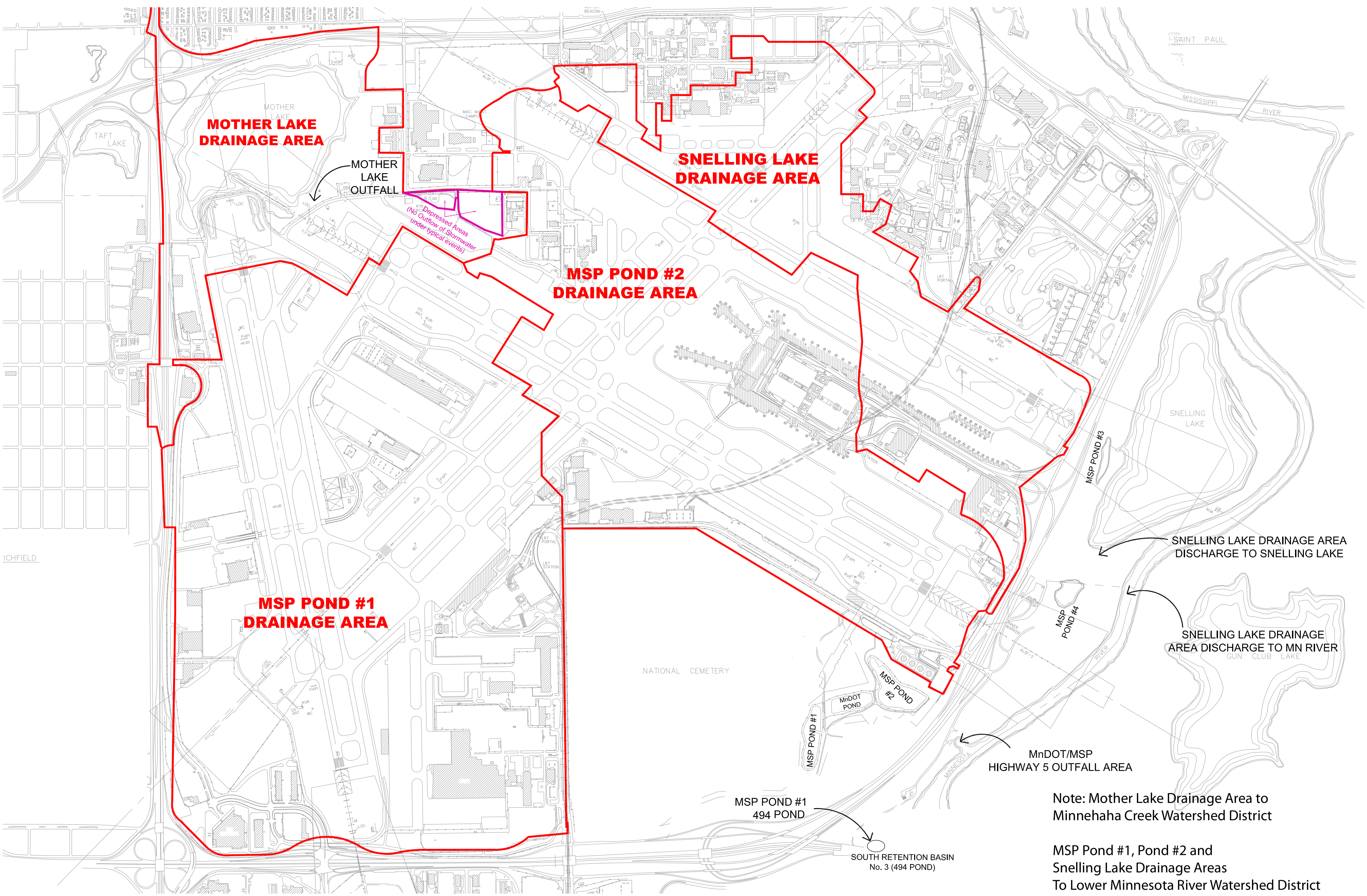
MSP tenant airlines support this program by using sophisticated equipment for ADF application, Glycol Recovery Vehicles (GRVs) to collect spent glycol and/or glycol-impacted storm water (GISW) for recycling and off-site treatment by local Publicly Owned Treatment Works (POTW) through an industrial discharge permit.

MAC implemented runway/pavement BMPs including prohibiting use of urea; use of mechanical runway snow removal procedures to reduce chemical pavement deicing and sand usage; advanced weather forecasting to facilitate preventative anti-icing practices; and extensive personnel training on efficient application techniques to minimize pavement deicer usage.

Drainage

The goal of the airport's water management plan is to effectively protect and manage water resources while ensuring safe and efficient operation of the airport facility.

There are two receiving waters for surface water runoff from MSP—Mother Lake and the Minnesota River. MSP has four drainage areas; one of the four MSP drainage areas discharges to Mother Lake and the remaining three discharge to the Minnesota River. The drainage areas are shown in **Figure 1-10.**



Note: Mother Lake Drainage Area to Minnehaha Creek Watershed District

MSP Pond #1, Pond #2 and Snelling Lake Drainage Areas To Lower Minnesota River Watershed District

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METROPOLITAN AIRPORTS COMMISSION	JAN 10
MSP NPDES PERMITTED OUTFALLS DRAINAGE AREA MAP	FIGURE 1-10

MOK 1-12-10 1=1 PRJ/MAC/AIRPORT DATA/CAD/WATERSHED MAPS/JAN 2010.DWG

Mother Lake Drainage Area

The Mother Lake drainage area from MSP is comprised of approximately 300 acres, of which an estimated 51 acres are hard-surfaced. A large percentage of the surface area is grassland and Mother Lake. Service roadways, and the outward half of taxiways associated with the end of Runways 12R and 17 are the only significant hard-surfaced areas in the Mother Lake drainage area from the airport. Other facilities also discharge to the Mother Lake Drainage Area such as the Richfield maintenance facility, Mn/DOT materials storage and maintenance facility, as well as adjacent portions of Cedar Avenue and Highway 62 roadways.

Figure 1-10 identifies two areas as depressed that will not convey storm water flow during typical precipitation events. Storm water conveyed from these two locations flow into the Mother Lake Drainage Area or the MSP Pond #2 Drainage Area.

The only significant airport operations within the Mother Lake drainage area are vehicular traffic and aircraft movement on the limited portions of the taxiway.

Storm water drainage from the MAC General Office, Field Maintenance and Trades building area flows into the City of Minneapolis storm sewer system, with the exception of the drainage directed into two infiltration basins located east of the Field Maintenance and Trades buildings. There is no access for aircraft within the area directed to the Minneapolis system; therefore, there is no aircraft maintenance, deicing or fueling conducted in this storm water discharge area.

Minnesota River North Drainage Area

The Minnesota River North drainage area – also defined as the MSP Pond #2 Drainage Area – is the second largest and most intensely developed drainage area on MSP. It is comprised of approximately 797 acres, of which 307 acres are hard-surfaced. This watershed includes a majority of Terminal 1 (Lindbergh), parts of Runways 12L-30R, 12R-30L and 4-22 and associated taxiways, parking and the Fuel Farm.

Included in this drainage area are the majority of all fueling activities, aircraft deicing/anti-icing activities, runway sanding and general snow/ice control activities, and other associated airport operations.

Snelling Lake Drainage Area

The Snelling Lake drainage area has an approximate area of 427 acres, of which an estimated 226 acres are hard-surfaced. This watershed includes the portion of the Lindbergh Terminal servicing regional aircraft, Runways 12L-30R and 4-22 and associated taxiways, inbound and outbound roadways, the US Post Office and Air Force Reserve and Air National Guard Airside Operations.

Minnesota River South Drainage Area

The Minnesota River South drainage area – also defined as the MSP Pond #1 Drainage Area - is comprised of approximately 1,191 acres, of which 596 acres are hard-surfaced. This watershed includes the Humphrey Terminal and associated parking facilities, Delta Building C, FedEx and UPS Cargo Operations, Metropolitan Transit Commission bus storage facility and the Glycol Recovery Facility.

The MAC has an extensive monitoring program to measure the quality and quantity of the MSP discharge to the Minnesota River. In addition, the MAC constructed detention ponds to reduce the potential loading of pollutants into the Minnesota River. Construction of Pond 1 was completed in 2001 and Pond 2 was completed in 2004. The storm water ponds that receive flow from the airport's network of storm sewer piping are visually checked daily for signs of petroleum impacts.

Pond 1 receives storm water discharges from the Minnesota River South Drainage area, which encompasses virtually all airport activity on the west side of MSP, including the Humphrey Terminal and Runway 17-35. Pond 2 receives storm water from the Minnesota River North Drainage area, which encompasses the majority of airport activity at MSP, including most of the Lindbergh Terminal. Ponds 3 and 4 receive storm water from the Snelling Lake Drainage area, which includes the inbound/outbound roadways, the US Post Office and a portion of the Lindbergh Terminal.

MSP Ponds 1 and 2 were designed as an MSP storm sewer upgrade to control discharge of total suspended solids (TSS) to the Minnesota River. These ponds, along with the Mn/DOT pond, discharge through one spillway with three pipes under Highway 5 at the same location.

MSP Ponds 1 and 2 each include a forebay area where influent is received. The forebays are the primary TSS separation areas and have an underflow design to protect against floating debris and provide sheen management. The forebays are followed by a large main body that storm water travels through prior to exiting through discharge structures. The discharge structures are equipped with an underflow baffle to prevent floating debris and sheens from discharging. Booms have been deployed across the forebay areas and around the discharge structures to enhance the capability of capturing floating debris and sheens. The ponds also have remotely-actuated valve controls on the discharge structures to supplement the manual controls. Ponds 3 and 4 have a storm water collection system that is comprised of a detention storm water basin followed by a retention storm water basin in series.

1.6 SANITARY SEWER, WATER AND SOLID WASTE

1.6.1 SANITARY SEWER

Wastewater discharges from MSP are conveyed to the MCES Metro Plant on Childs Road. This plant has a design capacity of 250 million gallons per day.

Wastewater is discharged to the Metro Plant through MCES' sewer interceptor system. Discharges from MSP are conveyed to the interceptor system through the sewer systems of three different jurisdictions. The majority is discharged from the airport to a tunnel near the Mississippi River that discharges into the interceptor system. A small volume of wastewater is discharged into the City of Minneapolis sewer system prior to reaching the MCES interceptors. Wastewater from the southwest portion of MSP is discharged through the City of Richfield sewer system prior to reaching the MCES interceptors.

1.6.2 WATER SUPPLY

All of the potable water used on the MSP campus is provided by the City of Minneapolis via three trunk main connections located along the northern boundary of the airport. Water usage is generated at the terminal buildings due to passenger amenities such as restrooms and concessions, cleaning requirements, and tenant facilities. Other airfield water uses include irrigation, rental car wash facilities, tenant hangar areas and cargo uses. The average daily water use reached 989,000 gallons per day in 2007, and declined slightly to 916,000 gallons per day in 2008. Peak flow requirements are largely dependent on fire flow demand. The peak fire flow demand is 4,500 gallons per minute for four hours at either the Lindbergh or the Humphrey Terminal, which is met by the existing system.

1.6.3 SOLID WASTE

MSP is located in Hennepin County, whose solid waste management plan provides for an integrated waste management system of transfer stations, waste processing, combustion facilities, recycling programs and facilities, yard waste composting and land-filling.

Using a centralized solid waste management system, the MAC contracts with a single vendor for all solid waste hauling at the Lindbergh and Humphrey Terminals. Trash is moved from the point of generation to six locations and from there is moved off-site by the airport's vendor. Compactors are used in all terminal locations to reduce waste volume which reduces the number of loads that must be transported off-site.

The airport provides the traveling public with a "dual stream" offering of receptacles in the terminal public areas. Newspapers/magazines and plastic/glass bottles/cans are collected separately. Recycling containers are located throughout the terminals but concentrated in gate areas where most recyclable materials are discarded.

The MAC's contracted vendor is required to deliver all municipal solid waste directly to the Hennepin Energy Recovery Center (HERC), a waste-to-energy facility. Part of an overall regional solid waste management plan, the HERC facility is owned by Hennepin County and burns trash for energy recovery.

1.7 METEOROLOGICAL DATA

In general terms, MSP enjoys good weather to accommodate the high level of operations associated with a major hub airport.

Table 1.2 below shows the historical percentages of different weather categories at MSP. VFR 1 is the best weather for flight operations. All aircraft can make what are called visual approaches to the airport in VFR 1 conditions. Departures can also use initial visual separation. The airport has the highest airfield capacity in VFR 1 conditions.

TABLE 1.2: AIRFIELD WEATHER

	Ceiling/Visibility	Occurrence (%)
VFR 1	3,200 feet and above/8 statute mile (sm) and above	70.7
VFR 2	1,000 to 3,200 feet/3 to 8 sm	20.9
IFR 1	200 to 1,000 feet/0.5 to 3 sm	8.2
IFR 2	Below 200 feet/below 0.5 sm	0.2
		Total: 100.0

Source: Minneapolis-Saint Paul International Airport Capacity Enhancement Plan, December 1993, Figure 10.

VFR 2 is almost as good as VFR 1 from an airfield capacity standpoint. In VFR 2 conditions, approaches typically need to be put on an instrument approach for the first part of the final approach phase. This increases aircraft separation slightly. Approaches to all three runways in the "north flow" condition (converging between Runway 35 and Runway 30L and 30R) can still be conducted in most VFR 2 conditions. Departures cannot use initial visual separation, so separations between departing aircraft also need to be increased slightly.

In IFR 1 conditions, all aircraft need to be on an instrument approach for the entire phase of the approach. Aircraft separation needs to be increased slightly beyond the separation used in VFR

2 conditions. Approaches to Runway 35 cannot be conducted at the same time approaches are occurring on Runways 30L and 30R, which causes an additional decrease in arrival capacity.

In IFR 2 conditions, operations can be significantly limited, depending on the direction of the wind. Aircraft need special equipment and pilots need special training to land during IFR 2 conditions. In addition, runways need to be specially-equipped for operations during IFR 2 conditions. Runways 12R and 12L are both equipped to accommodate operations in IFR 2 weather, and they can be used simultaneously, as long as aircraft maintain a staggered separation between adjacent runways. For north winds, Runway 30L is equipped for limited operation during IFR 2 conditions, and Runway 35 is fully equipped for IFR 2 conditions. However, the runways converge and cannot be used simultaneously for arrivals. Fortunately, the occurrence of IFR 2 conditions is very low, and the winds tend to be calm or are from a southerly direction a majority of the time in this condition.

1.8 LAND USE, AIRSPACE AND ZONING

Chapter 6 provides an analysis of land use, airspace and zoning considerations in the context of existing and planned airport facilities.

CHAPTER 2: FORECASTS

CHAPTER 2: FORECASTS

2.1 INTRODUCTION AND PURPOSE

The Metropolitan Airports Commission (MAC) is updating the Long Term Comprehensive Plan (LTCP) for Minneapolis-St. Paul International Airport (MSP). A critical element of this plan is to balance the long-term airfield, terminal, and landside facilities serving the airport. A re-appraisal of the forecasts is especially timely, given the acquisition of Northwest Airlines by Delta Air Lines and the impacts of recent fuel price increases and the current economic recession.

This forecast analysis contains the annual and derivative activity forecasts for the airport. Except where noted, the forecasts contained herein are unconstrained; they assume landside and airfield capacity will be available to accommodate the anticipated demand. Forecasts are presented for 2010, 2015, 2020, 2025, and 2030. Separate annual forecasts were developed for scheduled domestic and international passenger, non-scheduled passenger, air cargo, general aviation, and military activity.

This analysis first discusses historical and anticipated socioeconomic activity in the Twin Cities area, followed by a discussion of historical aviation activity and ongoing trends at MSP. Critical assumptions are then presented followed by the forecasts of domestic and international passengers, along with forecasts of non-scheduled passengers and peak activity. Forecasts of air cargo tonnage and operations, and general aviation and military activity are then discussed. The technical report concludes with a summary of forecast annual activity, estimated gate requirements, and a discussion of alternative forecast scenarios.

The assumptions in the following forecasts are based on input from airline and airport officials, previous MSP studies, relevant literature, and professional experience. Forecasting, however, is not an exact science. Departures from forecast levels in the local and national economy and in the airline business environment may have a significant effect on the projections presented herein. These uncertainties increase toward the end of the forecast period, when new technologies and business strategies and changes in work and recreational practices may have an unpredictable impact on aviation activity. For these reasons, the forecasts should be periodically compared with actual airport activity levels, and airport plans and policies adjusted accordingly. Tables 2.1 through 2.18 are included in this chapter, the rest of the tables, denoted with letters, can be found in Appendix A of this report.

2.2 ECONOMIC TRENDS

Passenger demand is determined by the strength of the economy and the cost of available services. Consequently, the development of an aviation activity forecast requires a clear understanding of local economic forecasts and trends.

The service area definition corresponds to the seven counties that comprise the Metropolitan Council (Met Council). This core area includes Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington Counties. Larger service area definitions that encompass additional counties have been tested in previous MSP forecast efforts, but in those studies, passengers proved to be most sensitive to trends in the 7-county Met Council area.

Table 2.1 presents historical and projected population, employment, income and per capita income for each county of the Met Council area. The tables in the Appendix provide more detailed information by county and also show data for the United States for comparison purposes. Two sets of forecasts are presented in the Appendix, one from the Met Council and the other from Woods & Poole Economics.

Both the Met Council and Woods & Poole socioeconomic forecasts have their strengths and weaknesses. The Met Council forecasts are prepared locally and reflect a detailed knowledge of the existing and projected growth trends within the Minneapolis-St. Paul metropolitan area. However, they do not include projections of income or projections of national activity. Income is important because an analysis of historical registered aircraft data by county indicated that registered aircraft were more closely correlated with income than with population or employment. Also, much of the analysis will be based on Federal Aviation Administration projections of national general aviation activity. For this analysis to be valid, the local and national socioeconomic projections need to be based on a consistent set of assumptions.

The Woods & Poole forecasts are more recent than the Met Council forecasts. They also include personal income and prepare metropolitan and national forecasts using a common set of assumptions. However, the Woods & Poole forecasts do not incorporate a detailed knowledge of local growth trends and development constraints.

A hybrid forecast that incorporates the strengths and minimizes the weaknesses of the two data sources was prepared for use in this study. For each county, Met Council forecast growth rates were applied to the latest base year data. These forecasts were then adjusted, on a prorated basis, to sum to the Woods & Poole forecasts for the 7-county Met Council metropolitan area.

2.2.1 POPULATION

Table A.1 of Appendix A shows historical population in the Twin Cities, Minnesota, and the United States. The historical population information was obtained from the Bureau of Economic Analysis in the US Department of Commerce. The Twin Cities have grown at a more rapid pace than the United States. The suburban areas are also growing slightly more quickly than the urban core (Hennepin and Ramsey Counties).

Table A.2 of Appendix A presents two alternative forecasts of population for Minneapolis-St. Paul. The first forecast was obtained from the Met Council's revised Regional Development Framework 2030 Forecasts and is available only for the 7-county Met Council area. The second forecast was obtained from Woods & Poole Economics, which provides forecasts for all counties and metropolitan areas in the United States. As shown, the two sources provide very similar forecasts for the 7-county area, both projecting an average annual growth rate slightly above 1.0% through 2030. The forecasts project the metropolitan area to continue to grow faster than the state, and the outer suburbs to grow faster than the inner suburbs.

TABLE 2.1: SUMMARY OF SOCIOECONOMIC DATA AND FORECASTS SEVEN-COUNTY METROPOLITAN COUNCIL AREA

Year	Population	Employment	Income (thousands of 2007 $)	Per Capita Income (2007 $)
1990	2,298,418	1,603,044	76,546,647	33,304
1991	2,332,897	1,605,181	76,567,544	32,821
1992	2,368,710	1,628,288	79,552,668	33,585
1993	2,406,000	1,662,568	80,492,172	33,455
1994	2,441,014	1,713,409	84,046,939	34,431
1995	2,474,926	1,766,851	88,005,525	35,559
1996	2,508,406	1,802,255	91,965,878	36,663
1997	2,540,725	1,834,525	96,874,609	38,129
1998	2,575,454	1,884,161	104,644,525	40,631
1999	2,613,594	1,927,990	109,008,820	41,708
2000	2,652,116	1,972,269	115,532,307	43,562
2001	2,684,454	1,982,015	116,168,728	43,275
2002	2,701,403	1,964,849	116,954,718	43,294
2003	2,714,033	1,971,415	118,465,846	43,649
2004	2,730,546	2,004,534	123,102,449	45,083
2005	2,745,769	2,045,068	124,827,612	45,462
2006	2,767,734	2,082,727	127,735,714	46,152
2010	2,924,557	2,233,505	129,480,127	47,023
2015	3,118,761	2,421,649	146,564,763	49,913
2020	3,318,224	2,609,428	165,854,464	53,087
2025	3,524,942	2,796,788	187,853,049	56,602
2030	3,744,009	2,983,675	212,841,334	60,379
		Average Annual Growth Rate		
1990-2006	1.2%	1.6%	3.3%	2.1%
2006-2030	1.3%	1.5%	2.2%	1.1%

Sources: Tables A.1 through A.8 and HNTB analysis.

2.2.2 EMPLOYMENT

Table A.3 in Appendix A presents historical employment for each of the seven Met Council counties, the service area, and the United States. The table shows the economic cycles that have occurred over the past two decades, including the boom times of the mid- to late-1980s and mid- to late-1990s, punctuated by the slowdowns and declines of the early 1980s, early 1990s, and 2001-2003. Overall, the metropolitan area has grown slightly more rapidly than the U.S. and again the outer suburbs have grown slightly faster than the inner suburbs.

Employment forecasts from the Met Council and Woods & Poole are presented in **Table A.4**. in Appendix A The Met Council uses a stricter definition of employment than is used by the US Bureau of Economic Analysis (USBEA) or Woods & Poole and therefore its historical and projected employment numbers are lower.[1] Consequently, to facilitate comparison an adjusted set of Met Council projections was developed by applying Met Council growth rates to base year USBEA numbers. The Met Council projections (0.9% per year) are more conservative than the Woods & Poole projections (1.5% per year).

2.2.3 INCOME AND PER CAPITA INCOME

Table A.5 in Appendix A shows historical income in the service area and the United States from 1980 through 2006. All numbers are provided in thousands of 2007 dollars. Total income in the metropolitan area grew at 3.3% annually through 2006, a higher rate than in the remainder of the State or the United States (2.9%). As was the case with employment, income has alternated between periods of rapid growth and periods of stagnation. No income data specific to the 7-county area are available for a more recent year than 2006. However, since the 2008-2009 recession has already had an impact on air travel demand, an effort was made to estimate income for more recent years based on State and national data. Those estimates are also presented in **Table A.5.**

Table A.6 in Appendix A shows historical per capita income in 2007 dollars. Per capita income in the Twin Cities is higher than in the rest of the State or than in the United States. Over the past 20 years, Minnesota per capita income has grown at roughly the same pace inside and outside the metropolitan area but more quickly than in the United States.

Projected per capita income is shown in **Table A.7** in Appendix A. No Met Council forecasts are presented because the Met Council does not publish income or per capita income forecasts. Woods & Poole projects per capita income to continue to grow but at a more moderate rate than it has in the past. This, in part, reflects an expectation that the growth in the economy will slow down as more members of the Baby Boom generation enter retirement. Per capita income is projected to grow at roughly 1% per annum in the Twin Cities metropolitan area, and in the United States.

Table A.8 in Appendix A presents two sets of income projections. The unadjusted Woods & Poole forecasts project real income to grow 2.4% per year in the metropolitan area. A second set of projections combines the Met Council population forecasts with the Woods & Poole per capita income forecasts to generate a hybrid income forecast for the 7-county service area. The resulting forecast was also adjusted downward to reflect lost economic growth in 2008 and

[1] The Bureau of Economic Analysis employment statistics, upon which Woods & Poole projections are based, include the self-employed in addition to wage and salary workers.

anticipated in 2009. The adjusted forecast projects income to increase at 2.2% rate over the forecast period.

2.3 HISTORICAL AVIATION ACTIVITY AND CURRENT TRENDS

This section provides a brief overview of historical passenger, cargo (freight and mail), general aviation and military activity at MSP.

2.3.1 PASSENGER ACTIVITY

Table 2.2 shows historical domestic and international originations and **Table 2.3** shows historical passenger enplanements at MSP from 1980 through 2008. In general, passenger growth has tracked economic growth. There were periods of slow growth in the early 1990s, and 2000-2003 and periods of more rapid growth in the mid- to late-1990s, as well as 2004 and 2005. Enplanements began to decline after 2005 and originations declined between 2007 and 2008. Key trends and factors at MSP over the past 24 years include:

- the reduction in traffic growth after 1987 following the Northwest/Republic merger and the economic slowdown;
- two rapid periods of regional carrier growth, first in the 1980s with the advent of code-sharing and then in the late-1990s with the widespread proliferation of regional jets;
- significant international passenger growth through the period as Northwest introduced non-stop service to Europe and Asia and the Canadian markets became liberalized;
- an extended period of passenger growth corresponding with the economic boom of the mid- and late-1990s;
- a brief slow-down in the growth in 1998 as a result of the Northwest work stoppage;
- another spurt in growth in 1999-2000 corresponding to Sun Country's introduction of scheduled service and Northwest's competitive reaction;
- a major downturn beginning in 2001 as a result of the September 11th terrorist attacks and associated security restrictions and passenger apprehensions coupled with an economic slowdown;
- rapid growth in 2004 resulting from an improving economy and relentless fare competition; and
- a decline after 2005 resulting from Northwest's Chapter 11 filing, followed by a rapid increase in jet fuel costs, and followed in turn by the financial crisis of 2008 and subsequent economic recession.

Total domestic originations have grown at a 3.0% average annual rate over the period. Total enplanements have grown at a 4.7% average annual rate over the same period indicating that international passengers and connecting enplanements have grown more rapidly than originating enplanements. International enplanements and regional carrier enplanements have grown most rapidly. Conversely, non-scheduled enplanements have grown the slowest and declined in recent years, although this is largely due to Sun Country's change in emphasis from charter to scheduled operations.

TABLE 2.2: HISTORICAL ORIGINATING PASSENGERS

Year	Domestic Originations (a)	Combined International (b)	Total Originations
1990	4,284,240	n/a	n/a
1991	4,288,090	n/a	n/a
1992	4,414,590	n/a	n/a
1993	4,511,050	n/a	n/a
1994	4,598,270	n/a	n/a
1995	5,021,830	n/a	n/a
1996	5,411,820	n/a	n/a
1997	5,750,780	n/a	n/a
1998	5,736,650	n/a	n/a
1999	6,365,610	n/a	n/a
2000	7,225,020	n/a	n/a
2001	6,603,320	709,489	7,312,809
2002	6,207,930	680,392	6,888,322
2003	6,390,140	675,401	7,065,541
2004	7,074,980	780,332	7,855,312
2005	7,609,360	840,887	8,450,247
2006	7,643,820	888,697	8,532,517
2007	7,857,050	951,196	8,808,246
2008	7,291,815 (c)	963,631 (c)	8,255,446
Average Annual Growth Rate			
1990-2008	3.0%	n/a	n/a
2001-2008	1.4%	4.5%	1.7%

(a) USDOT, Origin-Destination Survey as compiled by DataBase Products, Inc.

(b) USDOT, Origin-Destination Survey for U.S. Flag Carriers. Originations for Foreign-Flag Carriers estimated.

(c) Extrapolated from first three quarters.

Sources: As noted and HNTB analysis.

TABLE 2.3: HISTORIC PASSENGER ORIGINATIONS AND REVENUE ENPLANEMENTS

Year	Domestic Air Carrier Enplanements	International Air Carrier Enplanements (b)	Regional Enplanements	Non-Scheduled Enplanements	TOTAL Enplanements (c)
1980	4,285,217	28,731	159,727	113,793	4,587,468
1981	4,391,802	57,871	129,497	85,869	4,665,039
1982	5,071,395	50,574	178,590	82,278	5,382,837
1983	5,702,094	49,638	256,615	149,486	6,157,833
1984	5,986,288	73,014	287,762	187,076	6,534,140
1985	7,114,367	83,533	349,281	312,186	7,859,367
1986	7,845,494	81,700	481,188	238,972	8,647,354
1987	8,171,206	85,023	509,246	205,700	8,971,175
1988	8,023,121	65,265	516,083	266,344	8,870,813
1989	8,349,920	78,910	415,910	343,418	9,188,158
1990	8,609,638	102,673	495,439	387,320	9,595,070
1991	8,683,232	124,125	492,075	353,590	9,653,022
1992	9,550,986	144,255	566,186	419,060	10,680,487
1993	9,851,910	170,544	649,104	350,918	11,022,476
1994	10,261,328	166,114	646,788	457,715	11,531,945
1995	11,288,317	256,669	617,477	501,792	12,664,255
1996	12,142,783	276,575	720,749	481,532	13,621,639
1997	12,578,587	419,048	872,377	465,628	14,335,640
1998	12,645,248	519,395	820,709	635,290	14,620,642
1999	14,020,304	575,079	1,211,306	650,350	16,457,039
2000	15,278,927	644,096	1,204,681	399,683	17,527,387
2001	14,379,588	558,276	809,019	280,609	16,027,492
2002	13,794,354	551,203	1,054,192	365,023	15,764,772
2003	14,045,747	572,691	1,250,064	233,692	16,102,194
2004	14,901,675	677,318	1,778,396	240,250	17,597,639
2005	14,849,344	790,806	2,138,186	205,975	17,984,311
2006	14,143,459	692,757	2,190,679	151,412	17,178,307
2007	13,496,662	980,460	2,406,447	85,515	16,969,084
2008	11,750,665	1,264,507	3,336,724	32,376	16,384,272
			Average Annual Growth		
1980-1990	7.2%	13.6%	12.0%	13.0%	7.7%
1990-2001	4.8%	16.6%	4.6%	-2.9%	4.8%
2001-2008	-2.8%	12.4%	22.4%	-26.5%	0.3%
1980-2008	3.7%	14.5%	11.5%	-4.4%	4.7%

Sources: MAC activity statistics and HNTB analysis.

2.3.2 AIRCRAFT OPERATIONS

Table 2.4 presents historical aircraft operations at MSP. Each aircraft takeoff and each aircraft landing counts as an operation. Total aircraft operations have grown at an average annual rate of 1.7% over the 28-year period. The fastest growing categories have been international and regional passenger carriers. Conversely, general aviation and military operations have been declining.

2.4 GENERAL BASE FORECAST ASSUMPTIONS

This section describes the general forecast assumptions that were applied in this forecast. More detailed assumptions specific to a particular activity category are described in the sections pertaining to those categories. These general assumptions also apply to the forecast scenarios except where noted (see section 2.12). The major assumptions are as described below.

2.4.1 UNCONSTRAINED FORECASTS

The revised unconstrained forecasts contained herein are physically unconstrained. For the purposes of this study, "physically unconstrained" means that there are sufficient airport airfield, terminal, and landside facilities at the airport to accommodate all commercial aviation activity dictated by demand. Although no airfield limits are assumed for general aviation (GA), it is anticipated that the development of on-airport GA facilities will follow current trends. Therefore, it is assumed that limited on-airport GA facilities will continue to divert GA to reliever airports.

It is assumed that destination airports will be developed sufficiently to accommodate demand from the Twin Cities. However, it is recognized that airfield capacity constraints at some airports, such as London Heathrow and Tokyo Narita, will force an increase in aircraft size that would not occur in a truly unconstrained case.

2.4.2 REGULATORY ASSUMPTIONS

No return to airline regulation, as occurred prior to 1979, is assumed. This means that airlines will increase service and change fares as market conditions dictate. Also, except for the demand management scenarios, the forecasts in this report assume no slot control systems for MSP or destination airports other than those already in place.

2.4.3 ECONOMIC ASSUMPTIONS

The forecasts assume no major economic downturn, such as occurred during the depression of the 1930s. The local and national economies will periodically increase and decrease the pace of growth in accordance with business cycles. However, it is assumed that, over the forecast term, the high-growth and low-growth periods will offset each other so that the economic forecasts described in Section 2.2 will be realized. As noted in Section 2.2, the socioeconomic projections used for these forecasts have been adjusted for the current economic recession.

TABLE 2.4: HISTORICAL AIRCRAFT OPERATIONS (a)

Year	Domestic Air Carrier	Regional	International Air Carrier (b)	Non-Scheduled	All-Cargo	General Aviation	Military	Total
1980	146,524	12,128	350	1,976	1,214	114,260	6,604	283,056
1981	146,338	9,904	472	2,568	1,446	97,278	5,606	263,612
1982	150,450	22,838	390	2,478	2,556	82,303	5,359	266,374
1983	170,108	33,924	388	3,752	3,192	83,548	5,100	300,012
1984	189,830	35,938	506	2,234	5,966	93,367	7,721	335,562
1985	220,190	31,460	628	3,346	5,338	106,715	14,020	381,697
1986	231,760	50,520	680	2,426	12,360	71,406	6,869	376,021
1987	213,540	56,410	644	3,002	15,434	70,050	8,676	367,756
1988	211,562	58,896	544	2,836	17,958	68,634	6,698	367,128
1989	218,168	59,338	718	3,310	17,194	71,669	4,347	374,744
1990	223,884	74,446	860	4,538	18,526	58,864	2,804	383,922
1991	225,390	75,856	1,078	5,046	20,280	55,702	2,534	385,886
1992	242,670	85,926	1,222	5,824	18,900	60,929	3,003	418,474
1993	258,374	108,237	1,285	4,855	15,198	49,216	2,825	439,990
1994	264,519	115,164	1,478	6,103	14,110	50,898	2,451	454,723
1995	281,334	106,763	1,832	6,832	15,909	49,769	2,915	465,354
1996	295,776	105,926	2,256	8,750	20,362	49,786	2,624	485,480
1997	294,220	102,038	3,821	8,350	15,011	64,209	3,624	491,273
1998	278,828	90,421	5,109	11,531	15,323	79,757	2,044	483,013
1999	314,883	109,017	6,036	10,600	17,271	49,256	3,358	510,421
2000	341,980	89,105	7,224	5,959	18,395	58,076	2,473	523,212
2001	342,122	81,661	7,449	4,090	17,077	45,943	3,180	501,522
2002	338,744	95,248	7,048	4,833	14,974	44,279	2,543	507,669
2003	336,516	104,931	8,461	4,732	16,579	39,513	1,856	512,588
2004	334,452	135,785	9,360	3,793	16,709	39,018	1,976	541,093
2005	314,833	144,293	13,351	3,879	17,182	36,472	2,230	532,240
2006	277,525	128,156	10,900	3,233	16,355	37,459	2,040	475,668
2007	253,338	135,170	14,889	1,432	15,292	30,562	2,289	452,972
2008	212,167	166,106	24,074	536	14,361	30,685	2,115	450,044
				Average Annual Growth				
1980-1990	4.3%	19.9%	9.4%	8.7%	31.3%	-6.4%	-8.2%	3.1%
1990-2001	3.9%	0.8%	21.7%	-0.9%	-0.7%	-2.2%	1.2%	2.5%
2001-2008	-6.6%	10.7%	18.2%	-25.2%	-2.4%	-5.6%	-5.7%	-1.5%
1980-2008	1.3%	9.8%	16.3%	-4.6%	9.2%	-4.6%	-4.0%	1.7%

(a) MSP Airport data as reported on the MAC website.
(b) Does not include some Canadian traffic on Northwest Airlines. Canadian traffic included in domestic numbers.

Sources: As noted, MAC Activity Statistics, and HNTB analysis.

2.4.4 INTERNATIONAL POLITICAL ENVIRONMENT

No major international conflicts that would disrupt aviation at MSP are assumed. Likewise, no major trade wars or embargoes that would restrict the international flow of commerce and travel are assumed.

2.4.5 SECURITY ENVIRONMENT

Post-September 11th security requirements are still evolving. They affect passenger demand by increasing the cost of travel, delays, and inconvenience. For the purpose of this study it is assumed that the Transportation Security Agency will meet an objective of limiting security-related delays.

2.4.6 FUEL ASSUMPTIONS

In accordance with Department of Energy forecasts, the real cost of fuel is assumed to increase from 2009 levels. However, no major disruptions, as occurred in the mid- and late-1970s, are assumed. Also, no major increases in fuel taxes are assumed. If this assumption does not hold, and fuel prices continue to remain high, airlines would have to raise air fares to remain in operation, and the higher air fares would reduce demand. The effect of fuel prices on fares is discussed in more detail in Section 2.5. Also, the sensitivity of airport activity to fuel prices is explored further in Section 2.12.

2.4.7 ENVIRONMENTAL FACTORS

No major changes in the physical environment are assumed. It is assumed that global climate changes will not be sufficient enough to force restrictions on the burning of hydrocarbons or major fuel tax increases. A strict cap and trade system for carbon dioxide would have a similar impact as an increase in fuel prices, and that is explored in Section 2.12.

2.4.8 NATIONAL AIRSPACE SYSTEM

It is assumed that the Federal Aviation Administration will successfully implement any required changes and improvements for the national airspace system to accommodate the unconstrained forecast of aviation demand.

2.4.9 AIRLINE CONSOLIDATION

It is assumed that factors, such as government regulations and labor union resistance, will prevent any major airline consolidation beyond the Delta/Northwest merger. Although some minor airline consolidation could continue to occur, no attempt is made to predict the individual airlines that would be affected. It is also assumed that major airlines that are currently in Chapter 11 will successfully re-emerge from bankruptcy.

2.4.10 NEW ENTRANTS

As they expand their national route networks, established airlines that currently do not serve MSP, such as JetBlue, are assumed to introduce service by 2015. Southwest Airlines is assumed to expand service at MSP as it has at other major connecting hubs. New airlines may attempt to become established during the forecast period; however, it is not possible to predict the names and characteristics of these airlines.

2.4.11 AIRLINE ALLIANCES

The SkyTeam alliance is assumed to continue with its current membership through the future. Current members include Delta Air Lines, Air France, KLM Royal Dutch Airlines, Alitalia Airlines, Korean Air, Aeromexico, Aeroflot, China Southern Airlines, Air Europa, Copa Airlines, Kenya Airways and CSA Czech Airlines.

2.4.12 AIRLINE STRATEGY

Delta Air Lines is assumed to continue to operate as a hub carrier at MSP. It is not assumed to either add or delete major hubs elsewhere in the United States, and therefore the connecting percentage is assumed to remain at levels similar to those from 1992-2008.

2.5 DOMESTIC PASSENGER FORECASTS

This section describes the domestic passenger forecast for MSP. This section includes a discussion of assumptions and data sources, the methodology for the passenger originations forecast, and the assumptions used to determine potential new markets. This section also includes a discussion of the projections of enplanements and connections, load factor, and seat departures. The methodology and assumptions used to estimate the type of air service that would accommodate the projected passenger are also described. This section concludes with a forecast of domestic passenger carrier aircraft operations.

2.5.1 METHODOLOGY, ASSUMPTIONS AND DATA SOURCES

Following is a summary of the methodology used in the domestic passenger forecast:

1. Determine drivers of passenger activity in the Twin Cities area
2. Project future domestic passenger originations at MSP using regression analysis
3. Adjust originations for impact of Southwest Airlines
4. Project future domestic passenger enplanements
5. Allocate MSP passengers by market
6. Determine future non-stop markets based on airline revenue thresholds for existing non-stop markets
7. Project outbound revenue passengers for each destination market as a ratio of origination and destination (O&D) traffic
8. Project load factor for each market
9. Project seat departures for each market using the outbound revenue passenger and load factor forecasts
10. Estimate the most likely way that airlines would accommodate the seat departure forecast in terms of aircraft type and frequency of service
11. Convert the outbound passenger forecast to enplanements using MSP enplanement data
12. Convert the scheduled aircraft departure forecast to actual departures using historical departure completion data

The methodology will be described in greater detail below.

The following data sources were used in the analysis:

- Historical and projected information on population, employment, and real income were obtained from the Regional Economic Information System developed by the Bureau of Economic Analysis in the U.S. Department of Commerce (see Section 2.2).
- The US Department of Transportation OD1A domestic O&D database was used to obtain yield (airline revenue per passenger mile) and distance and historical originating traffic and on a market-by-market basis.
- The USDOT T-100 database was used to obtain outbound passengers on a market-by-market basis.
- Official Airline Guide (OAG) information on scheduled operations was used to determine existing scheduled service and historical non-stop service.
- The OAG, JP Fleet Airline-Fleets International, and individual airline websites were used to determine aircraft seat configurations for each airline.
- JP Fleet Airline-Fleets International and other industry publications were used to identify information on airline fleet orders.

2.5.2 YIELD AND FARE PROJECTIONS

Since passenger originations are local, they are sensitive to local economic factors such as population, employment, and income, and also to airline factors such as air carrier service and fares. Therefore, the critical assumptions for this analysis include the use of the growth rates in Section 2.2 for socioeconomic data and assumptions regarding future yield (revenue per passenger mile) and fare levels. The detailed yield and fare analysis is presented in the Appendix.

Table B.1 in Appendix A presents historical fares and yields at MSP. Since the price to the passenger includes taxes and fees, in addition to the base fare reported by the airlines, these taxes and fees were added to the historical data. As shown in the table, there has been a long-term decline in the real cost of air travel at MSP, with the rate of decline accelerating after the September 11, 2001 terrorist attacks.

Table B.2 in Appendix A provides the Federal Aviation Administration (FAA) forecasts of yield. An estimate of FAA fares was derived by multiplying the FAA forecasts of average yield and average trip distance. Since the FAA provides separate forecasts for mainline and regional carriers, these were weighted by FAA forecasted enplanements to generate combined mainline-regional carrier fare projections. As shown in the Table, the FAA projects yield to continue to decline but, because of increasing trip distance, national fares are projected to increase slightly.

The FAA forecasts in **Table B.2** were prepared prior to the major spike in fuel prices that occurred in 2008. The airlines need to cover the cost of fuel in their fare structure if they are to remain financially viable; therefore there was a concern that the more recent expectations about the price of fuel were not adequately reflected in the FAA projections. To compensate for this, an adjustment was made to the FAA yield forecast to incorporate the more recent US Department of Energy (DOE) forecasts of jet fuel. In effect, the additional increase in fuel cost estimated by the DOE was allocated by revenue passenger mile and then allocated to the FAA's original yield estimate. **Table B.3** in Appendix A shows the calculations.

Real yields and fares (constant 2007 dollars) at MSP were assumed to change at the adjusted FAA national-projected rate (see **Table B.4** Appendix A). **Table B.5** in Appendix A shows projected MSP fares and yields including estimated taxes and fees.[2] Although real fares are anticipated to dip slightly between 2008 and 2010, as a result of a weak economy and reduced fuel prices, they are expected to increase thereafter.

2.5.3 PASSENGER ORIGINATION FORECAST

This section presents the forecast of domestic passenger originations. It includes a discussion of the projection of domestic MSP originations, adjustments for the introduction of Southwest Airlines service, and the market-by-market distribution of projected originations.

Base Domestic Originations

Base domestic passenger originations were projected using regression analysis. Additional originations resulting from the introduction of air service by Southwest Airlines are discussed later in this section. Regression analysis is a statistical method of generating an equation (or model) which best explains the historical relationship among selected variables, such as origination and destination (O&D) passenger data and real income. If it is assumed that the model that best explains historical activity will continue to hold into the future, this equation can be used as a forecasting equation. Using historical (1980-2006) data, several passenger origination forecasting models were tested. The potential driving factors tested included socioeconomic variables, aviation industry variables, and instrument variables (also called dummy variables). The socioeconomic variables included population, employment, income, and per capita income for the service area (see Section 2.2). The aviation industry variables included MSP fares and yields. Instrument variables representing the first Gulf War, the 1998 Northwest Airlines work stoppage, and the September 11th attacks and ensuing industry recovery were also tested. The model was tested in both linear and logarithmic formulations. The variables that were tested are shown in **Tables C.1** and **C.2** in Appendix A.

Several of the equations that were calculated showed strong correlations with passenger originations. The model that produced the best results, from both a theoretical and statistical standpoint, was a logarithmic formulation that specified MSP originations as a function of local income and average fares (including taxes and fees) as independent variables. The regression equation is presented in **Table 2.5**.

The model's projections for 2008 were compared with preliminary numbers for 2008 and the results suggested a further downward adjustment over and above that explained by the economic variables. Based on the difference between the forecast results and actual numbers, the value of this imputed dummy variable is $10^{-.0211}$. This negative impact, along with that of the post-September 11th dummy variables, was carried through the forecast period.

The metropolitan area income and employment variables represent the size of the market, and the fare variable represents the cost of the service. Since the forecasting model has a

[2] It was assumed that taxes and fees, as a proportion (%) of total fare, would remain at their 2008 levels over the forecast period.

logarithmic formulation, each of the exponents associated with the input variables is defined as an elasticity. With small changes in the input variables, the forecasting model can be interpreted as indicating that every 1.0% increase in metropolitan area income will increase originations by approximately 1.14% and that every 1.0% decrease in MSP fares will increase originations by approximately 0.34%. Therefore, the forecast equation says that domestic originations have an income elasticity of 1.14 and a fare elasticity of -0.34.

Projections of the input variables are necessary to use the forecasting equation. Specifically, income projections were obtained from **Table A.8** and fare and yield projections from **Table B.5**. Both tables are found in Appendix A of this report.

Table 2.5 shows the base forecast of scheduled domestic passenger originations prepared using the equation presented above. As shown, base domestic MSP originations are projected to rise from 7.3 million in 2008 to 12.3 million in 2030, an average annual increase of 2.4%. This growth rate is lower than that experienced since 1990 (3.0%). The reduced future growth rate is anticipated to result from slower-than-historical rates of real income growth and from a slight increase in real fares.

There are several assumptions implicit in the base passenger origination forecasts:

- The historical relationship between originations, income, and fares will continue throughout the forecast period. Forces that could disrupt this relationship, such as a return to regulation, severe congestion at destination airports, or the wide-scale use of teleconferencing as a travel alternative, could alter this relationship.

- In accordance with US Department of Energy forecasts, fuel prices will increase over the forecast period, causing fares to increase rather than continue to decline.

- Real income in the extended service area will grow at the rate projected in **Table A.8** in Appendix A.

- The population's distribution of income through the forecast period will be similar to what it is today.

- As a percentage of income, taxes and medical expenses, which are the principal budget items over which households have little control, will not increase sufficiently to affect household or business budgets devoted to air travel.

Originations Resulting from Southwest Airlines Service

Southwest Airlines began to serve MSP directly in March 2009. Many in the aviation industry have noted a phenomenon termed the "Southwest effect" in which the introduction of air service to an airport by Southwest Airlines has resulted in a substantial increase in passenger activity. The principal cause of the increase is the reduction in fares resulting from increased competition. The effect, however, often exceeds the amount that would be expected from the reduction in fares, possibly because of Southwest's high frequency of service, price transparency, and consistent level of service, and because of increases in the size of the catchment area.

TABLE 2.5: BASE FORECAST OF ANNUAL DOMESTIC ORIGINATIONS

Year	Income (thousands of 2007 dollars) (a)	Fare (b)	Originations (c)	Southwest Adjustment Factor (d)	Originations Including Southwest Factor (e)
2006	127,735,714	197.36	7,643,820	-	7,643,820
2007	131,147,791	190.64	7,857,050	-	7,857,050
2008	131,859,584	215.40	7,291,815	-	7,291,815
2009	128,299,375				
2010	129,480,127	188.98	7,468,129	1.03	7,692,173
2015	146,564,763	218.20	8,191,488	1.15	9,420,211
2020	165,854,464	221.79	9,381,527	1.15	10,788,756
2025	187,853,049	224.85	10,765,239	1.15	12,380,025
2030	212,841,334	229.12	12,336,341	1.15	14,186,792
			Average Annual Growth Rate		
2008-2030	2.2%	0.3%	2.4%	n/a	3.1%

(a) Table A.8.
(b) Table B.5.
(c) Projected using following equation:

ORIG = (10^-1.5452)*(INCOME^1.14219)*(FARE^-.34159)*(STRIKE)*(D2001)*(D2002)*(D2004)*(A2008)

where: ORIG = domestic originations
INCOME = 7-county metropolitan income in thousands of 2007 dollars)
FARE = average fare in 2007 dollars, including taxes and fees
STRIKE = instrument variable equal to (10^-.0266) in 1998 during NWA pilot job action, and equal to 1 in all other years.
D2001 = instrument variable equal to 1 prior to 2001, and to (10^-.04316) thereafter
D2002 = instrument variable equal to 1 prior to 2002, and to (10^-.02858) thereafter
D2004 = instrument variable equal to 1 prior to 2004, and to (10^.02318) thereafter
A2008 = adjustment factor of .95257, representing difference between actual 2008 originations and originations projected by the equation.

R-squared = .991
F-statistic = 307.52
Durbin-Watson = 1.93
Degrees of Freedom = 10
T-statistics
intercept = -1.73
INCOME = 16.82
FARE = -2.01
STRIKE = -2.50
D2001 = -3.82
D2002 = -2.81
D2004 = 2.13

(d) Adjustment for Southwest stimulation. Please see text for details.
(e) Originations multiplied by Southwest factor.

Sources: As noted and HNTB analysis.

Table D.1 in Appendix A shows the historical impact of Southwest service on originations at large United States airports. The airports listed include large and medium hub airports where Southwest initiated service after 1990. Detroit is included for comparison, although Southwest began serving the market in the 1980s. Originations in the table are expressed as a share of national originations to net out the impact of changes in the general economy and industry trends. To facilitate comparison, the shares are indexed so that in the two years prior to the introduction of Southwest service, the relative share is set equal to 1.00. In each case, the data series begins the first full year after the introduction of Southwest service. Therefore, all other things being equal, the relative share of United States originations would remain at 1.00 if Southwest service had no impact on originations. The relative share would be greater than 1.00 if Southwest had a positive impact and less than 1.00 if Southwest had a negative impact.

In all cases, the addition of Southwest service caused an airport's share of national originations to increase. In one instance – Cleveland Hopkins International Airport – the relative share eventually dipped below 1.00 again, most likely because of Cleveland's poor record of economic growth relative to the remainder of the country. The increase in share was exceptional in the case of Baltimore Washington International Airport and Fort Lauderdale/Hollywood International Airport, mainly because Southwest was able to capture traffic from other markets – Washington and Miami.

To better evaluate the potential effect on MSP, the analysis was refined to include only airports similar to MSP, i.e., airports that host major connecting operations and whose catchment areas do not substantially overlap that of another major airport. Three airports met those criteria – Denver, Philadelphia, and Cleveland. **Table D.2** in Appendix A shows the results of the analysis, indicating that for the airports most similar to MSP, the average impact of Southwest service was to increase originations by 15% over what they would otherwise have been.

The domestic originations forecasts in **Table 2.5** were adjusted to reflect the anticipated impact of Southwest Airlines service. It was assumed that the effects would be fully realized by 2015. As shown, with the effect of Southwest Airlines included, originations are projected to increase from 7.3 million in 2008 to 14.2 million by 2030, an average annual increase of 3.1%.

2.5.4 DOMESTIC ENPLANEMENT FORECASTS

The forecast of domestic passenger enplanements is a function of the originating passenger forecast and the ratio of enplanements to originations (hubbing ratio). When queried, Delta Air Lines indicated that it did not anticipate a significant change in the ratio between enplanements and connections for its operation at MSP in the short-term. In the longer term, there are a number of national industry factors that are affecting the relationship between enplanements and originations. These include:

- The loss of service at small communities, where the vast majority of passengers connect to their final destination;
- The increase in regional jets, which facilitate point-to-point service for market pairs that had previously been too small to justify non-stop service;
- The proliferation of low-cost carriers that typically provide more point-to-point service than legacy carriers; and
- Faster economic growth in communities served by large and medium hub airports as opposed to small hub airports.

In combination, these forces have caused connections to grow at a slightly lower rate than originations nationally, as shown in **Table E.1** in Appendix A. If this trend is carried forward, the ratio of enplanements to originations will continue to decline, albeit at a slow rate. **Table E.2** in Appendix A shows the projected future hubbing ratio at MSP, assuming that it will decline at the same rate as the national hubbing ratio.

Table 2.6 provides the forecast of domestic enplanements at MSP. The hubbing ratio in **Table E.2** was applied to base originations rather than total originations, since it is not anticipated that the additional originations stimulated by Southwest will lead to additional connecting passengers. As shown in **Table 2.6**, total domestic enplanements at MSP are projected to increase from 15.1 million in 2008 to 25.6 million in 2030, an average annual increase of 2.4%.

2.5.5 DOMESTIC PROJECTIONS BY MARKET

Since one of the end products of this forecast is a detailed fleet mix for use in gate requirements analyses and noise simulation, domestic passenger forecasts were disaggregated by individual market.

Originations by Market

MSP originations in each market were projected to increase from 2007 at the same rate as total domestic MSP originations, adjusted by the relative difference in income growth in the destination markets. As seen in the forecasting equation, there is a strong relationship between income and originations. Therefore, it is reasonable to assume that the relative growth rate in each region's originations to the Twin Cities area will vary in relation to each region's growth in personal income relative to the United States. Woods & Poole Economics was used as the source of income forecasts by market. The individual market originations forecasts were proportionately adjusted as necessary so that they would sum to the forecast of total domestic originations.

The detailed calculations of the market-by-market originations forecast are presented in **Table E.3** in Appendix A**.**

Forecast Of Outbound Passengers by Market

Data for outbound passengers on a market-by-market basis were obtained from the US Department of Transportation's T-100 database, which provides data on total revenue passengers (enplaned plus on-board) for each segment. Outbound passengers include both originating and connecting passengers. This section first discusses assumptions regarding new non-stop markets, and then discusses the methodology for estimating future non-stop outbound passengers.

TABLE 2.6: BASE CASE FORECAST OF DOMESTIC ENPLANEMENTS

Year	Base Originations (a)	Hubbing Ratio (b)	Base Enplanements w/o Southwest (c)	Total Originations (d)	Total Enplanements including Southwest (e)
2006	7,643,820	2.137	16,334,138	7,643,820	16,334,138
2007	7,857,050	2.024	15,903,109	7,857,050	15,903,109
2008	7,291,815	2.069	15,087,389	7,291,815	15,087,389
2010	7,468,129	2.021	15,092,264	7,692,173	15,316,308
2015	8,191,488	1.999	16,377,788	9,420,211	17,606,511
2020	9,381,527	1.978	18,555,194	10,788,756	19,962,423
2025	10,765,239	1.956	21,060,262	12,380,025	22,675,048
2030	12,336,341	1.924	23,729,505	14,186,792	25,579,956
			Average Annual Growth Rate		
2008-2030	2.4%	-0.3%	2.1%	3.1%	2.4%

(a) Table 5. Originations without Southwest Factor.
(b) Table E.2.
(c) Base originations multiplied by Southwest factor.
(d) Table 5. Total originations including Southwest factor.
(e) Base enplanements plus originations resulting from Southwest factor.

Sources: As noted and HNTB analysis.

A critical element of the forecasts is the determination of new non-stop markets. The number of new non-stop markets will affect the number of enplaned passengers and aircraft operations.

Candidate markets for non-stop domestic air carrier service were determined by identifying the current thresholds of total revenue (passengers multiplied by average fare) that justified non-stop service to MSP. A market's total revenue includes revenue from both originating and potential connecting passengers and is therefore a better measure of the market's value to the airline than just originating revenue to MSP. These thresholds are presented in **Table E.4** in Appendix A. Thresholds are lower for nearby markets than for more distant markets because service can be offered with smaller aircraft and because there is less competition from connecting hubs between the two markets. Thresholds of revenue necessary to justify non-stop service were estimated using the average of revenue in the smallest market with non-stop service and the largest market without non-stop service in each mileage band (0-300 miles, 301-500 miles, 501-700 miles, etc.). These thresholds are in large part determined by aircraft capabilities. For example, there is a big jump in the threshold above 1300 miles because that is beyond the capability of most regional jets. Therefore, these more distant markets would need to be large enough to justify mainline aircraft.

In markets to the west of MSP, specifically the rest of Minnesota, the Dakotas, and Montana, MSP is the most realistic connecting hub to most destinations. Since these are essentially "captive" markets, the ratio of connections to originations tends to be very high and the revenue threshold required for non-stop service tends to be lower. This is reflected in **Table E.4** which shows lower thresholds for markets to the west of MSP.

It was assumed that revenue in each market would increase at the same rate as the forecast of MSP originating passengers in that market. New markets that are projected to grow sufficiently to justify non-stop service to MSP are shown in **Table E.4**.

No service stimulation was assumed for originations at new non-stop markets. Experience at other airports indicates that the stimulation effect is less than 10% and often less than 5%. In addition, the historical growth in Twin Cities area originations has been caused, in part, by new non-stop service. Therefore, the forecasting equation implicitly includes the effect of new service stimulation. Including additional service stimulation would result in double counting.

Markets that were most likely to attract non-stop service by Southwest Airlines were identified based on the experience of other Midwest airports with Southwest service. The additional originations resulting from the Southwest effect were distributed proportionately to these markets. These are also identified in **Table E.3** in Appendix A.

The forecasts of outbound domestic passengers by market area are presented in **Table E.3**. Outbound passengers in most markets were estimated by assuming that the ratio of outbound passengers to originating passengers declines at the same rate as the hubbing ratio. Data for outbound passengers were adjusted proportionately where necessary so that the resulting sum of enplanements would equal the total in **Table 2.6**.

The ratio of outbound passengers to originating passengers in new non-stop markets (markets that have had non-stop service for fewer than two years or are projected to obtain non-stop service in the future) was assumed to be the same as in the most similar existing non-hub originating market in the same mileage band.

Load Factor and Seat Departure Forecast

This section discusses the assumptions used to estimate load factor in each market and the calculation of projected annual and daily seat departures in each market.

Over the past several years, the airline industry has experienced a significant increase in the average boarding load factor on both domestic and international flights. The load factor average has increased dramatically, from an average in the mid- to upper-50% range in the early 1980s to close to 80% nationally in 2007. This growth was fueled by a strong economy, coupled with strong travel demand and actions by the airlines to remove capacity from their systems and to use sophisticated yield management procedures. Since national load factors have recently been at historically high levels, the Federal Aviation Administration (FAA) does not project them to go significantly higher.

In existing non-stop markets, load factors were assumed to increase at the projected FAA rate for domestic operations. Load factors in new non-stop markets were assumed to be same as in the most similar existing market in the same mileage band.

Annual scheduled seat departures in each market were estimated by dividing the projections of outbound passengers by the load factor projections. Average annual day (AAD) seat departures were estimated by dividing annual seat departures by 365 days. Detailed calculations of annual and AAD seat departures by market are presented in **Table E.3** in Appendix A.

2.5.6 AIR SERVICE PROJECTIONS

The AAD seat departure projections were translated into projections of scheduled aircraft flights for each market using a set of assumptions regarding airline strategies and available equipment. The service projections are guided by the general assumptions outlined in Section 2.4. Based on previous surveys and discussions with the major airlines operating at MSP, industry publications, and professional experience, additional, more-detailed air service assumptions were developed, as listed below:

- No radical changes in airline strategy for how to serve and compete in markets are assumed.
- The current pattern of airline dominance at other airport hubs and non-hubs is assumed to remain substantially in place.
- Delta Air Lines (including its SkyTeam partners) is assumed to continue to maintain a constant share of the MSP market, after allowance for the expansion of Southwest Airlines.
- As projected by the FAA and Boeing, airlines will continue to emphasize frequency when adding service to meet demand. This means that domestic service will be provided principally by narrow-body air carrier aircraft and regional jets.
- Relaxation of legacy carrier scope clauses will allow their code-sharing regional partners to add regional jets, as necessary, to meet demand.

- Carriers that do not currently provide service to MSP, such as Jet Blue, are assumed to gradually introduce service from their main focus cities.

- Delta Air Lines is assumed to continue Northwest's current directional connecting bank structure.

- The existing relationship between aircraft size and frequency for each distance category was assumed to remain stable through the forecast period unless the frequency exceeded the number of connecting banks.

- The existing connecting bank structure limits the number of Delta Air Lines daily frequencies to medium- and long-haul markets to six, or seven at most. It is assumed that once the frequency limit is reached, Delta will accommodate increases in demand with larger aircraft rather than with increases in frequency.

- Full integration of the Delta and Northwest fleets is assumed by 2015.

- Delta Air Lines is assumed to continue to gradually remove the hush-kitted DC9 aircraft from its fleet, and completely remove them by 2015.

- It is assumed that Delta will phase-out the 757 and MD80 aircraft by 2025.

- It is assumed that the Saab 340 aircraft will be phased out by 2030.

- In the short-term, major growth is expected to occur in the 76-seat CRJ-900 and EMB 175 aircraft fleet.

- Next generation replacement aircraft for the 757 and 737/320 categories are assumed to be available by 2025.

- It is assumed that 50-seat turboprop aircraft will replace the Saab 340 in small short-haul markets.

- Southwest Airlines is assumed to fly Boeing 737-700 aircraft through the forecast period.

- Future schedule information provided by Sun Country was reviewed in estimating future Sun Country markets. Sun Country is assumed to continue to fly Boeing 737-800 aircraft.

- United Airlines is expected to replace its older Boeing 737 aircraft with Airbus 319s and 320s.

- American Airlines is expected to gradually replace its MD-80 aircraft with newer Boeing aircraft, specifically the 737-800.

- Continental is anticipated to replace its older Boeing 737 aircraft with next generation Boeing 737 aircraft.

- Future fleet additions beyond those presently announced by the airlines are assumed to be consistent with current announced fleet expansion plans and existing acquisitions.

- No supersonic, hypersonic, or tilt-rotor aircraft are projected because of poor operating economies and potential noise impacts.

Using the above assumptions for guidance, air service scenarios were developed for each market in each forecast year. The scenarios were developed so that the selected aircraft types and frequencies in combination matched the average annual day (AAD) seat departure projections for that market. Factors considered in each market included historical service patterns, current dominant carriers, aircraft in place and on order, length of haul, and announced plans of current carriers and new entrants. Individual market scenarios are presented in **Table E.5** in Appendix A.

2.5.7 DOMESTIC PASSENGET FORECAST SUMMARY

Table 2.7 summarizes the forecast of domestic passenger enplanements and aircraft operations for MSP. It should be noted that some of the domestic enplanements are international originations departing through another gateway and therefore do not appear as originations in this table.

Table 2.7 also shows the forecast of scheduled domestic aircraft operations. Completed aircraft departures are slightly less than the scheduled aircraft departures identified in **Table E.5**, because, typically, approximately 2-3% of scheduled flights are cancelled for weather, mechanical, or miscellaneous other reasons. As shown, scheduled domestic passenger aircraft departures are projected to increase at 1.5% per year through 2030. **Table E.6** in Appendix A presents the forecast of AAD scheduled aircraft departures by aircraft type.

2.6 INTERNATIONAL PASSENGER FORECASTS

This section discusses the international passenger forecasts, including assumptions, methodologies, and results.

2.6.1 METHODDOLGY, ASSUMPTIONS, AND DATA SOURCES

The methodology used to develop the international passenger forecasts was essentially a top-down approach. The type of bottom-up approach that was used to estimate domestic passenger traffic was not suitable for the international passenger forecast for several reasons. First, origination and destination (O&D) data for passengers flying their entire itinerary on foreign-flag carriers are not available; therefore, the historical record is incomplete. Second, many of the international markets are still being developed, so insufficient historical data exist from which to establish trends. Finally, past international service has been constrained by physical factors, such as distance, and political factors, such as bilateral agreements. These constraints tend to obscure the relationship between traditional drivers of demand, such as income and yield, and international passenger traffic.

TABLE 2.7: FORECAST OF DOMESTIC SCHEDULED PASSENGER AIRCRAFT OPERATIONS AND SEAT DEPARTURES

	2007	2008	2010	2015	2020	2025	2030
Scheduled Aircraft Departures							
Daily (a)	533.3	536.0	547.5	604.4	652.8	706.8	749.8
Annual (b)	194,662	195,655	199,819	220,591	238,272	257,982	273,688
Completed Aircraft Departures							
Annual (c)	194,254	189,304	193,333	213,431	230,538	249,608	264,804
Ratio (Completed to Scheduled) (d)	0.998	0.968	0.968	0.968	0.968	0.968	0.968
Completed Aircraft Operations (e)	388,508	378,273	386,666	426,862	461,076	499,216	529,608
Scheduled Aircraft Seat Departures							
Daily (a)	56,442	54,204	54,901	62,677	70,595	79,356	89,061
Annual (b)	20,601,474	19,784,490	20,038,792	22,877,112	25,767,073	28,964,772	32,507,126
Seats per Departure (f)	105.8	101.1	100.3	103.7	108.1	112.3	118.8
Enplanements (g)	15,903,109	15,087,389	15,316,308	17,606,511	19,962,423	22,675,048	25,579,956
Enplanements per Departure (h)	81.9	79.7	79.2	82.5	86.6	90.8	96.6

(a)Table E.6
(b) Daily activity multiplied by 365 days.

(c) Existing departures from MSP Monthly Summary Reports. Future completed departures estimated by multiplying scheduled departures by completion ratio.
(d) Assumed to remain constant at 2008 levels.
(e) Completed aircraft departures multiplied by 2.
(f) Scheduled seat departures divided by scheduled aircraft departures.
(g) Table 6.
(h) Enplanements divided by completed aircraft departures.

Sources: As noted and HNTB analysis.

A top-down approach provides an opportunity to exploit the research and analysis into international travel conducted by the Federal Aviation Administration (FAA), and major aircraft manufacturers, such as Boeing and Airbus. These organizations have resources available to investigate the factors driving international demand, and are able to incorporate the findings into their forecasts. The selected top-down approach can be summarized as follows:

1. Develop forecasts of United States international passenger traffic by major region.

2. Estimate future Twin Cities share of United States international passenger originations in each region.

3. Estimate future Twin Cities international passenger enplanements from originations forecast.

4. Disaggregate regional forecasts into individual markets.

5. Identify potential new non-stop markets.

6. Develop passenger forecasts by market.

7. Estimate future load factor.

8. Project future seat departures by market using the passenger and load factor forecasts.

9. Estimate the most probable way that airlines would accommodate the seat departure forecast in terms of aircraft type and scheduled frequency.

10. Convert the passenger forecast to enplanements using local airport enplanement data.

11. Convert the scheduled aircraft departure forecast to actual departures using historical departure completion data.

The methodology will be described in greater detail in subsequent sections of this report.

The following data sources were used in the analysis:

- FAA, Boeing, and Airbus international projections.

- US Department of Transportation (USDOT) International Schedule T-100 database.

- USDOT International O&D Survey.

- OAG information on scheduled operations, which was used to determine current scheduled service.

- The Official Airline Guide (OAG), and JP Airline-Fleets International guide, which were used to determine aircraft seat configurations for each airline.

- JP Airline-Fleets International and other industry publications, which were used to gather information on airline fleet orders.

2.6.2 FORECASTS BY INTERNATIONAL REGION

Table F.1 in Appendix A presents a comparison of international forecast growth rates developed by the FAA, Boeing, and Airbus. The projections show agreement in some areas, such as Europe, but vary in other regions. For example, Airbus is more optimistic about Middle East travel than Boeing, while Boeing is more optimistic about South America and Oceania.

A consensus forecast was developed for each region using the average of the forecast indexes from the three organizations. Based on the consensus forecast, Oceania and the Middle East are expected to grow most rapidly, followed by Asia, South America, and Africa. More mature markets, such as Europe, Canada and Mexico and Central America, are expected to grow more slowly.

2.6.3 MSP FORECASTS BY REGION

The estimated existing breakout of international originations from MSP by world region is provided in **Table F.2** in Appendix A. The estimate is complicated by two factors. First, foreign-flag carriers are not required to submit originating data to the USDOT. Secondly, international originating data submitted by the United States-flag carriers are restricted, and cannot be published publicly. The estimates in **Table F.2** were prepared by adding estimated foreign-flag originations (based on a percentage of enplanements) to the USDOT originating passenger numbers. The two largest international markets are Europe and Mexico and Central America, followed by Asia, Canada, and the Caribbean.

Table F.3 in Appendix A shows projected MSP international originations. The basis for the projections is the regional growth rates from **Table F.1** with two adjustments. First, the 2009 projections were adjusted downward to reflect Delta Air Lines' planned international capacity reductions in response to the recession. Secondly, the growth rates in **Table F.1** were adjusted to reflect the difference in estimated Twin Cities income growth and United States income growth. As shown, total international originations at MSP are projected to rise from slightly less than 1.0 million in 2008 to 2.4 million by 2030.

2.6.4 MSP INTERNATIONAL ENPLANEMENT FORECASTS

Similar to the domestic forecast approach, future international passenger enplanements were estimated by applying a hubbing ratio to the forecast of international originations. The international hubbing ratio has been increasing in recent years. However, there is a question as to whether this increase can be sustained given Delta's acquisition of Northwest, because of its heavy investment in international facilities at Atlanta and New York JFK. In addition, international enplanements are heavily dependent on domestic connecting passengers and will be sensitive to trends in that segment. For these reasons, it was assumed that the future international hubbing ratio would change at the same rate as the domestic hubbing ratio, and therefore decline slightly in the future. **Table E.4** of Appendix A shows the estimated future international ratio of enplanements to originations and **Table 2.8** shows the future forecast of international enplanements at MSP. Total international enplanements are projected to increase from about 1.3 million in 2008 to 2.8 million in 2030, an average annual increase of 3.7%.

TABLE 2.8: FORECAST OF INTERNATIONAL ENPLANEMENTS BASE CASE

Year	International Originations (a)	International Hubbing Ratio (b)	International Enplanements (c)
2006	888,697	0.780	692,757
2007	951,196	1.031	980,460
2008	963,631	1.312	1,264,507
2010	959,808	1.230	1,180,400
2015	1,210,171	1.217	1,472,452
2020	1,525,839	1.204	1,836,550
2025	1,923,847	1.191	2,290,408
2030	2,425,675	1.171	2,839,469
	Average Annual Growth Rate		
2008-2030	4.3%	-0.5%	3.7%

(a) Table F.3.
(b) Table F.4.
(c) Originations multiplied by international hubbing ratio.

Sources: As noted and HNTB analysis.

2.6.5 INTERNATIONAL PASSENGER PROJECTIONS BY MARKET

This section discusses the forecasts of MSP international passengers, first in markets with existing non-stop service, then in potential new markets.

Existing Markets

International originations in existing and potential non-stop markets were projected to increase at the same rate as the consensus growth indexes for each region developed in **Table F.1**. Details of the calculations are presented in **Table F.5**. Both of these tables are found in Appendix A of this report.

New Markets

Similar to the methodology used for domestic markets, passenger thresholds were used to identify potential new international non-stop markets. The process was more difficult because international originating passenger data are not available for foreign-flag carriers. Therefore, several threshold criteria were used to estimate new markets. The methodology involved the following steps:

1. *Identify originating passenger thresholds for non-stop service in each region*. Thresholds will vary by region because: a) shorter-haul markets require smaller aircraft and thus reduce the required threshold; and b) the direction of the market will determine how much connecting traffic can logically be funneled through the MSP gateway, thereby reducing the required originating passenger percentage. For example, most East Coast United States passengers can fly to Asia or western Canada via MSP with relatively little increase in circuity. However, those same passengers would incur much greater circuity if they were to use MSP as a gateway to Europe. Originations in each potential market were assumed to grow at the rates in **Table F.3** to determine if and when they would exceed the threshold.

2. *Identify seat departure thresholds for non-stop service to each region*. As a crosscheck on the passenger data, seat departures from all United States gateways to international markets were identified. Similar to Step 1, the threshold for new service in each region was assumed to be the average of the smallest market (measured in terms of seat departures) with non-stop MSP service and the largest market without non-stop MSP service. Scheduled seat departures in each potential market were assumed to grow at the rates in **Table F.3** to determine if and when they would exceed the threshold. **Table F.6** in Appendix A shows the seat departure thresholds by region.

3. *Identify thresholds for regions with no existing service.* Some regions, such as Africa or China, have insufficient service history from which to identify originating passenger thresholds. In these instances, thresholds were adopted from other regions based on similar distance and circuity characteristics. For example, European thresholds were used for Africa.

4. *Estimate new non-stop markets*. Information from the two sets of threshold criteria was integrated to estimate new non-stop markets. In general, any market that satisfied both threshold criteria was assumed to gain new non-stop service in the year in which those criteria were reached.

The new non-stop markets that were estimated using the above approach are listed in **Table F.5**. These projections are the best estimate of new market potential given available information. It is acknowledged that additional factors such as local economic trends, political circumstances, airline strategies, and market development initiatives may serve to either accelerate or delay the introduction of non-stop service to the markets listed in the Appendix.

Load Factor and Seat Departure Forecast

The load factor projections vary by market. Load factors in each region were projected to increase at the same rate as the Federal Aviation Administration forecast load factor for that region. Projected seat departures in each market were estimated by dividing the passenger projections by the load factor. Annual scheduled international seat departures at MSP are presented in **Table F.5**. As shown, total scheduled international seat departures are projected to increase from 1.65 million in 2008 to 3.75 million by 2030. Average annual day (AAD) seat departures were estimated by dividing by 365 days.

2.6.6 AIR SERVICE PROJECTIONS

The procedure used to allocate international passenger activity to airlines and aircraft equipment was similar to that used for the domestic air service projections. The following assumptions were used to guide the process:

- Annual aircraft departures and aircraft types were projected to be consistent with the AAD seat departure forecast for each market, as presented in **Table F.5**.
- The trend toward more Open Skies agreements is assumed to continue.
- No radical changes in airline strategy for how to serve and compete in markets is assumed.
- The current pattern of airline dominance at other airport hubs and gateways is assumed to remain in place.
- The current airline alliance structure is assumed to remain intact. Thus, SkyTeam members and code-sharing partners are expected to be more likely to provide service at MSP than other foreign-flag carriers.
- Except where noted, sufficient airport expansion in Europe and the Far East is anticipated to accommodate market demand.
- Delta Air Lines is assumed to serve its overseas international markets with A-330s, Boeing 777s and Boeing 787s.
- Next generation replacement aircraft for the 757 and 737/320 categories are assumed to be available by 2025.
- Future fleet additions beyond those presently announced by the airlines are assumed to be consistent with current announced fleet expansion plans and existing acquisitions.

- No supersonic, hypersonic, or tilt-rotor aircraft are projected because of poor operating economies and potential noise impacts.

The air service projections for each international market are outlined in detail in **Table F.7** in Appendix A. Projecting individual flights over an 11-year forecast horizon is an ambitious undertaking. The air service scenarios presented in **Table F.7** are considered reasonable and plausible, given the available information. However, it is acknowledged that actual service patterns may deviate from those projected, and that these deviations could be material.

2.6.7 SUMMARY

Table 2.9 summarizes the unconstrained international scheduled passenger and aircraft operation forecasts. Total international enplanements are projected to increase from 1.3 million in 2008 to 2.8 million in 2030. Completed international aircraft operations are projected to increase from 24,074 in 2008 to 47,074 in 2030, an average annual increase of 3.1%.

Table F.8 in Appendix A shows the scheduled international passenger fleet mix forecast. Although an increase in wide-body operations is anticipated, narrow-body aircraft operations to Canadian, Mexican and Caribbean markets are projected to account for the majority of the total.

2.7 CHARTER ENPLANEMENTS AND AIRCRAFT OPERATIONS

The forecast of charter (non-scheduled) passenger enplanements and aircraft operations is discussed in this section.

2.7.1 CHARTER PASSENGERS

Good historical data on charter activity are difficult to obtain and, therefore, it is not possible to develop a forecast using regression analysis or trend analysis. The Federal Aviation Administration does not publish forecasts of national charter activity so a share analysis is not possible either. Typically, charter operators cater to tour groups traveling to leisure destinations or to sports teams traveling to road games. Airport counts of charter passengers have declined significantly in recent years at MSP. This can be attributed to several factors:

- Sun Country, which has accounted for the majority of past charter operations at MSP, has placed more of an emphasis on scheduled operations, although in many instances to the same markets where it offered charter service.
- Some major charter operators, such as Champion, have ceased operations.
- Northwest's (now Delta) Amigo flights to Mexico have cut into traditional charter markets. These are assumed to continue under Delta in the future.
- Continued price reductions by legacy carriers have diminished the price advantage that charter carriers can offer.

There is little indication that any of the above factors will be reversed. The entry of low-fare service by Southwest Airlines will place additional pressure on charter operators. For these reasons, the historical decline in charter passengers is projected to continue. The rate of decline is assumed to be moderate, however, given that the effect of most of the above factors has been realized already.

TABLE 2.9: FORECAST OF INTERNATIONAL SCHEDULED PASSENGER AIRCRAFT OPERATIONS AND SEAT DEPARTURES

	2008	2010	2015	2020	2025	2030
Scheduled Aircraft Departures						
Daily (a)	34.1	33.5	40.6	45.9	56.3	66.5
Annual (b)	12,429	12,224	14,826	16,764	20,531	24,265
Completed Aircraft Departures						
Annual (c)	12,056	11,857	14,381	16,261	19,915	23,537
Ratio (Completed to Scheduled) (d)	0.970	0.970	0.970	0.970	0.970	0.970
Completed Aircraft Operations (e)	24,074	23,714	28,762	32,522	39,830	47,074
Scheduled Aircraft Seat Departures						
Daily (a)	4,530	4,398	5,403	6,738	8,384	10,248
Annual (b)	1,653,480	1,605,168	1,971,971	2,459,202	3,059,985	3,740,418
Seats per Departure (f)	133.0	131.3	133.0	146.7	149.0	154.1
Enplanements (g)	1,264,507	1,180,400	1,472,452	1,836,550	2,290,408	2,839,469
Enplanements per Departure (h)	104.9	99.6	102.4	112.9	115.0	120.6

(a) Table F.8.
(b) Daily activity multiplied by 365 days.
(c) Existing departures from MSP Monthly Summary Reports. Future completed departures estimated by multiplying scheduled departures by completion ratio.
(d) Assumed to remain constant at 2008 levels.
(e) Completed aircraft departures multiplied by 2.
(f) Scheduled seat departures divided by scheduled aircraft departures.
(g) Table 8.
(h) Enplanements divided by completed aircraft departures.

Sources: As noted and HNTB analysis.

Table G.1 in Appendix A shows the forecast of charter enplanements. The forecast assumes that Sun Country continues operating principally as a scheduled carrier. Total charter enplanements are projected to decline from about 32,000 in 2008 to about 12,000 in 2030. The current split between domestic and international passengers is projected to continue.

2.7.2 CHARTER AIRCRAFT OPERATIONS

Tables G.2 and **G.3** in Appendix A show the derivations of domestic and international charter aircraft operations from the passenger forecast. The tables also show the forecast fleet mix. Passenger aircraft departures for charter carriers were estimated as follows:

1. Assume constant load factors since they are already at very high levels.

2. Project total charter seat departures by dividing forecast enplanements by the projected load factor.

3. Estimate future fleet mix based on existing carrier fleets and available information on aircraft acquisition plans.

4. Calculate average seats per aircraft from the future fleet mix.

5. Divide forecast seat departures by projected seats per aircraft to generate projected charter aircraft departures and operations.

No attempt was made to forecast charter activity by market. **Table G.4** in Appendix A summarizes the forecast of charter aircraft operations. As shown, total passenger charter aircraft operations are projected to decline from 536 in 2008 to 218 in 2030. Narrow-body aircraft are forecast to continue to account for the vast majority of charter operations.

2.8 SUMMARY OF PASSENGER FORECASTS

Table 2.10 summarizes the scheduled and non-scheduled domestic and international passenger enplanement forecasts. Total enplanements at MSP are projected to increase from 16.4 million in 2008 to 28.4 million in 2030, an average annual increase of 2.5%.

Many facility requirements are dependent on peak hour activity. **Tables H.1** through **H.6** in Appendix A provide domestic and international peak month, average weekday peak month, and peak hour estimates of enplaning, deplaning, originating and terminating passengers. These estimates were organized by SkyTeam, Southwest, and other airline categories.

The distribution of passengers by airline was in accordance with the distribution of scheduled seat departures that resulted from the market projections in **Tables E.5** and **F.7**. The peak month shares of passengers in the domestic and international categories were assumed to remain constant. However, since the categories are projected to grow at different rates, the combined peak month percentage changes slightly. Because international activity, which peaks in March, is expected to grow more quickly than domestic activity, which peaks in July, the peak month for overall airport activity is expected to eventually shift from July to March.

Because the connecting bank structure for Delta Air Lines is expected to remain the same, the percent of daily passenger activity occurring during the peak hour was assumed to remain

TABLE 2.10: FORECAST OF ANNUAL DOMESTIC AND INTERNATIONAL DEPARTURES

Year	Domestic (a)	International (b)	Charter (c)	Total
2006	16,334,138	692,757	151,412	17,178,307
2007	15,903,109	980,460	85,515	16,969,084
2008	15,087,389	1,264,507	32,376	16,384,272
2010	15,316,308	1,180,400	29,677	16,526,385
2015	17,606,511	1,472,452	23,872	19,102,835
2020	19,962,423	1,836,550	19,203	21,818,176
2025	22,675,048	2,290,408	15,447	24,980,903
2030	25,579,956	2,839,469	12,425	28,431,850
	Average Annual Growth Rate			
2008-2030	2.4%	3.7%	-4.3%	2.5%

(a) Table 6.
(b) Table 8.
(c) Table G.1.

Sources: As noted and HNTB analysis.

constant for the SkyTeam airlines. As of this writing, Southwest Airlines is just beginning its operation at MSP, so there are no historical data upon which to base peak hour percentage. A 10% peak percentage was assumed for Southwest, suggesting an operation that is fairly evenly spread throughout the day, which is typical of the way Southwest operates at most airports. The peak hour percentage for other airlines was also assumed to remain constant. However, in the case of non-SkyTeam international passengers, the seasonal distribution of activity was assumed to become more evenly distributed than is currently the case. It is not expected that other new entry international carriers will have the same pronounced spike of activity in March that Sun Country currently experiences.

2.9 AIR CARGO TONNAGE AND AIRCRAFT OPERATIONS

The forecasts of air cargo tonnage and related all-cargo aircraft operations are discussed in this section.

Table I.1 in Appendix A shows historical enplaned air cargo, including both freight and mail, at MSP from 1990 through 2008. In the early part of the decade FedEx won a major postal service contract to carry mail and includes mail with cargo when reporting statistics. Hence, the apparent recent downturn in air mail at MSP is mostly an artifact of changes in reporting practices. Air cargo tonnage at MSP grew rapidly in the 1980s and then at a slower rate through 1997. It has since declined, in part because of the stricter security restrictions imposed after the September 11, 2001 terrorist attacks. The stricter security restrictions have led to an especially sharp downturn in air cargo carried on passenger carriers. Cargo carried on all-cargo carriers continued to increase through 2004 but has since declined.

2.9.1 AIR CARGO TONNAGE

As noted earlier, some carriers have ceased distinguishing between air mail and air freight when reporting their statistics. Consequently, the forecast contained herein combines freight and mail into a single air cargo category. All statistics are presented in short tons (2000 pounds per ton).

Table I.1 shows the forecasts of air cargo at MSP. There are two main categories of air cargo tonnage: 1) cargo carried on passenger aircraft (belly cargo); and 2) cargo carried on dedicated all-cargo aircraft. Separate approaches were developed to forecast each category.

Forecasts of belly cargo activity are based in part on Federal Aviation Administration (FAA) forecasts of revenue ton miles (RTMs) of air cargo traveling on domestic passenger carriers. An index was developed which related the FAA forecast of RTMs on domestic passenger carriers to the forecast of Available Seat Miles (ASM) for domestic air carriers. This ratio provided the expected future relationship of cargo to available seats. This index was then applied to the forecasts of scheduled seat departures prepared in Sections 2.5 and 2.6 to produce a belly cargo forecast for MSP.

As shown in **Table I.1**, enplaned belly cargo is projected to increase from 24,179 tons in 2008 to 35,701 tons in 2030, an average annual increase of 1.8%. Although this represents an increase from base year levels, it is still well below the belly cargo tonnages experienced in the 1990s. Increased security restrictions and strong competition from the dedicated all-cargo carriers will make it difficult for passenger carriers to recapture market share.

All-cargo carrier air cargo tonnage was estimated as a share of the FAA forecast of domestic all-cargo RTMs. All-cargo carrier tonnage at MSP roughly paralleled United States all-cargo carrier RTMs in the 1990s but has declined since 2003. The MSP share was assumed to continue to decline but at half the rate of the recent past, reflecting a combination of long-term and short-term historical rates. Enplaned all-cargo tonnage is forecast to increase from 102,508 tons in 2008 to 143,943 tons in 2030, an average annual increase of 1.6%.

Table 2.11 summarizes the cargo tonnage forecast. The ratio of deplaned to enplaned cargo tonnage was assumed to equal the 2007-2008 average in the future. Combined belly and all-cargo carrier enplaned tonnage is forecast to increase at an average annual rate of 1.6% from 126,687 tons in 2008 to 179,643 tons in 2030.

2.9.2 ALL-CARGO AIRCRAFT OPERATIONS

Table I.2 in Appendix A presents the forecast of all-cargo aircraft operations and fleet mix.

The future all-cargo carrier fleet mix was estimated based on available information on future aircraft acquisition plans by the carriers serving MSP. The average lift capacity per aircraft operation was estimated from the projected fleet mix and future all-cargo carrier aircraft departures were estimated by dividing total all-cargo carrier lift capacity by the capacity per aircraft. No attempt was made to forecast cargo activity by market.

Total all-cargo aircraft operations are projected to rise from 14,361 in 2008 to 18,834 in 2030, an average annual rate of 1.2%.

2.10 GENERAL AVIATION AND MILITARY OPERATIONS

This section discusses the forecast of general aviation and military operations.

2.10.1 GENERAL AVIATION

In contrast to commercial activity at MSP, general aviation (GA) activity has been declining in the long-term. This mirrors the experience at many other major airports, where many GA operators have relocated to reliever airports to avoid the congestion generated by scheduled commercial operations.

The Minneapolis-St. Paul Reliever Airports: Activity Forecasts – Technical Report for the MAC Reliever Airport System provides much of the basis of the GA forecast for MSP. The report was selected because it was performed on a system basis, and therefore takes into account the interactions resulting from the differing growth rates among the Twin Cities counties and the differing capabilities and capacities of the airports in the system.

Table 2.12 shows the based aircraft forecast for MSP, which comes from the Reliever Airport forecasts. Based on available hangar facilities, the maximum capacity was estimated at 30. Based aircraft in each category were projected to grow at national trends, adjusted for local factors, until the capacity limit was achieved. As shown, all based aircraft are anticipated to be jets, as is the case currently.

TABLE 2.11: ENPLANED AND DEPLANED AIR CARGO (SHORT TONS)

	Passenger Carrier (a)			Cargo Carrier (a)			Total		
Year	Enplaned	Deplaned	Total	Enplaned	Deplaned	Total	Enplaned	Deplaned	Total
2007	25,124	28,745	53,870	116,058	113,849	229,908	141,182	142,595	283,777
2008	24,179	27,412	51,591	102,508	103,018	205,526	126,687	130,430	257,116
2010	23,298	26,537	49,834	108,379	107,537	215,915	131,677	134,073	265,750
2015	25,603	29,162	54,765	118,759	117,836	236,595	144,362	146,998	291,360
2020	31,627	36,023	67,650	127,749	126,756	254,506	159,376	162,780	322,156
2025	43,274	49,290	92,565	135,617	134,563	270,180	178,891	183,853	362,745
2030	66,129	75,322	141,451	143,943	142,824	286,767	210,071	218,146	428,217
Average Annual Growth Rate									
	4.7%	4.7%	4.7%	1.6%	1.5%	1.5%	2.3%	2.4%	2.3%

(a) Table I.1 and MSP Monthly Summary Reports. Deplaned cargo assumed to increase at same rate as enplaned cargo.

Sources: As noted and HNTB analysis.

TABLE 2.12: SUMMARY OF BASED AIRCRAFT FORECAST

Year	Single Engine Piston	Multi-Engine Piston	Turboprop	Microjets	Other Jets	Helicopter	Other (b)	Total
2008	0	0	0	0	24	0	0	24
2010	0	0	0	1	26	0	0	27
2015	0	0	0	1	29	0	0	30
2020	0	0	0	1	29	0	0	30
2025	0	0	0	1	29	0	0	30
2030	0	0	0	1	29	0	0	30
Average Annual Growth Rate								
2008-2030	-	-	-	-	0.9%	-	-	1.0%

Source: Table G.6 in Minneapolis-St. Paul Reliever Airports: Activity Forecasts - Technical Report.

Table J.1 in Appendix A shows the MSP forecast of GA operations based on the methodology in the Reliever Airport forecast. As shown, even with the constraint on based aircraft, the anticipated increase in jet aircraft utilization results in growing forecast of GA aircraft operations. The Reliever Airport methodology addresses hangar capacity but does not address airfield capacity and delay.

Table 2.13 shows the recent history of GA operations at MSP and compares it to the FAA count of itinerant GA operations in the United States. As shown, MSP GA activity, as a share of the United States, has been consistently declining. GA activity in the United States rose in the late 1990s but then declined as a result of the recession and the September 11th attacks. Since 2001, United States GA activity (itinerant operations) has been relatively constant. The FAA predicts that GA will begin to grow again in the near future based on the following assumptions:

- Moderate sustained economic growth;
- No dramatic changes in the GA regulatory environment; and
- Increased growth in the fractional ownership market, which brings new owners and operators into business aviation.

Table 2.13 shows the MSP GA forecast if the airport share of United States GA activity accounted for by the airport is assumed to continue to decline at historical rates.

As shown, under this assumption, GA operations would decline at a -1.7% annual rate to slightly over 21,000 by 2030.

The Reliever Airport methodology accounts for the anticipated stimulation resulting from the higher utilization of jet aircraft while the United States share methodology captures the ongoing trend of GA operators diverting their aircraft from MSP to one of the regional reliever airports. The recommended forecast incorporates both trends by taking the average of the two methodologies. As shown in **Table 2.13**, based on the average, total GA operations are projected to increase slightly from 30,685 in 2008 to 32,988 in 2030, an average annual increase of 0.3% per year.

Forecast operations by aircraft type are shown in **Table J.1**. Based on current practices at MSP, all these operations are projected to be itinerant operations. Operations in each GA aircraft category were assumed to grow at the same rate as the FAA's forecast of hours flown in that category. The results were then adjusted on a prorated basis to sum to the original forecast of GA aircraft operations. The result, as shown in the table, is a slight increase in jet operations through 2030, while turboprop and piston operations decrease.

2.10.2 MILITARY

Military operations are related to national and international political and institutional factors rather than local economic conditions. The number of military operations at MSP decreased during most of the 1980s and early 1990s and then leveled off after a spike in activity in 2001. Due to the uncertainties enumerated above and consistent with the principal trend occurring since 1990, military operations are assumed to remain constant at 2008 levels throughout the forecast period. This assumption is consistent with FAA forecasts of national military activity. However, future national defense actions could increase or decrease future military operations.

TABLE 2.13: FORECAST OF ANNUAL GENERAL AVIATION OPERATIONS

Year	FAA Itinerant GA Ops (000's) (a)	Ratio of MSP Operations to US Operations (b)	MSP Operations from Ratio Method (c)	MSP Operations from Reliever LTCP	Average (e)
1995	20,860	2.39	49,769		
1996	20,823	2.39	49,786		
1997	21,669	2.96	64,209		
1998	22,086	3.61	79,757		
1999	23,019	2.14	49,256		
2000	22,844	2.54	58,076		
2001	21,433	2.14	45,943		
2002	21,451	2.06	44,279		
2003	20,231	1.95	39,513		
2004	20,007	1.95	39,018		
2005	19,315	1.89	36,472		
2006	18,741	2.00	37,459		
2007	18,577	1.65	30,562		
2008	18,637	1.65	30,685	30,685	30,685
2010	19,298	1.57	30,291	32,793	31,542
2015	20,928	1.32	27,569	39,140	33,354
2020	22,839	1.11	25,250	41,413	33,331
2025	24,951	0.93	23,150	43,289	33,220
2030	27,063	0.78	21,073	44,903	32,988
		Average Annual Growth Rate			
2008-2030	1.7%	-3.3%	-1.7%	1.7%	0.3%

(a) FAA Aerospace Forecasts: Fiscal Years 2008-2025.

(b) Ratio of MSP GA operations to thousands of US operations. Assumed to change at historical rate in the future.

(c) Historical from Table 4. Future estimated by multiplying FAA forecast by ratio of MSP operations to US operations.

(d) Unconstrained GA forecasts estimated using methodology in Minneapolis-St. Paul Reliever Airports: Activity Forecasts - Technical Report.

(e) Average of Ratio and LTCP methods.

Sources: As noted and HNTB analysis.

Table 2.14 shows the forecast of military operations. As shown, annual operations are projected to remain constant at 2,115.

2.11 SUMMARY OF ANNUAL FORECASTS

This section summarizes the passenger and aircraft operation forecasts.

Table 2.15 provides a summary of the passenger forecasts. Total revenue enplanements are forecast to increase from 16.4 million in 2008 to 28.4 million in 2030, an average annual increase of 2.5%. Originating passengers are projected to increase from 8.3 million to 16.6 million over the same period. As a percentage of enplanements, originations are projected to increase, but with the majority of the increase occurring in the early part of the period as a result of Southwest's entry into the market. The percentage of enplanements accounted for by originations is expected to increase from 51% in 2008 to 58% by 2030.

Table 2.16 summarizes the unconstrained forecast of aircraft operations at MSP. Total aircraft operations are estimated to increase from 450,044 in 2008 to 630,837 in 2030, an average annual increase of 1.5%. The scheduled passenger operation categories are projected to grow the most rapidly, and air cargo, general aviation, and military aircraft operations are projected to grow slowly.

2.12 FORECAST SCENARIOS

The assumptions used in developing the forecasts are likely to vary over the forecast period, and the variations could be material. One way to explore the impact of these variations is to develop alternative scenarios in which the impact on the forecast of a variation in a critical assumption is evaluated. The base case forecast provides the basis for determining what additional facilities will be required at the airport through 2030. The airport must be able to respond to a range of contingencies that could occur, taking into account political and economic changes, technological changes, and changes in individual airline policies. The recommended development program must be flexible enough to accommodate these contingencies.

To address these potential changes, four alternative forecast scenarios were selected with the assistance of airport staff. Much of the background information used to develop the scenarios is provided in previous chapters; except where noted, the assumptions are the same as those presented in section 2.4. The four scenarios are:

Scenario 1 – High Fuel Cost. This scenario assumes that jet fuel costs to the airlines increase significantly, either as a result of increased demand/supply imbalances, or stringent environmental restrictions, such as a cap and trade program or a carbon tax. The cost of jet fuel is assumed to increase to $4.50 per gallon after the recession ends and then continue to increase at 2% per year thereafter. This would cause air fares to rise and passenger demand to fall. As detailed in **Table K.2**, in Appendix A, total enplanements would rise slowly to 21.4 million by 2030, an average annual increase of 1.2%. Total operations would increase to 514,042 in 2030, an average annual rate of 0.6% per year. Because of the low growth, it is assumed that under this scenario Delta Air Lines would consolidate its connecting activity among fewer hubs and, therefore, the connecting percentage at MSP would decline more than in the base case.

TABLE 2.14: FORECAST OF ANNUAL MILITARY AIRCRAFT

Year	Total (a)
1990	2,804
1991	2,534
1992	3,003
1993	2,825
1994	2,451
1995	2,915
1996	2,624
1997	3,624
1998	2,044
1999	3,358
2000	2,473
2001	3,180
2002	2,543
2003	1,856
2004	1,976
2005	2,230
2006	2,040
2007	2,289
2008	2,115
2010	2,115
2015	2,115
2020	2,115
2025	2,115
2030	2,115
Average Annual Growth Rate	
2008-2030	0.0%

(a) Table 4 for historical data. Assumed to remain constant in future.

Sources: As noted and HNTB analysis.

TABLE 2.15: SUMMARY OF BASE CASE PASSENGER FORECAST

	2007	2008	2010	2015	2020	2025	2030	Average Annual Growth Rate
Enplanements								
Domestic Scheduled Air Carrier (a)	15,903,109	15,087,389	15,316,308	17,606,511	19,962,423	22,675,048	25,579,956	2.4%
International Scheduled Air Carrier (b)	980,460	1,264,507	1,180,400	1,472,452	1,836,550	2,290,408	2,839,469	3.7%
Subtotal Scheduled	16,883,569	16,351,896	16,496,708	19,078,963	21,798,973	24,965,456	28,419,425	2.5%
Domestic Charter (c)	41,874	16,990	15,574	12,527	10,077	8,106	6,520	-4.3%
International Charter(c)	43,641	15,386	14,103	11,345	9,126	7,341	5,905	-4.3%
Subtotal charter	85,515	32,376	29,677	23,872	19,203	15,447	12,425	-4.3%
Total	16,969,084	16,384,272	16,526,385	19,102,835	21,818,176	24,980,903	28,431,850	2.5%
Originations								
Domestic Scheduled Air Carrier (a)	7,857,050	7,291,815	7,692,173	9,420,211	10,788,756	12,380,025	14,186,792	3.1%
International Scheduled Air Carrier (b)	951,196	963,631	959,808	1,210,171	1,525,839	1,923,847	2,425,675	4.3%
Subtotal Scheduled	8,808,246	8,255,446	8,651,981	10,630,382	12,314,594	14,303,872	16,612,467	3.2%
Domestic Charter (d)	41,874	16,990	15,574	12,527	10,077	8,106	6,520	-4.3%
International Charter(d)	43,641	15,386	14,103	11,345	9,126	7,341	5,905	-4.3%
Subtotal charter	85,515	32,376	29,677	23,872	19,203	15,447	12,425	-4.3%
Total	8,893,761	8,287,822	8,681,658	10,654,254	12,333,797	14,319,319	16,624,892	3.2%

(a) Table 6.
(b) Table 8.
(c) Table G.1.
(d) Assumed to be the same as enplanements.

Sources: As noted and HNTB analysis.

TABLE 2.16: SUMMARY OF FORECAST AIRCRAFT OPERATIONS

	2007	2008	2010	2015	2020	2025	2030	Average Annual Growth Rate
Domestic Scheduled Air Carrier (a)	388,508	378,273	386,666	426,862	461,076	499,216	529,608	1.5%
International Scheduled Air Carrier (b)	14,889	24,074	23,714	28,762	32,522	39,830	47,074	3.1%
Charter (c)	1,432	536	542	440	352	276	218	-4.0%
All-Cargo Carrier (d)	15,292	14,361	14,902	16,136	17,540	18,192	18,834	1.2%
General Aviation and Air Taxi (e)	30,562	30,685	31,542	33,354	33,331	33,220	32,988	0.3%
Military (f)	2,289	2,115	2,115	2,115	2,115	2,115	2,115	0.0%
Total	452,972	450,044	459,481	507,669	546,936	592,849	630,837	1.5%

(a) Table 7.
(b) Table 9.
(c) Table G.4.
(d) Table I.2.
(e) Table 13.
(f) Table 14.

Sources: As noted and HNTB analysis.

Scenario 2 – Low Fuel Cost. This scenario assumes that jet fuel costs to the airlines decrease in real terms, either as a result of increased supply or the accelerated availability of alternative fuels such as biofuels. The real cost of jet fuel is assumed to decrease by 2% per year from early 2009 levels. This would cause air fares to fall and passenger demand to increase. As detailed in **Table K.3**, in Appendix A, total enplanements would rise slowly to 31.1 million by 2030, an average annual increase of 3.0%. Total operations would increase more slowly to 697,815 in 2030, an average annual rate of 2.0% per year.

***Scenario 3 – High Economic Growth*.** This scenario assumes a full recovery from the current economic recession, to the extent that post-recession growth is sufficient to offset the losses of the recession and restore income levels to where they would be absent the recession. **Table K.4** in Appendix A shows that in this scenario, passenger enplanement would increase to 30.7 million by 2030, an average annual increase of 2.9%. Total operations are projected to increase 2.0% per year to 688,431 by 2030.

Scenario 4 – Declining Connecting Ratio. This scenario assumes the same originating passenger forecast as the base case, but also assumes that Delta Air Lines reduces the size of the MSP connecting operation. The connecting ratio is assumed to decline at the average rate of the last five years. Under this scenario, the percentage of enplanements accounted for by originations is expected to rise from 51% in 2008 to 70% in 2030. As shown in **Table K.5**, in Appendix A, total enplanements are projected to increase at an average annual rate of 1.6% to 23.7 million by 2030 and total operations are projected to increase at an annual 1.1% rate to 571,934 by 2030.

Table 2.17 summarizes the alternative scenarios and provides a comparison with the base case.

2.13 GATE REQUIREMENTS

Table 2.18 summarizes the estimated gate requirements resulting from the above forecasts and **Tables L.1** through **L.3** in Appendix A provide more detailed information organized by the SkyTeam Alliance members (Delta Air Lines and its partners), Southwest, and all other carriers.

Gate requirements are a function of passenger aircraft operations and average gate utilization. Base year gate requirements were calculated using the summer 2008 schedule from the Official Airline Guide (OAG) and assuming a 20-minute buffer between a departing aircraft and the next arriving aircraft at any given gate. Note that the existing number of gates that are required, based on schedule, is less than the available number of gates, indicating that there is excess gate capacity at this time. Since airlines cannot always operate according to their schedules, additional spare gate capacity was included to allow for off-schedule flights. This additional spare gate capacity was assumed to be 8% of the requirements calculated based solely on schedule.

Future average gate utilization was assumed to remain at existing levels for Delta Air Lines and the SkyTeam Alliance based on input provided by Delta Air Lines. Southwest Airlines is typically able to use its gates more intensively than other carriers. Southwest was assumed to average 8.5 departures per gate based on its experience at other airports. Average gate utilization for other carriers (non-SkyTeam and non-Southwest) was assumed to remain at existing levels, approximately 4.7 turns per gate.

TABLE 2.17: SCENARIO SUMMARY

	2007	2008	2010	2015	2020	2025	2030
Total Originations							
Base Case	8,893,761	8,287,822	8,681,658	10,654,254	12,333,797	14,319,319	16,624,892
Scenario 1: High Fuel Cost	8,893,761	8,287,822	8,662,834	9,904,026	11,280,808	12,867,215	14,707,543
Scenario 2: Low Fuel Cost	8,893,761	8,287,822	8,696,250	11,114,205	13,054,856	15,402,032	18,256,782
Scenario 3: High Economic Growth	8,893,761	8,287,822	8,693,849	11,377,997	13,217,186	15,408,919	17,979,093
Scenario 4: Low Connecting Ratio	8,893,761	8,287,822	8,681,658	10,654,254	12,333,797	14,319,319	16,624,892
Total Enplanements							
Base Case	16,969,084	16,384,272	16,526,385	19,102,835	21,818,176	24,980,903	28,431,850
Scenario 1: High Fuel Cost	16,969,084	16,384,272	16,039,649	16,651,548	18,068,039	19,643,363	21,401,089
Scenario 2: Low Fuel Cost	16,969,084	16,384,272	16,544,330	19,921,290	23,063,023	26,803,327	31,111,241
Scenario 3: High Economic Growth	16,969,084	16,384,272	16,541,378	20,421,185	23,378,479	26,843,490	30,656,311
Scenario 4: Low Connecting Ratio	16,969,084	16,384,272	16,074,766	17,868,992	19,601,262	21,559,813	23,708,077
Total Air Cargo Tonnage							
Base Case	283,777	257,116	265,750	291,360	322,156	362,745	428,217
Scenario 1: High Fuel Cost	283,777	257,116	265,172	270,798	294,609	325,919	378,794
Scenario 2: Low Fuel Cost	283,777	257,116	266,198	303,967	341,019	390,202	470,282
Scenario 3: High Economic Growth	283,777	257,116	266,124	311,197	345,266	390,377	463,124
Scenario 4: Low Connecting Ratio	283,777	257,116	265,750	291,360	322,156	362,745	428,217
Total Operations							
Base Case	452,972	450,044	459,481	507,669	546,936	592,849	630,837
Scenario 1: High Fuel Cost	452,972	450,044	443,941	449,443	469,455	492,352	514,042
Scenario 2: Low Fuel Cost	452,972	450,044	463,938	534,013	583,925	643,175	697,815
Scenario 3: High Economic Growth	452,972	450,044	463,875	546,593	591,594	644,305	688,431
Scenario 4: Low Connecting Ratio	452,972	450,044	448,018	484,668	512,041	542,975	571,934

Sources: Tables K.1 through K.5.

TABLE 2.18: SUMMARY OF FORECAST GATE REQUIREMENTS - TOTAL

	2008		2010	2015	2020	2025	2030
Daily Departures	569.4		580.2	644.3	698.0	762.4	815.6
			Gate Requirements				
Total	w/o Spares	w/ Spares					
Widebody (a)	3	5	5	7	11	13	15
757 Class (b)	10	11	9	6	4	9	16
Narrow Body (c)	42	45	45	48	54	56	57
Large Regional (d)	13	15	18	26	29	33	36
Medium Regional (e)	22	23	24	25	25	26	31
Small Regional (f)	12	12	11	11	10	8	-
Subtotal	102	111	112	123	133	145	155
International							
Widebody (a)	3	5	5	6	7	9	11
757 Class (b)	1	1	1	1	1	-	1
Narrow Body (c)	6	6	5	7	9	12	12
Large Regional (d)	-	-	-	-	-	-	-
Medium Regional (e)	-	-	1	1	1	1	1
Small Regional (f)	-	-	-	-	-	-	-
Subtotal	10	12	12	15	18	22	25
Domestic							
Widebody (a)	-	-	-	1	4	4	4
757 Class (b)	9	10	8	5	3	9	15
Narrow Body (c)	36	39	40	41	45	44	45
Large Regional (d)	13	15	18	26	29	33	36
Medium Regional (e)	22	23	23	24	24	25	30
Small Regional (f)	12	12	11	11	10	8	-
Subtotal	92	99	100	108	115	123	130
Average Utilization (g)		5.1	5.2	5.2	5.2	5.3	5.3

(a) Includes all multiple aisle aircraft.
(b) Includes 757-200, 757-300 and anticipated replacement aircraft.
(c) Includes all mainline narrow-body aircraft except for 757 class.
(d) Includes Embraer 175 and Canadair 900 aircraft.
(e) Includes all regional aircraft between 44 and 70 seats.
(f) Includes all regional aircraft less than 44 seats.
(g) Total aircraft operations divided by gate requirements.

Sources: As noted, Tables L.1, L.2, and L.3, and HNTB analysis.

Gate requirements in each category (wide-body, 757-class, etc.) were assumed to increase at the same rate as aircraft departures in that category. For the purpose of calculating gate requirements, however, it was assumed that aircraft would be able to use any gate sized to accommodate aircraft larger than their class. Therefore, a new 757-class gate requirement was not assumed if there was available wide-body gate capacity.

As shown in **Table 2.18**, a requirement of 155 total contact gates is anticipated by 2030, of which 25 would need to be capable of accommodating non-pre-cleared international flights. SkyTeam would account for 119 of the required gates (see **Table L.1**). Factors that could change future gate requirements at MSP include the following:

- Changes in forecast activity
- Adjustments in the spare gate percentage
- Increased future gate utilization among the carriers
- Changes from preferential use to common-use gate lease arrangements
- Use of hardstands
- Shuttling of international arrival passengers from domestic gates to Customs and Border Protection facilities. (This would not reduce the total number of gates but would reduce the number of international gates.)

CHAPTER 3: FACILITY REQUIREMENTS

CHAPTER 3: FACILITY REQUIREMENTS

3.1 INTRODUCTION

Facility requirements identify the scale and type of improvements the various airport facilities will need to safely and comfortably accommodate forecast growth in passengers and operations in future years. Facility requirements are developed through a 3-step process.

1. Facilities are inventoried to determine their existing condition and capacity.
2. Forecasts of aviation activity are prepared to determine future passenger and operations levels expected at the airport.
3. Requirements are determined for those facilities with inadequate capacity to accommodate future levels of passengers and operations.

Facility requirements are intended to be objective and to identify how much additional capacity should be provided. Facility requirements do not, however, evaluate how or where additional capacity should be provided. The details of how future requirements are met are addressed during the development of concepts.

For the purposes of the Minneapolis-St. Paul International Airport (MSP) Long Term Comprehensive Plan Update (LTCP), the airport's existing facilities were broadly described in Chapter 1. The facility requirements analysis presented in this chapter includes a more detailed evaluation of the conditions of the existing facilities including their current capacity.

The forecast of aviation activity presented in Chapter 2 estimates future operations and passenger levels. The airfield facilities will be impacted by the total number of operations at MSP while the terminal and landside facilities will be impacted by the number of passengers. Most airport support facilities can be evaluated based on the total number of operations.

Fifteen key focus areas were identified for the LTCP Update to evaluate. Each of these focus issues recognized existing facilities that are operating inefficiently today or are expected to operate efficiently with moderate increases in passenger numbers. The 15 focus areas are:

1. Balancing passenger demand between the two terminals
2. Reallocation of airlines between the two terminals
3. Arrival curbside capacity (Lindbergh Terminal)
4. Public parking (Both Terminals)
5. Way-finding / Signage for the airport roadways
6. Baggage claim facilities (Lindbergh Terminal)
7. Security Screening Check Points (Lindbergh Terminal)
8. International arrivals (Customs and Border Protection) facilities (Lindbergh Terminal)
9. Regional carrier aircraft gates (Lindbergh Terminal)
10. Refurbishing Concourses E and F (Lindbergh Terminal)
11. Rental car facilities (Both Terminals)
12. Airfield capacity and taxiways
13. The United States Post Office facility (Lindbergh Terminal)
14. Potential development of an airport hotel
15. Air Traffic Control Tower (ATCT) improvements

Though the LTCP will focus on these facility issues, an evaluation of all facilities has been included in the study to identify any other potential facility issues.

3.1.1 GATE ALLOCATION AND THE TWO-TERMINAL SYSTEM

As described in Chapter 1, MSP has two terminals: the Lindbergh Terminal and the Humphrey Terminal. Today, the Lindbergh Terminal is substantially larger than the Humphrey Terminal and accommodates the majority of passenger activity at MSP. However, even today, the terminal landside facilities, notably the arrivals curb and parking facilities are congested at the Lindbergh Terminal. Future expansion of terminal facilities is probably more feasible at the Humphrey Terminal where there is more available land and the supporting landside facilities have available capacity to serve more passengers. This theme – the expansion of the Humphrey Terminal – is a central element of the LTCP Update and is critical to the evaluation of facility requirements within the LTCP Update.

Each airline that serves MSP utilizes one or more gates on a consistent basis. Passengers can expect to find Delta Air Lines operating from the Lindbergh Terminal and Sun Country Airlines operating from the Humphrey Terminal. However, as passenger boardings increase at MSP, both terminals will require improvements and expansion. Further, Delta Air Lines operates a major hub at MSP. This is an important fact because approximately 60% of Delta Air Lines' passengers at MSP do not begin or end their trips at MSP, they simply fly through on their way between two other airports. These connecting passengers do not rely on MSP's bag claim facilities, ticketing facilities, roadways, or parking. However, most passengers on other airlines are beginning and ending their trips at MSP and do rely on the ticketing, bag-claim, roadways and parking facilities.

Today, in addition to Delta Air Lines, the Lindbergh Terminal accommodates eight other airlines: American Airlines, United Airlines, US Airways, Alaska Airlines, Midwest Airlines, Continental Airlines, Air Canada, and Frontier Airlines. The forecast of aviation activity identifies that the 117 gates at the Lindbergh Terminal will not be able to accommodate the forecast growth of these carriers at MSP beyond 2015. More critically, the landside facilities at the Lindbergh Terminal, including the curbs and parking areas, are unable to accommodate the arriving and departing passengers. The Humphrey Terminal, however, has expansion capability sufficient to expand passenger processing and landside facilities to accommodate passenger growth and additional boarding gates.

The existing capacities and constraints of the terminal and landside facilities will be discussed in greater detail within this chapter. However, it is essential to note that for the purposes of the LTCP Update facility requirements analysis, it was assumed that by 2015 all non-SkyTeam airlines (all airlines except Delta Air Lines and its alliance partners) will relocate to an expanded Humphrey Terminal.

Reallocating airline passengers between the two terminals by 2015 will relieve some capacity constraints at the Lindbergh Terminal. However, improvements and expansion of the Humphrey Terminal will be required to accommodate these airlines. The details of required improvements are presented in this chapter of the LTCP Update report.

After the initial reallocation of airlines between the two terminals, ongoing expansions and improvements will be required at both facilities throughout the 20-year LTCP Update planning period.

The aviation activity forecast presented in Chapter 2 includes a forecast of required aircraft gates. Delta and its SkyTeam partners are forecasted to require 119 gates by 2030 while all non-SkyTeam airlines combined are forecasted to require 36 gates by 2030. In addition to the increased number of gates, the types of aircraft that each gate can accommodate will also change as the fleet of aircraft evolves with more modern planes. This will impact the size and layout of each required gate.

The reallocation of airlines between the two terminals will impact terminal and landside facility requirements. This reallocation was an assumption utilized in developing all facility requirements for the terminal and landside facilities at MSP as part of the LTCP Update.

The reallocation of airlines between the Lindbergh Terminal and Humphrey Terminal accomplishes three key goals:

1. Each terminal will accommodate originating (i.e., passengers beginning or ending their trips at MSP) passenger volumes commensurate with its capacity.

2. Passengers will be able to find their way to the appropriate terminal relatively easily because the Lindbergh Terminal would exclusively serve Delta and its SkyTeam partners while the Humphrey Terminal would serve all other airlines. This would organize all MSP airlines into two distinct and easily identified groups.

3. Expansion of the Humphrey Terminal is more easily accomplished in the near term and will allow the airport to continue a program of carefully phased improvements to both terminal facilities.

The facility requirements for the LTCP Update required that the reallocation of airlines between the two terminals be considered and evaluated early in the process. Therefore, each of the terminal and landside facility requirements discussions addresses the impacts the airline reallocation will have on the respective facilities at each terminal.

3.2 AIRFIELD CAPACITY ANALYSES

3.2.1 AIRFIELD CAPACITY AND DELAY

For the purposes of the LTCP Update, annual airfield capacity was evaluated to determine whether the runway system at MSP could likely accommodate the forecast annual number of takeoffs and landings.

There have been three capacity analyses completed for MSP in recent years that were reviewed to establish an approximate annual airfield capacity:

- The Dual-Track Airport Planning process completed in the mid 1990s
- The Draft Environmental Assessment for the 2015 terminal expansion
- The SIMMOD computer analysis of the proposed cross-field taxiway

As presented in Chapter 2, MSP is projected to have approximately 630,000 annual operations (takeoffs and landings) by 2030. Based on a review of the previous airfield capacity studies for MSP, at 630,000 annual operations MSP is expected to experience average annual delay of approximately ten minutes per operation. Some flights would experience no delays while others, during poor weather in most cases, would experience longer delays. This level of average annual delay compares to other busy hub airports in the United States and is considered acceptable for airports of this size and number of operations.

The topic of capacity and delay is multi-faceted and can, at times, be heavily impacted by the interaction of other airports within the National Airspace System (NAS) The FAA conducts systematic evaluations of the major airports within the NAS and attempts to identify how impacts at one facility affects other facilities. To better understand MSP facilities and infrastructure, the MAC will initiate a capacity study two years in advance of when MSP is expected to reach 540,000 annual operations and incorporate the results of this study into the following LTCP Update.

3.3 AIRSIDE REQUIREMENTS

3.3.1 RUNWAYS

The LTCP Update does not recommend the development of any additional runways at MSP. The existing runways are expected to accommodate the forecast growth at MSP through 2030, the duration of the planning period.

3.3.2 TAXIWAYS AND CIRCULATION

The taxiway system allows aircraft to move between the runways and other airport facilities (e.g., terminals) in an efficient and safe manner. As the airfield becomes increasingly congested, improvements may be required to help reduce taxi time and delays. The existing MSP taxiway system works efficiently and does not require any immediate significant improvements. However, as the number of operations grows, improvements to the taxiway system will need to be evaluated.

A pair of crossover taxiways located east of the Lindbergh Terminal complex that would connect the approach ends of runways 30L and 30R were recommended in the previous master plan, which was prepared for the airport as part of the Dual-Track Airport Planning process conducted in the 1990s. A crossover taxiway in the same location was also considered in the 2020 Vision Plan proposed by Northwest Airlines in 2004.

The LTCP Update recommends further study of the crossover taxiways at this location and will make a preliminary recommendation that they be accommodated in all facility planning at MSP.

The taxiways will be planned to airplane design Group IV (wingspan less than 171 feet) criteria. Air Traffic Control Tower (ATCT) line-of-sight, though restricted, is not considered to be a constraint to implementing the crossover taxiways. It is assumed that ASDE-X (enhanced ground control RADAR), local area control by the airport, or other means will be used to compensate for limited line of sight from the existing ATCT.

An extension of Taxiway C on the south side of the airport is recommended to alleviate localized congestion in and out of the Humphrey remote apron.

3.4 GATE REQUIREMENTS

The forecast of aviation activity, presented in Chapter 2, includes a forecast of required gates for all airlines for the forecast period through 2030. MSP is characterized by an exclusive use agreement whereby most airlines lease gates for their exclusive use and do not share their facilities with other airlines. Calculating the number of required airline gates in future years requires consideration of several factors including:

- How frequently a given airline uses its gates
- What size aircraft a given airline flies (larger aircraft require larger gates)
- Access to international passenger processing facilities

MSP airlines were split into three broad categories for calculation of future gate requirements:

- Delta Air Lines and its SkyTeam alliance partners
- Southwest Airlines
- All other passenger airlines

Delta Air Lines and its SkyTeam alliance partners were segregated because of the large hub operation Delta has at MSP. The characteristics of a hub airline differ from those of other airlines operating at MSP. Southwest Airlines was segregated because the airline has a history of significantly higher gate utilization than other airlines. For example, Delta Air Lines and its SkyTeam partners are assumed to operate, on average, 4.7 flights per day from each of their gates. However, Southwest is assumed to operate, on average, 8.5 flights per day from each of its gates. Finally, all other airlines were grouped after SkyTeam and Southwest were segregated.

Though the requirements call for 155 total gates, additional analysis has been provided to identify the characteristics of the gates. First, as presented in the introduction to this chapter, Delta and its SkyTeam partners are assumed to operate out of the Lindbergh Terminal by 2030 while all other airlines are assumed to operate out of the Humphrey Terminal, possibly as soon as 2015.

Lindbergh Terminal – Delta Air Lines/SkyTeam Airlines Requirements

- 119 total gates are required in 2030
- 13 gates must accommodate wide-body aircraft
- 63 gates must accommodate medium and large regional aircraft
- 20 gates must have access to international arrivals facilities

Though there are a total of 117 gates at the Lindbergh Terminal today, the 2030 requirements are far more demanding because, on average, aircraft in 2030 are anticipated to have larger wingspans and thus each gate position would be larger. Therefore, building two additional gates at the Lindbergh Terminal would not meet the 2030 gate requirements. Further, today only 10 gates provide access to international arrivals facilities. By 2030, 20 gate positions would require access to international arrivals facilities.

Humphrey Terminal – All non-SkyTeam Airlines Requirements

- 36 total gates are required in 2030
- 2 gates must accommodate wide-body aircraft
- 30 gates must accommodate narrow-body jet aircraft
- 5 gates must have access to international arrivals facilities

The 36 gates required at the Humphrey Terminal in 2030 will serve predominantly narrow-body aircraft operated by airlines with hubs elsewhere. Most air service to MSP on these airlines is anticipated to be operated by common narrow-body aircraft such as the Boeing 737 or Airbus A320. However, some international service is expected to be accommodated at the Humphrey Terminal and some airlines may like to operate smaller regional jets to MSP for some domestic service.

Though the timing of relocating all non-SkyTeam airlines to the Humphrey Terminal from the Lindbergh Terminal is predicated upon the increasing congestion at the curb and in the parking facilities at the Lindbergh Terminal, the need for additional gates is an essential component. In 2015, when the relocation is recommended to occur, the Humphrey Terminal would require an additional 17 gates to accommodate the associated demand of all non-SkyTeam airlines. In spite of the fact that this relocation would free all 15 gates on Concourse F in the Lindbergh Terminal, growing passenger numbers combined with the evolving fleet of aircraft at Delta Air Lines and its SkyTeam partners would require the Concourse F gates by 2020. This means that between 2015 and 2020 there is a window of approximately five years during which the Lindbergh Terminal may have excess gate capacity and some terminal improvements may be more easily phased due to the ability to relocate operations among gates.

3.5 TERMINAL REQUIREMENTS

3.5.1 OVERVIEW

The functional performance of the terminal facilities is measured by their ability to accommodate passengers during busy periods. Though it is possible to evaluate a terminal based upon annual passenger numbers, a more accurate assessment of the facility can be achieved by evaluating how it operates during peak hours of activity. Flight schedules can vary dramatically throughout the day and the airport must continue to operate efficiently and safely, even during these busy periods.

The terminal facility program was developed by quantifying the peak hour passenger numbers and analyzing the capacity of various terminal components (e.g., ticketing) at a desired level of service. A pragmatic approach to developing facility requirements will describe the desired characteristics of the terminal components in terms of passenger processing rates and spatial requirements.

- Process rates quantify the performance capability of a facility measured in terms of a unit of demand in relation to time - for example, passengers or bags per minute.

- Space templates have been developed for these facilities to illustrate the preferred arrangement of equipment and operational clearances around them as typically representing the industry's “best practices”.

- Level of Service (LOS), as established by the International Air Transport Association, generally indicates the level of performance at which a facility operates under given demand levels (**Table 3.1**). It primarily uses passenger comfort (space) and convenience (time) as indicators of service quality.

Conforming to industry standard best practices for planning terminal facilities, LOS C is the preferred design day performance level as it typically represents good service quality at a reasonable cost. Level D is considered tolerable during peak periods.

TABLE 3.1: IATA SERVICE LEVELS

LOS A	Excellent level of service; condition of free flow; no delays; excellent level of comfort
LOS B	High level of service; condition of stable flow; very few delays; high level of comfort
LOS C	Good level of service; condition of stable flow; acceptable delays; good level of comfort
LOS D	Adequate level of service; condition of unstable flow; acceptable delays for short period of time; adequate level of comfort
LOS E	Inadequate level of service; condition of unstable flows; unacceptable delays; inadequate level of comfort
LOS F	Unacceptable level of service; condition of cross-flows, system breakdown and unacceptable delays; unacceptable level of comfort

Source: International Air Transport Association (IATA), Airport Development Manual.

Pragmatic requirements in themselves are not a facility program since they do not fully address other program considerations such as functional arrangement, site constraints, or quality of service goals. Instead, they provide the basis to assess needs and begin the reciprocal process of defining a comprehensive facility program.

The following terminal functional areas of the LTCP Update were developed using this process:
- Ticket Counter/Passenger Check-in Area
- Security Screening Checkpoint Area
- Baggage Claim Area
- US Customs and Border Protection Area

Please note that for the purposes of the terminal facility requirements, the Lindbergh Terminal is assumed to accommodate only Delta Air Lines and its SkyTeam Alliance partner airlines. The Humphrey Terminal is assumed to accommodate all other airlines serving MSP.

The planning level of arrivals for Lindbergh Terminal domestic passengers is forecast to be 3,958 in the peak hour by year 2030. The forecast peak hour departure by year 2030 at the Lindbergh Terminal is 3,909 passengers.

3.5.2 PASSENGER CHECK-IN AREA

Currently, there are four different check-in options for departing passengers:

1. Off-Site (Internet) Check-In
2. Self-Service Units - positions where passengers acquire boarding passes
3. Bag Drop Positions - locations where airline staff tag and accept bags after passengers complete their self-service check-in transactions
4. Full-Service (Agent) Counter Check-in – locations where an agent may assist the passengers to acquire boarding passes and accepts their check-in bags

Market penetration of each check-in method is based on various surveys conducted on passenger travel and behavior, such as whether the passenger is checking bags. It assumes that, in the future, an increasing proportion of passengers will use self-service units and Internet check-in. This reflects the growing preference of passengers — coincidentally encouraged by airline staffing practices — for moving away from traditional agent check-in towards self-serve check-in.

Based on the peak hour passenger forecast for 2030, the Lindbergh Terminal is projected to require 85 ticketing positions. The conceptual plans of the ticket counter positions are based on a modular width of 7'-0" plus a 2'-6" baggage scale unit. To provide space for circulation and queuing, the reconfigured plan depth of the ticketing area is approximately 55 ft., which is an additional depth of 10 feet within the existing terminal.

3.5.3 SECURITY SCREENING CHECKPOINT

While the Transportation Security Administration (TSA) has direct responsibility for determining the size and configuration of the passenger screening checkpoints, it is typical for the TSA to collaborate with airports on those aspects along with the checkpoint location.

The "Checkpoint Design Guide" (CDG) Revision 1 - Transportation Security Administration (TSA), February 11, 2009, has been used as the basis for planning. The Security Screening Checkpoint (SSCP) template module includes:

Minimum clearance ahead of the divestiture tables that would typically accommodate:

- Minimum depth for queuing
- Document check podiums
- Private screening
- Post document queues and internal circulation

Main Screening Area, including:

- Divestiture tables
- Metal detectors
- X-Ray equipment
- Secondary search/ examination

Compose Area, including:

- Compose benches
- Supervisor and Local Enforcement Official stations

The following operational criteria have been used to assess security checkpoint facility needs:

- Document Check Throughput Rates: 5 passengers per minute per agent
- Screening Lane Throughput: 180 passengers per hour per lane

The numbers of document checkers and screening lanes necessary to accommodate the peak hour demand has been determined using the following criteria: 95% of passengers require no more than 10 minutes to reach the screening divestiture tables.

The basis for determining the amount of space that should be allocated for passengers queuing for document check has been based on having sufficient capacity to contain the peak hour demand at the checkpoint under the following parameters and level of comfort:

- The number of passengers standing in queue should be calculated on the basis of containing a 20-minute build-up of total checkpoint throughput. This would allow capacity for any throughput changes at the checkpoint – e.g., a shift change of TSA personnel.
- Sufficient area to provide each passenger 10.8 square feet of space while in queue, which conforms to IATA LOS C recommendations for this function.

Based on the SSCP peak hour of 3,909 passengers, 22 security lanes are required at the Lindbergh Terminal in 2030. While each SSCP lane is planned at 1,200 square feet, (for a total of 26,400 square feet for all 22 lanes), the combined total area that is required for the SSCP and passenger queuing is 40,656 square feet. Due to the minimal depth and constraint of the existing terminal lobby, the passenger queuing area of the preferred SSCP conceptual plan is deficient by approximately 2,750 square feet. However, as a means of off-setting this queuing deficiency, two additional checkpoint lanes could potentially be accommodated bringing the total number of lanes to 24. The required TSA support space would be approximately 7,200 square feet, generally based on 75 square feet per agent position with each line supporting four agents. This area would be identified and planned as the LTCP Update is further developed.

It should be noted that the SSCP requirement of 22 lanes and associated queuing space is all for Lindbergh Terminal originations including both domestic and international. There are alternatives for redistributing international originations at the Lindbergh Terminal which would reduce the required facilities within the existing ticketing lobby area.

3.5.4 BAGGAGE CLAIM AREA

The inbound baggage system consists of in-feed conveyors and claim devices. Typically, bags from arriving flights are delivered via baggage carts to the terminal and manually unloaded onto a loading conveyor with a direct feed to a sloped-plate claim device. The baggage claim area in the Lindbergh Terminal currently has twelve sloped-plate claim devices with a total of 1,249 linear feet. Two of the devices are sloped-plated carousels configured as ovals with 145 and 204 linear feet of claim frontage, and the remaining 10 are configured as circles, each having a diameter of approximately 29 feet with 90 linear feet of claim frontage. Due to the size of the circular-shaped claim devices and the minimal circulation around the claim units, the passenger waiting area becomes overcrowded during peak periods resulting in a reduced level of service.

The 2030 peak hour baggage claim requirement of 1,312 linear feet of claim frontage for the Lindbergh Terminal was calculated based on the following:

Domestic Peak Hour Terminating Passengers	3,958 passengers
Assumed Passengers Claiming Bags: 65% of 3,958	2,573 passengers
Assumption: ½ of total passengers (i.e., 1,286) will spend 30 minutes in the claim area	
Requirement Metric: 10.2 square feet (sf) per passenger x 1,286 passengers	13,121 square feet
Minimum Waiting Depth of Passenger Circulation Area	10 feet
Claim Frontage Required: 13,121 sf/10 feet	1,312 linear feet

The 2030 peak hour baggage claim requirement of 27,274 square feet of claim area (excluding the claim devices) for the Lindbergh Terminal was calculated based on the International Air Transport Association (IATA) Level of Service (LOS) C which recommends 21.2 square feet per passenger.

- 1,286 passengers x 21.2 square feet per passenger = 27,274 square feet

An analysis based on the existing number of 956 peak hour passengers claiming bags (26,550 square feet / 956 passengers) yields 27.8 square feet per passenger. While the total area of 26,550 square feet is adequate under the existing peak hour passenger activity, it is the configuration of the area (inadequate frontage of the small circular claim devices that limits passenger access to retrieving their bags) that causes overcrowding circulation conditions, thereby reducing the level service.

3.5.5 US CUSTOMS AND BORDER PROTECTION FACILITIES

The existing international arrivals facility at the Lindbergh Terminal has limited throughput for processing passengers arriving from foreign countries. There are 10 gates, all located on Concourse G, which provide access to the international arrivals facility. However, not all can be used simultaneously.

Customs and Border Protection (CBP) Programming

The Lindbergh Terminal international arrivals facility requirements were developed based on the latest US Customs and Border Protection Airport Technical Design Standards for Passenger Processing Facilities, dated August 2006. Based on the CBP space program categories, the Lindbergh Terminal's forecast international gate operation falls under the Large Airport category, which is between 2,000 and 5,000 passengers per hour operation. There are four sub-categories within the Large Airport program, which are listed as 2,000 passengers per hour (PPH), 3,000 PPH, 4,000 PPH, and 5,000 PPH. Based on the 2030 forecast of 2,855 passengers, the CBP space program category of 3,000 PPH was used in developing facility requirements.

The following areas shown on **Table 3.2** are based on the CBP Design Guidelines to meet the Large Airport category projections:

TABLE 3.2: CBP DESIGN GUIDELINES FOR LARGE AIRPORTS

Description	Area (SF)
Secure Area	
Sterile Corridor System	73,565
Primary Processing and Support	44,485
International Baggage Claim Area	60,935
Secondary Processing and Support	14,028
CBP Officer/Staff Area	6,270
Restrooms	1,495
Subtotal	**200,778**
Non-secure Area	
Public	33,086
Restrooms	1,908
Concessions – Meeter/Greeter Area	3,013
Subtotal	**38,007**
Total	**238,785**

The optimum international arrivals facility primary processing and baggage claim requirements were calculated based on the following:

Primary Processing Requirement	30 Primary Booths (3000 Passenger Category; 2,855 actual peak hour forecast)
Baggage Claim Requirement	The year 2030 peak hour baggage claim requirement is 1,383 linear feet
International Peak Hour Terminating Passengers	2,855 Passengers
Passengers Claiming Bags (95% of total International Peak Hour Terminating Passengers)	2,712 Passengers
Assumption: ¾ of total passengers (i.e., 2,034) will spend 45 minutes in the claim area	
Area Requirement: 10.2 square feet per passenger x 2,034 passengers	20,747 square feet
Minimum Waiting Depth of Passenger Area	15 feet
20,747 square feet/15 feet	1,383 linear feet of Claim Device
Total Passenger Claim area required (excluding claim devices): 41,252 square feet /2,034	20.28 square feet per passenger for IATA LOS C

The 238,785 square feet listed above is the total required international arrivals facility area for the Lindbergh Terminal in 2030. The existing international arrivals facility has a total area of 79,300 square feet.

3.6 LANDSIDE REQUIREMENTS

3.6.1 OVERVIEW

This section documents the existing landside conditions and traffic volumes on Glumack Drive at MSP's Lindbergh Terminal. Based on the forecasts of passenger activity, this section also documents the facility requirements for the following landside functions: terminal curb roadways, public parking, rental car ready and return spaces, and commercial vehicle spaces.

3.6.2 ROADWAY ACCESS AND CURB REQUIREMENTS

Traffic Volumes on Glumack Drive

Average Daily Traffic (ADT) and peak hour volumes on Glumack Drive were calculated based on counts available for Glumack Drive from the *Ground Transportation Vehicle Classification Study* performed in 2004. The 2008 and 2030 volumes were calculated by factoring the 2004 volumes in proportion to the growth of originating passengers to 2008 and 2030. **Table 3.3** summarizes the peak hour and ADT volumes on Glumack Drive.

TABLE 3.3: TRAFFIC VOLUMES ON GLUMACK DRIVE

Type of Traffic Volumes	Glumack Drive Volumes Approaching the Lindbergh Terminal	
	Existing (2008)	Future (2030)
Peak Hour	5,900	8,000
Average Daily Traffic	82,000	112,000

Terminal Curb Roadways

At the Lindbergh Terminal there is a two-level curb roadway system, with multiple parallel curbs on both the ticketing (departures) and baggage claim (arrivals) levels. At the Humphrey Terminal, there is a single-level terminal curb roadway which serves in sequence drop-off for departures and pick-up of arrivals.

Lindbergh Terminal Departures Curb Roadway

The departures curb roadway is designated for drop-offs of all departing passengers. The inner departures curb is the primary curb for drop-offs. It is 815 feet long with four striped lanes of traffic. The outer departures curb is currently used as a "backup" curb for peak periods and for public transit. It is 40 feet wide with two full (12-foot wide) lanes and three 16-foot wide left lane curb pockets, totaling 630 feet of curbside. This configuration allows two through lanes of traffic with opposite-side unloading in the curb pockets.

The inner (terminal-side) departures curb roadway provides access to six doorways, which are signed according to the associated airline ticket counters. Patrons using the outer (garage-side) curbs must use vertical circulation to either cross over or under the roadways before entering the terminal. The outer curb is designated for certain classes of commercial ground transportation. Patrons are not permitted to cross roadways at grade on either level.

Lindbergh Terminal Arrivals Curb Roadway

The arrivals roadway is designated for pick-ups of all arriving passengers. It is 60 feet wide and has five striped lanes of traffic. This roadway is generally operated with at least two through lanes of traffic, while the remaining three are used either for loading, standing, or through traffic, depending on the airport's level of activity.

The outer arrivals curb roadway is designated for use only by commercial vehicles. The outer curb is segregated by a barrier that prevents pedestrians from crossing. The outer roadway is on the west side of the Lindbergh Terminal Ground Transportation Center (GTC). The curb on the west side of the GTC has approximately 45 pull-through spaces for taxicabs and hotel shuttle services. The climate-controlled GTC also has pull-through stalls located on the east side which serve special taxis, limousines, scheduled shuttles, and off-airport parking shuttles.

Humphrey Terminal Curb Roadway

The Humphrey Terminal curb is a 670-foot long, single-level roadway, half of which is utilized for passenger drop-off at ticketing/check-in, and half of which is used for passenger pick up at baggage claim. The curb roadway is four lanes wide. The left lane is signed to bring rental car return traffic to the rental car area located in the Purple Ramp located on the other side of the curb roadway from the terminal.

Analysis of Curb Roadways and Estimate of Future Requirements

The capacity of a curb roadway is a balance between its ability to move vehicles (through capacity) and its ability to load and unload passengers (service capacity). The through capacity and service capacity depend upon the number of lanes in the roadway and how those lanes are utilized: for loading/unloading, through movement, or a combination of the two. Service capacity is also a function of the effective curb length and the characteristics of the vehicles using the curb, e.g., how long they dwell (dwell time) and their length. There is a point at which increasing the length of a curb (to add service capacity) is pointless unless an additional lane is added (adding through capacity), as the length cannot be utilized if there are not enough lanes to bring the traffic to or take the traffic away from the new length of curb.

The measure of effectiveness of a curb is its volume/capacity (v/c) ratio. The v/c ratio reflects the level of congestion on the curb, and gives an indication of the unused or spare capacity of the curb roadways. A curb would be at capacity when the volume using the curb equals the equilibrium capacity of the curb, i.e., when v/c = 1. This would represent a highly congested condition. Congestion on a curb roadway increases disproportionately at v/c ratios above approximately 0.70, and curb conditions deteriorate very quickly under such circumstances. Thus, for planning purposes, the target v/c = 0.70 is desirable for the typical peak hour condition (the peak hour of the average day of the peak month). This implies that for the several hundred additional hours of the year when heavier curb traffic volume is present, conditions will be worse, but the investment in the curb roadway will not be so great as to overbuild its capacity.

Future requirements for curb length were calculated based on standard planning factors for the airport to achieve a v/c ratio of 0.70. These assumptions included average dwell times and average vehicle length. Additional assumptions were made regarding future number of lanes, which were set to balance against the curb length requirement. The 2030 forecast for passenger activity was used to generate a growth rate in landside activity, which was used to factor existing curb traffic volume counts. The number of vehicles by class on each of the curbs was obtained from the *Ground Transportation Vehicle Classification Study* performed in 2004 by URS Corporation. **Table 3.4** summarizes the estimates of curb requirements at both the Lindbergh and Humphrey Terminals for 2030.

TABLE 3.4: CURRENT CURB CONDITIONS AND FUTURE REQUIREMENTS

Curb Summary	Lindbergh Terminal		Humphrey Terminal	
	Existing Conditions and v/c	2030 Conditions at v/c=0.7	Existing Conditions and v/c	2030 Conditions at v/c=0.7
Departures Curb (feet)	4 lanes @ 815 feet (inner curb) v/c = 0.74	4 Lanes @ 1,600 feet (inner curb)	4 lanes @ 335 feet v/c = 0.33	4 lanes @ 760 feet or 5 lanes @ 460 feet
	3 Lanes @ 815 feet (outer curb) v/c = 0.13	3 Lanes @ 815 feet (outer curb)	No outer curb	No outer curb
Arrivals Curb (Feet)	5 lanes @ 815 feet v/c = 0.98	5 lanes @ 2,000 feet	4 lanes @ 335 feet v/c = 0.37	4 lanes @ 1,000 feet or 5 lanes @ 620 feet
Departures Curb Peak Hour Volumes	914 (inner curb)	1,114 (inner curb)	228	807
	75 (outer curb)	417 (outer curb includes some POV)	228	807
Arrivals Curb Peak Hour Volumes	922	1,576	184	766

3.6.3 PARKING REQUIREMENTS

On-Airport Public Parking Facilities

There are currently 14,400 public parking spaces provided at the Lindbergh Terminal, chiefly in the Green, Gold, Red, and Blue parking ramps. These include short-term, general, and valet spaces (which are located in the basement of the terminal) as per the data in **Table 3.5**.

There are currently 9,200 public parking spaces provided at the Humphrey Terminal, including short-term and general spaces as per the data in **Table 3.5.** The Orange ramp includes the newest parking product, MSP Value Parking, which is intended to attract patrons who otherwise might seek parking in the busier Lindbergh Terminal ramps. During busy periods, the public parking at the Lindbergh Terminal reaches capacity, and patrons are directed to the Humphrey Terminal parking ramps, from which they can ride the public Light Rail Transit (LRT) back to the Lindbergh Terminal to board their flight. However, even with this additional demand, the Humphrey Terminal's Purple and Orange ramps do not reach capacity. Approximately 2,500 parking spaces within the Purple and Orange ramps have been reserved for employee parking on a temporary basis.

The following methodology was used in estimating the 2030 parking requirements:

- The capacity for the public parking was defined as:
  - 85% of available spaces for short-term
  - 90% of available spaces for general parking

- o 100%of available spaces for valet parking

Note: By using these percentages, vehicles arriving in the peak periods can still find enough spaces available that they can fill efficiently without an endless search for the very last space.

- Existing demand for parking at the Lindbergh Terminal was calculated based on information obtained from Metropolitan Airports Commission (MAC) staff. The demand in 2009 was down from 2008, so 2008 data were used to define the busy "existing" condition.
- Absent better data, the existing general parking demand at the Humphrey Terminal was assumed to be 40% of existing general parking capacity; for short-term parking, the assumption was that demand was 50% of existing short-term capacity.
- With the peak demand defined, the ratio of required spaces to meet that demand was compared with the annual originating passenger volumes. The ratio was rounded off to 2,000 spaces per Million Annual Originating Passengers.
- The 2030 future requirements were calculated by multiplying this ratio by the forecast number of annual originations.
- The estimates also included consideration of the anticipated migration of some off-airport parking demand onto the airport. That methodology is described below.

Table 3.5 summarizes the findings of parking requirements at both the Lindbergh and Humphrey Terminals in 2030.

TABLE 3.5: FUTURE PARKING REQUIREMENTS

Parking Summary	**Lindbergh Terminal**				**Humphrey Terminal**			
	Existing Spaces (2009)	Capacity (2008)	Existing Demand	Future Reqts (2030)	Existing Spaces (2009)	Capacity (2008)	Existing Demand	Future Reqts (2030)
Short Term Parking Spaces	900	820	490	900	500	460	230	600
General Parking Spaces	13,110	10,100	12,000	21,200	8,700	8,140	3,300	13,000
Valet Parking Spaces	390	380	430	700	-	-	-	500
Future Off-Airport Parking	-	-	-	1,700	-	-	-	1,000
Total Parking Spaces	14,400	11,300	12,920	24,500	9,200	8,600	3,530	15,100

Private Parking Facilities

There are currently four off-airport parking providers near MSP. All four off-airport parking providers are located within six miles of the airport. The following methodology was used in estimating the future off-airport parking:

- In the existing conditions there are 5,200 off-airport parking spaces which are assumed to be 60% full during the Average Day Peak Month.
- In the future, the demand will grow proportionately with originations and the supply will decrease down to 3,200 spaces due to development pressures and restrictions by the City of Bloomington.
- Any surplus demand that the future off-airport parking supply cannot handle will translate into spaces required at the airport. But 25% of the surplus demand is assumed to divert to an alternative mode or behavior, e.g., passengers will get dropped off at the curb or use the LRT or taxi, etc.
- The remaining 75% of the surplus demand will be distributed between the Lindbergh and the Humphrey Terminals pro rata with originations.

Table 3.6 summarizes the findings of future off-airport parking to be accommodated at both the Lindbergh and Humphrey Terminals in 2030.

TABLE 3.6: OFF-AIRPORT PARKING

Parking Summary	**Spaces**
Total Existing (2008) Spaces	5,200
Existing (2008) Demand (60 % full and 90 % efficiency)	3,400
Future (2030) Demand	6,800
Future (2030) Supply at Off-Airport	3,200
Future (2030) Surplus Demand	3,600
Future (2030) Surplus Demand (Assuming 25 % will use Alternative Modes)	2,700
Future (2030) Surplus to be accommodated at Lindbergh Terminal	1,700
Future (2030) Surplus to be accommodated at Humphrey Terminal	1,000

3.6.4 RENTAL CAR REQUIREMENTS

Rental car operations exist at both the Lindbergh and Humphrey Terminals. Currently, there is a Quick-Turn Around (QTA) facility (where rental vehicles are washed and fueled before being re-rented) at the Lindbergh Terminal only. Existing rental car information on number of spaces and transaction counts was obtained from MAC staff. The following approach was used in determining the future requirement:

- Peak month for total number of transactions was determined to be August

- Based on number of transactions in peak month, average daily transactions were determined

- Peak daily transactions were then calculated as twice the number of average daily transactions

- The turnover ratio was calculated by dividing peak transactions by the total number of ready/return spaces. Turnover ratio is an index of how labor-intensive the facility is, with labor costs increasing with turnover ratio, and thereby decreasing profitability. Turnover ratios below 3.0 indicate an under-used facility; turnover ratios higher than 4.0 indicate a very busy facility, and ratios higher than 5.0 indicate an undersized facility.

- Finally, the calculated turnover ratio of 3.8 was used to determine the number of rental spaces required in the future. This turnover ratio is desirable for future Rental Auto Companies operations as current operations at MSP are in the efficient range.

- The size of future QTAs was estimated by determining the ratio of square feet of QTA in the Red/Blue ramps to the number of ready/return spaces it serves. This ratio was then applied to the number of spaces proposed at the Humphrey Terminal to estimate the future square feet which would be required to serve the rental cars at that terminal.

Table 3.7 summarizes the total number of space requirements in the future.

TABLE 3.7: RENTAL CAR REQUIREMENTS

RAC Summary	**Lindbergh Terminal**		**Humphrey Terminal**	
	Existing Spaces (2008)	**Future Requirements (2030)**	**Existing Spaces (2008)**	**Future Requirements (2030)**
Total Spaces	3,500	2,235	274	1,385
2030 Additional Requirements	-	-	-	819
2030 QTA Requirement	549 sf	350 sf	No QTA	215 sf

3.6.5 GROUND TRANSPORTATION CENTER REQUIREMENTS

The requirements for the Ground Transportation Center were calculated based on the number of commercial vehicles arriving during the peak hour. Commercial vehicles include taxis, limousines, and shuttles (hotel/parking/courtesy). A dwell time of 3.0 minutes was used for taxis and limos, and 5.0 minutes was assumed for shuttles. The total number of spaces required was calculated based on a desirable volume/capacity (v/c) ratio of 0.55. With a lower target v/c ratio for commercial vehicle stalls, the risk of a vehicle not finding an empty stall upon arrival is minimized.

Table 3.8 summarizes the space requirement for the Ground Transportation Center.

TABLE 3.8: GROUND TRANSPORTATION CENTER (GTC) REQUIREMENTS

GTC Requirements Summary	Lindbergh Terminal		Humphrey Terminal	
	Existing Spaces (2008)	**Future Requirements (2030)**	**Existing Spaces (2008)**	**Future Requirements (2030)**
Total Spaces	46	63	25	32

3.7 LIGHTING AND NAVIGATION REQUIREMENTS

The LTCP Update does not recommend the addition of any runways to the MSP airfield during the 20-year planning period. Commensurate with this recommendation, no substantial improvements to navigational aids and/or lighting of the existing runway approaches is recommended.

However, it is recommended that during the planning period, emerging technologies for navigational aids be monitored and evaluated to determine the potential benefit of implementation at MSP.

3.8 SECURITY REQUIREMENTS

The Metropolitan Airports Commission (MAC) has recently completed an upgrade to the entire airport perimeter security fence. Gate improvements have also recently been completed, with new technologies being studied in some locations. The MAC will continue to evaluate the perimeter security fence and upgrade as necessary. The Transportation Security Administration may also enforce changes from time to time that the MAC will coordinate and comply with as necessary.

Aside from the security checkpoint improvements discussed in Section 3.5.3, there are no specific security requirements that need to be met at this time.

3.9 UTILITY REQUIREMENTS

The MAC continues to coordinate airport projects with the primary utility companies. The proposed projects will impact existing utilities on the field. Any necessary re-locations are completed as a part of impacting projects. If the utility companies have specific upgrades that are required to their systems, the MAC will coordinate with them to have the work completed at the utility company’s cost.

3.10 OBSTRUCTION-RELATED REQUIREMENTS

Mitigation of obstructions to critical surfaces for navigation to MSP runways should be monitored and evaluated.

3.11 OTHER AIRPORT SERVICES REQUIREMENTS

The two existing Aircraft Rescue & Fire Fighting (ARFF) facilities are adequate to provide services for all proposed projects in the Long Term Comprehensive Plan Update.

The MAC maintains its own police force. The police department operates from a couple of scattered locations within the Lindbergh Terminal. Ultimately, the MAC may choose to consolidate the department in one new building location on the airfield. The department's existing areas within the terminal could then be remodeled, occupied and leased by tenants. The MAC will continue to review this option and weigh the justifications against estimated costs before making a final decision.

CHAPTER 4: ALTERNATIVES

CHAPTER 4: ALTERNATIVES

4.1 INTRODUCTION

Several alternatives were developed and evaluated based on their capability to meet the facility requirements as well as the goals for the MSP LTCP Update set forth by the Metropolitan Airport Commission. There are three components to the alternatives development and evaluation process:

1. Develop broad concepts for facility improvements
2. Evaluate and refine the concepts
3. Establish and select alternatives for development

Though it is typical for an airport master plan to provide a series of broad concepts for airport development, the nature of the LTCP Update was to focus on key facilities at MSP and develop concepts that would resolve existing and forecast facility deficiencies. The specific facilities with existing deficiencies and forecast deficiencies were identified through an assessment of known issues and the facility requirements evaluation presented in Chapter 3.

Facilities were evaluated and concepts were developed by a planning team of subject matter experts in the areas of airfield facilities, terminal facilities, ground transportation facilities, and airport support facilities. The planning team worked through these challenges in concert with one another so that each concept would, ideally, complement the others and a cohesive plan for MSP could be realized. Additionally, the elements of this LTCP Update will incorporate sustainable airport development practices whenever feasible. The MAC will use its Stewards of Tomorrow's Airport Resources program to focus on developing and exploring new and innovative opportunities that will allow the airport to meet the needs of the present without compromising the ability of future generations to meet their own needs. By focusing on sustainable solutions, MSP will be able to address long-term environmental, operational, financial and social needs.

Sustainable development practices will focus on a holistic approach that will ensure the integrity of the Economic viability, Operational efficiency, Natural Resource Conservation and Social responsibility (more commonly referred to as EONS) of the airport. The EONS approach attempts to balance the four functional parts of airport management by taking into consideration the economic, ecological and social components with respect to operational efficiency. The MAC will also consider the US Green Building Council's Leadership in Energy and Environmental Design (USGBC LEED®) program for guidance in the design and construction of new or rehabilitation of existing facilities. A description of each subject area is described below and a summary of the airport-wide plan is provided at the end of this chapter.

The LTCP Update for MSP is illustrated in **Figure 4-1 - MSP 2030 Conceptual Plan**. The plan includes:

- Airfield improvements
- Expansion and improvements of Lindbergh Terminal
- Expansion and improvements of Humphrey Terminal
- Roadway access improvements
- Expanded parking capacity
- An airport hotel
- Land use designations for cargo and airport support facilities

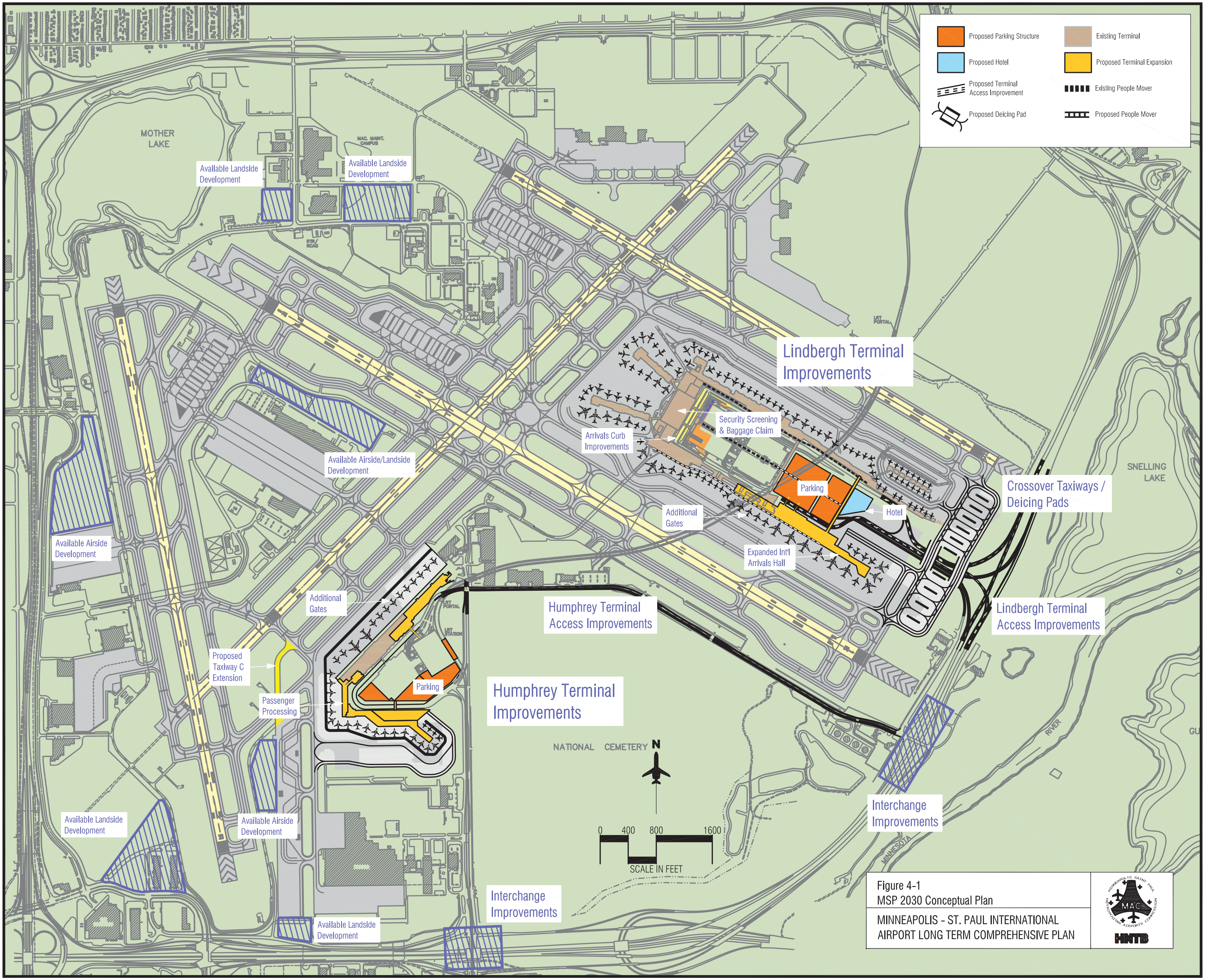

Figure 4-1
MSP 2030 Conceptual Plan

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4.2 AIRFIELD

Airfield facilities include the system of runways, taxiways, and aprons where aircraft land, take off, taxi, and park. Generally speaking, these are the portions of the airport where aircraft operate. In the context of long-term planning, airfield facilities must be assessed for their capabilities to efficiently accommodate forecast aircraft operations. An operation is either a takeoff or a landing. The aviation activity forecast prepared for the MSP LTCP anticipates growth from approximately 450,000 annual operations in 2008 to 630,000 annual operations in 2030. MSP currently has four runways. Runway 17-35 was opened in October 2005 and has helped to reduce delays at the airport, especially during poor weather conditions. As reported in Chapter 3, several analyses of MSP's airfield capacity (with all four runways in place) have been completed in recent years. At 630,000 annual operations, these studies anticipated average annual delay of approximately 10 minutes per operation.

Because the airfield can operate at this level of operations with a level of annual delay acceptable for a large hub airport, the LTCP Update did not evaluate alternatives for constructing additional runway capacity at MSP. The existing four-runway airfield is considered to have sufficient capacity to accommodate forecast levels of operations through the planning period.

However, the airfield also includes the taxiway system which allows aircraft to move between the runways and the terminal facilities, cargo facilities, maintenance facilities, and general aviation facilities. The taxiway system does not allow the airport to accommodate more landings or takeoffs but it does contribute to the overall efficiency of the airfield. An efficient taxiway system allows aircraft to circulate efficiently about the airfield and gives air traffic controllers the ability to route aircraft to and from runways in the most direct route.

As shown in **Figure 4-2 - Crossover Taxiway Concept**, MSP's terminal area is located between Runways 12R-30L and 12L-30R. Previous expansions of the Lindbergh Terminal have included the continued extensions of boarding concourses to the east including Concourses A, B, C, and G. Though aircraft parked at Concourses A and B are very close to the end of Runway 30R, they require a substantial taxi distance, and time, to reach the ends of other runways, including Runway 30L. In a similar fashion, the proposed expansion of Concourse G will require more taxi distance and time for aircraft to reach Runway 30R and will add to taxiway congestion.

Providing an additional taxiway connection at the east end of the airfield will help resolve this congestion and provide efficient access to Runways 30L and 30R for aircraft parked along Concourses A, B, C, and G.

Considerations in planning a crossover taxiway include maintaining existing end-of-runway deicing pads, avoiding impacts to the navigational aids for aircraft approaching Runways 30L and 30R, avoiding impacts to Concourses A and B, protecting for the potential extension of Concourse G, and bridging the airport's primary entrance road (Glumack Drive).

Three configurations for these crossover taxiways were evaluated. In all three, two taxiways were provided so that aircraft could taxi in both directions. The preferred alternative would reconfigure the deicing pads and relocate them between the proposed taxiways as shown in **Figure 4-2**. This was preferred because the deciding pads would be available to aircraft departing either Runway 30L or Runway 30R. The preferred alternative is located as far east as feasible without impacting the approach zones for Runways 30L and 30R. However, a portion

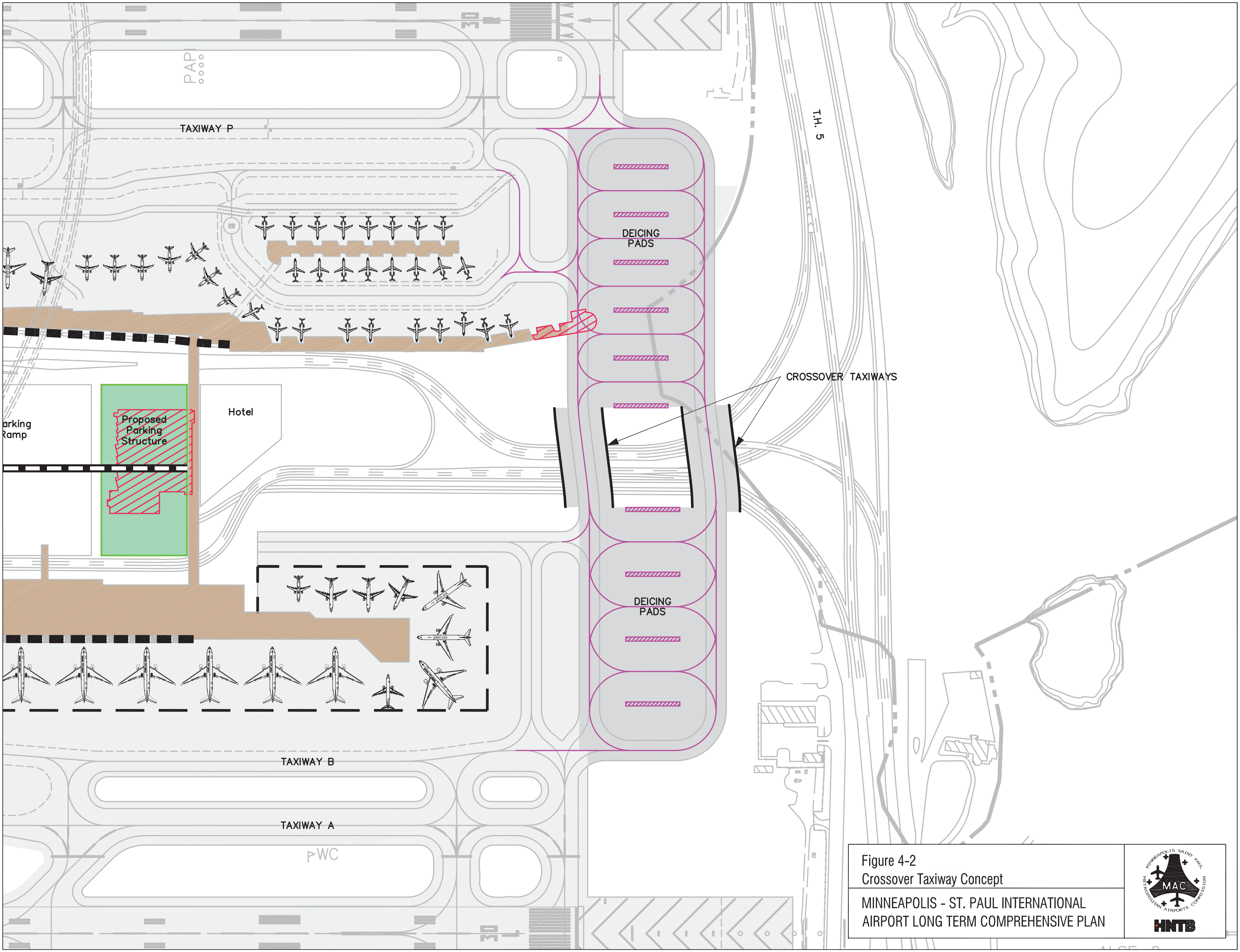

Figure 4-2
Crossover Taxiway Concept

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of Concourse A would be impacted and approximately three commuter gates would require relocation to another portion of the terminal area. The proposed crossover taxiways would bridge Glumack Drive, which is discussed in detail in Section 4.4, Ground Transportation Alternatives.

An extension of Taxiway C on the south side of the airport is recommended to alleviate localized congestion in and out of the Humphrey remote apron. No other significant improvements to the airfield were evaluated as part of this update to the MSP LTCP.

4.3 TERMINAL

As presented in Chapter 1, MSP has two airline terminals, the Lindbergh Terminal and the Humphrey Terminal. Delta Air Lines hub operations are accommodated at the Lindbergh Terminal while MSP's other airlines are accommodated at both the Lindbergh Terminal and the Humphrey Terminal. In evaluating alternatives for terminal development at MSP, there were two primary issues to resolve:

1. Forecast growth and an assessment of gate requirements indicate that the Lindbergh Terminal would be unable to accommodate the growth of its current mix of airlines through the 20-year planning period, even with an extension of Concourse G.

2. The Lindbergh Terminal is characterized by a series of acute facility deficiencies including its international arrivals (Customs and Border Protection – CBP) facility, ticketing lobby, security screening facilities, and bag-claim facilities. These deficiencies were noted in Chapter 1 and in Chapter 3.

The facility requirements analysis presented in Chapter 3 identified a requirement for an additional 28 gates at MSP by 2030. The forecast of gate requirements by airline also indicates that Delta Air Lines and its SkyTeam alliance partners would require a total of 119 gates while all other airlines at MSP would require a total of 36 gates by 2030. Providing sufficient gates, ticketing, bag-claim, and ground transportation facilities at the Lindbergh Terminal for the existing mix of airlines is not feasible. Thus, a key task for the LTCP Update was to evaluate the potential to relocate some airlines from the Lindbergh Terminal to the Humphrey Terminal where expansion could be more readily accommodated. It was determined that relocating all airlines other than Delta and its SkyTeam partners to the Humphrey Terminal would better balance the mix of passengers beginning and ending their trips at MSP between the two facilities and would allow all airlines, including Delta and its SkyTeam partners, room to expand their facilities.

4.3.1 LINDBERGH TERMINAL

The Lindbergh Terminal requires both expansion and resolution of several facility deficiencies noted above. Each of the Lindbergh Terminal's existing passenger concourses is currently adjacent to a taxiway, except the east end of Concourse G. Concourse G currently provides the only available location for expansion without significantly impacting the airfield. This is due to Delta Air Lines' vacation of one of its maintenance hangars and the hangar's subsequent demolition by the MAC, which was located to the east of the Lindbergh Terminal. The extension of Concourse G would provide several new gates that would meet the gate requirements for the Lindbergh Terminal including access to international arrivals facilities.

The proposed improvements to the Lindbergh Terminal will result in a net increase of three gates bringing the total to 120 gates. This accounts for a loss of two Concourse A gates, reconstruction of nine Concourse G gates and will allow all of Delta's 2030 fleet to be accommodated simultaneously at peak periods. The Lindbergh Terminal will also accommodate 20 international parking positions. These are substantial improvements over today's Lindbergh Terminal gate layout, which is incapable of supporting the forecast future aircraft fleet and operations. The proposed expansion of the Lindbergh Terminal is illustrated in **Figure 4-3 – Lindbergh Terminal Concept Phase I (2015-2020), Figure 4-4, Lindbergh Terminal Concept Phase II (2020-2025)** and **Figure 4-5, Lindbergh Terminal Concept Phase II (2025-2030).**

The Lindbergh Terminal's ticketing, bag-claim, security screening, and international arrivals facilities are also in need of improvements to improve efficiency and capacity.

Ticketing

The Lindbergh Terminal ticketing lobby will be reconfigured to provide additional passenger circulation and queuing space. Currently, Delta Air Lines and its SkyTeam partners occupy approximately half of the ticketing lobby. It is anticipated that the relocation of non-Delta/SkyTeam airlines to the Humphrey Terminal could alleviate some crowding in the ticket lobby as will the continued deployment of new technologies that allow passengers to print their own boarding passes and bypass the ticketing facilities entirely. Facilities for checking bags will still be required, however, for those passengers who do not carry their luggage on-board.

Baggage Claim

The Lindbergh Terminal baggage claim facility is outdated and undersized, as discussed in Chapter 3. A reconfiguration of the baggage claim facility where the outdated round claim devices are replaced with larger carousels would help alleviate much of the congestion and lack of circulation. The proposed conceptual plan of the baggage claim area includes seven sloped-plate oval devices that will range in size from 145 to 260 linear feet, and will replace the circular-shaped smaller claim devices to provide improved passenger circulation and claim frontage within the area. The relocation of non-Delta/SkyTeam airlines to the Humphrey Terminal would also alleviate congestion within the Lindbergh Terminal bag-claim area.

Security Screening

There are currently six security screening checkpoints adjacent to the Lindbergh Terminal ticketing hall providing access to the secure area and passenger boarding areas. As described in Chapter 3, these areas lack sufficient queuing area and operate somewhat inefficiently. Two concepts were provided for consolidating the security screening facilities in the Lindbergh Terminal. In each concept, the security screening facilities would be consolidated to a large central node and a queuing area would accommodate forecast passenger demand. The final configuration of the security screening facilities would be determined during an advanced planning and design phase for Lindbergh Terminal improvements.

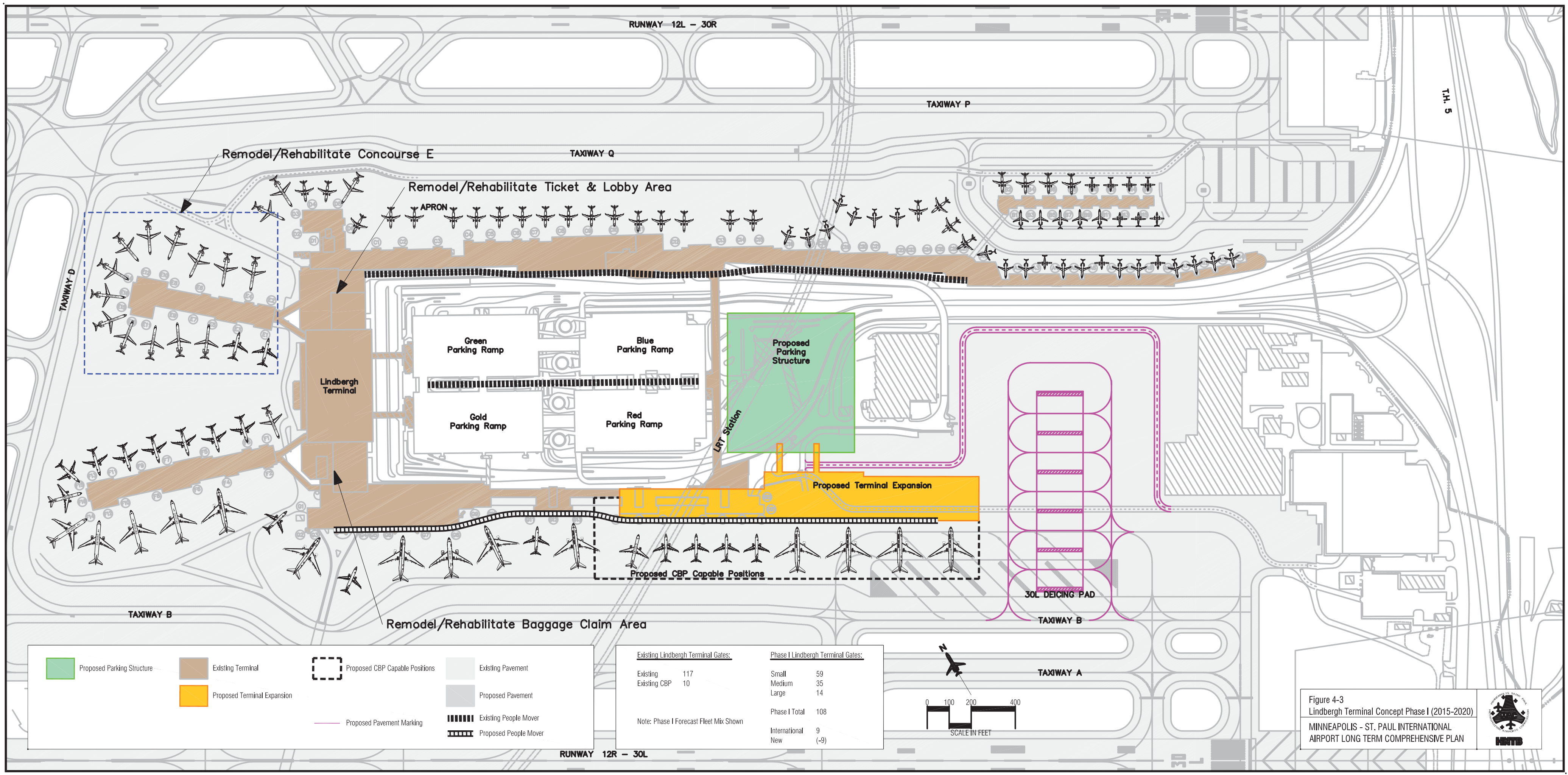

Figure 4-3
Lindbergh Terminal Concept Phase I (2015-2020)
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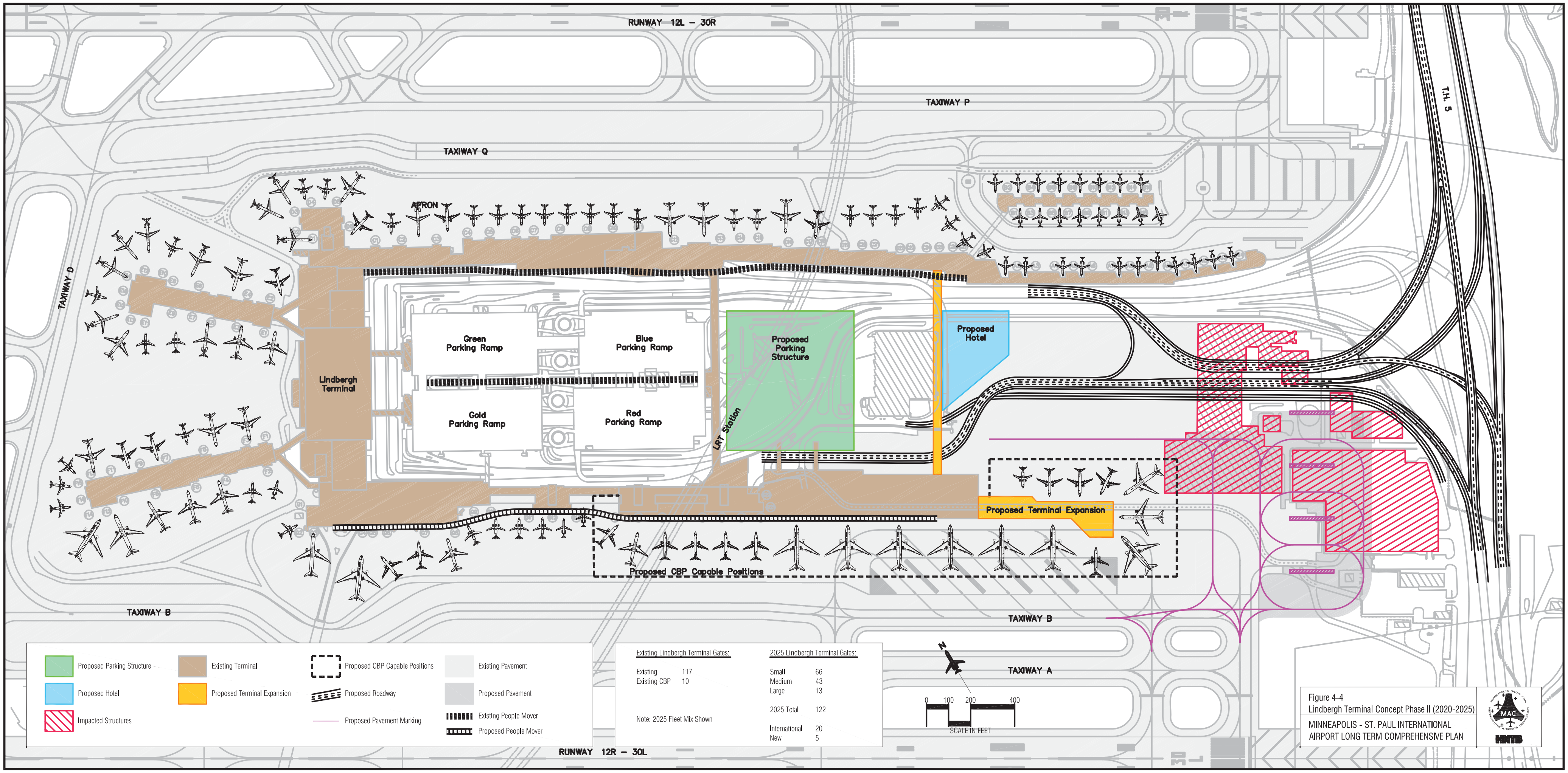

Figure 4-4
Lindbergh Terminal Concept Phase II (2020-2025)
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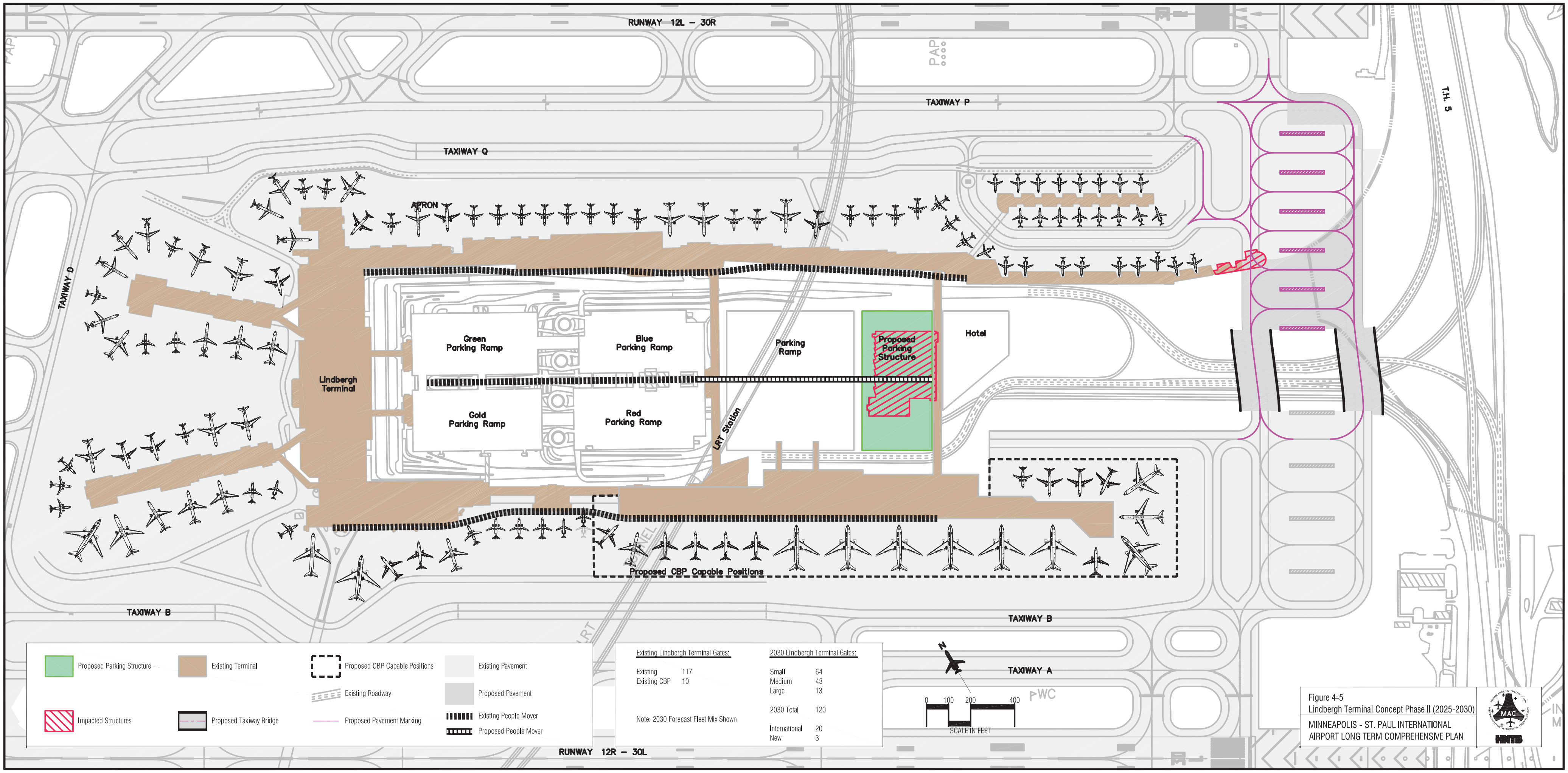

Figure 4-5
Lindbergh Terminal Concept Phase II (2025-2030)
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International Arrivals (Customs and Border Protection)

Delta Air Lines currently operates international flights to Europe, Asia, Mexico (on a seasonal basis), and Canada from MSP. The airport's existing international arrivals facility is undersized for forecast demand levels and would be unable to efficiently process forecast international passenger arrivals. Three concepts were evaluated for improving the international arrivals facility at MSP and are outlined below.

Concept 1: Vertical Expansion of Federal Inspection Services

Concept 1 would expand the existing international arrivals facilities by providing a second level for immigration processing so that the baggage claim area and customs area could be expanded into the area currently occupied by immigration. These two functions would then operate on separate levels requiring passengers to move vertically, as well as horizontally through the facility. Additional gates would need to be connected to the international arrivals facility via secure corridors. These corridors would likely be provided by extending them along the curtain wall of the concourse façade, similar to how the secure corridor is currently configured along Concourse G.

Concept 2: Reconstruct Concourse F

Concept 2 would require the closure and demolition of existing Concourse F. It would be reconstructed as a facility that could accommodate both domestic and international arrivals and departures. A new immigration and customs processing facility would be integrated into Concourse F.

Concept 3: Construct a New International Arrivals (Customs and Border Protection) Facility at Concourse G

Concept 3 would extend Concourse G and provide new gates that could accommodate both domestic and international arrivals as well as provide a new passenger processor with ticketing, bag-claim, immigration, and security screening for both domestic and international passengers.

The recommended alternative is Concept 3. Concept 3 is illustrated in four figures:

- **Figure 4-6 – New Int'l Terminal – Departures Level**
- **Figure 4-7 – New Int'l Terminal – Mezzanine Level**
- **Figure 4-8 – New Int'l Terminal – Ground Level**
- **Figure 4-9 – New Int'l Terminal – Sections**

Concept 3 provides the required additional gates and gate frontage required for larger aircraft anticipated in the future as well as an entirely new international arrivals facility. The new gates would be multi-use gates in that each could accommodate either domestic or international flights without any impact to adjacent gates. This is an improvement over the current facility which can require the closure of several adjacent gates in order to utilize the sterile corridors when an international flight arrives. The primary advantage of Concept 3 is the addition of a new passenger processing facility. The existing Lindbergh Terminal passenger processor cannot be expanded. Its ticketing lobby and baggage claim areas can be reconfigured but the overall size is constrained by its location between Concourses F and G. In Concept 3, international passengers and, potentially, some domestic passengers could utilize the supplemental passenger processing facility that would replicate the convenience of a stand-alone international terminal while still fully integrated into the Lindbergh Terminal complex.

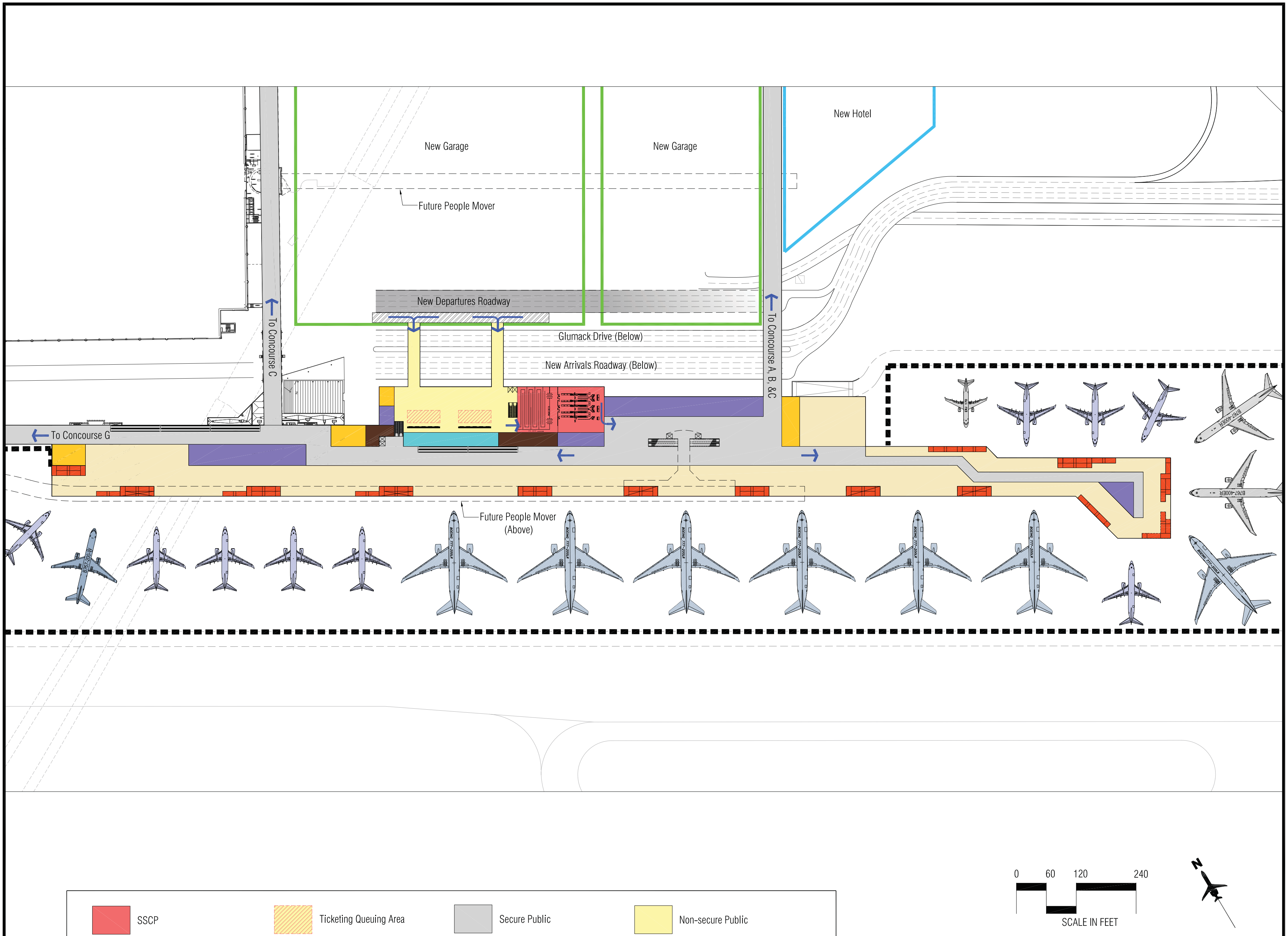

Figure 4-6
New Int'l Terminal - Departures Level

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AIRPORT LONG TERM COMPREHENSIVE PLAN

HNTB

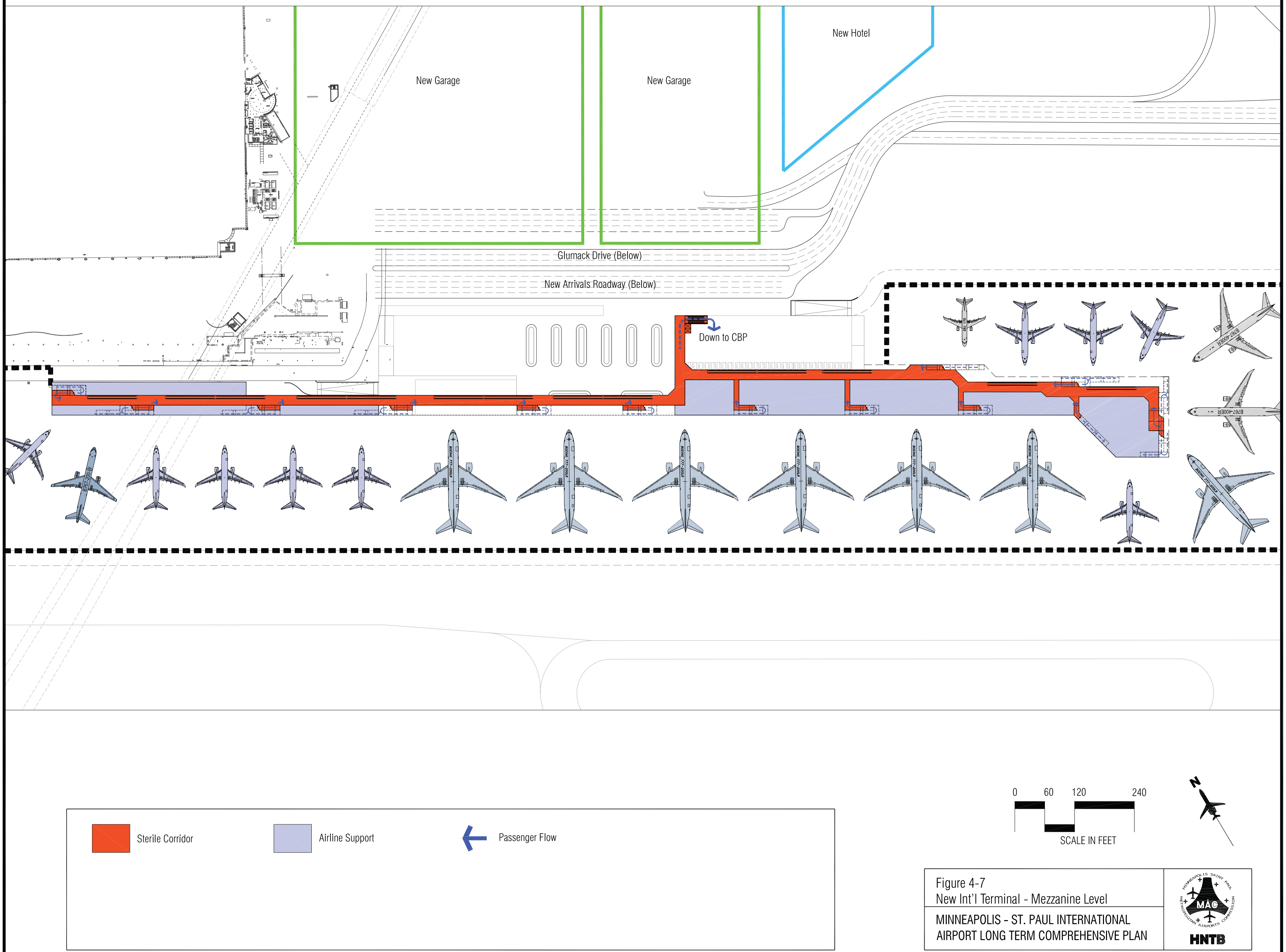

Figure 4-7
New Int'l Terminal - Mezzanine Level

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AIRPORT LONG TERM COMPREHENSIVE PLAN

HNTB

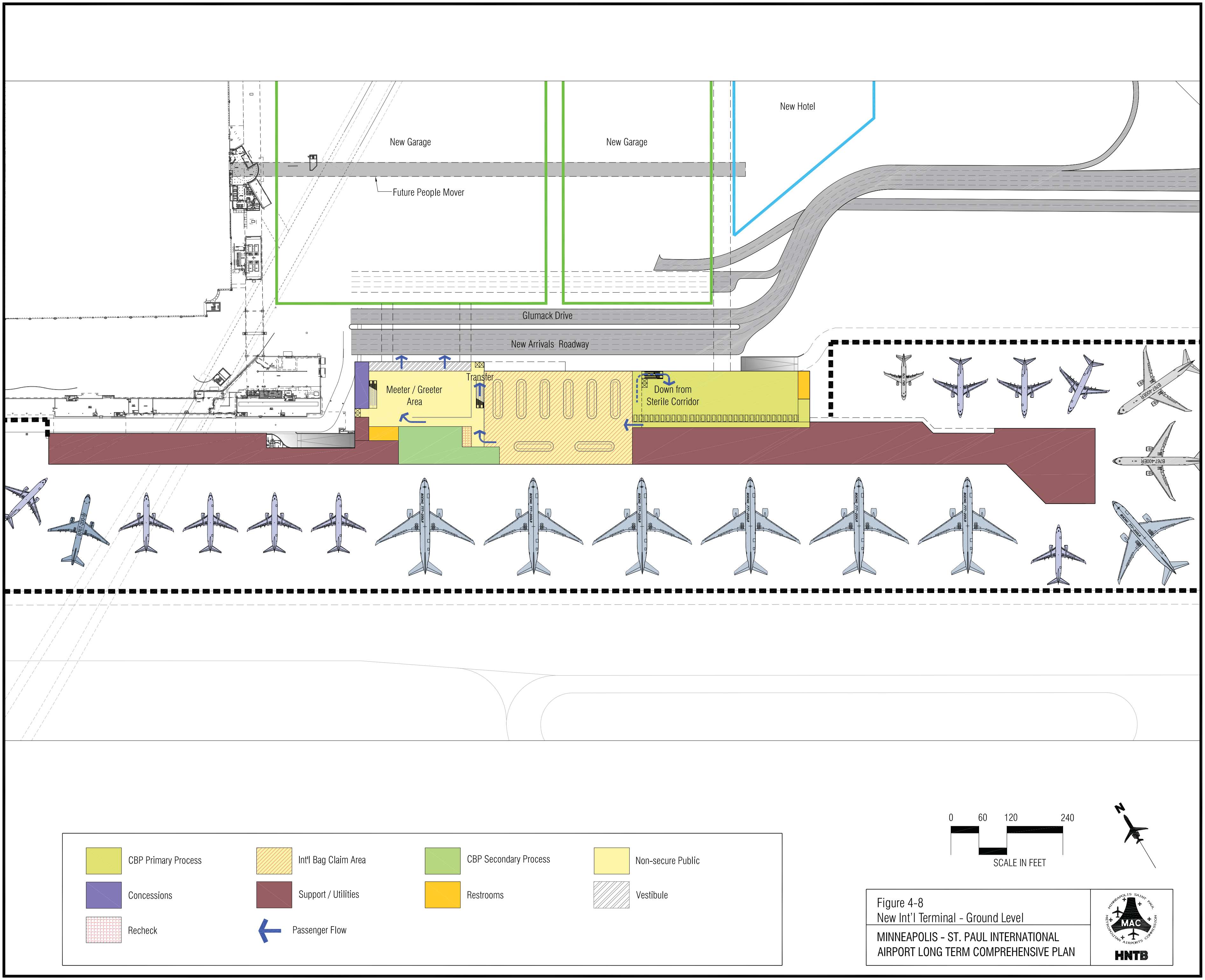

Figure 4-8
New Int'l Terminal - Ground Level

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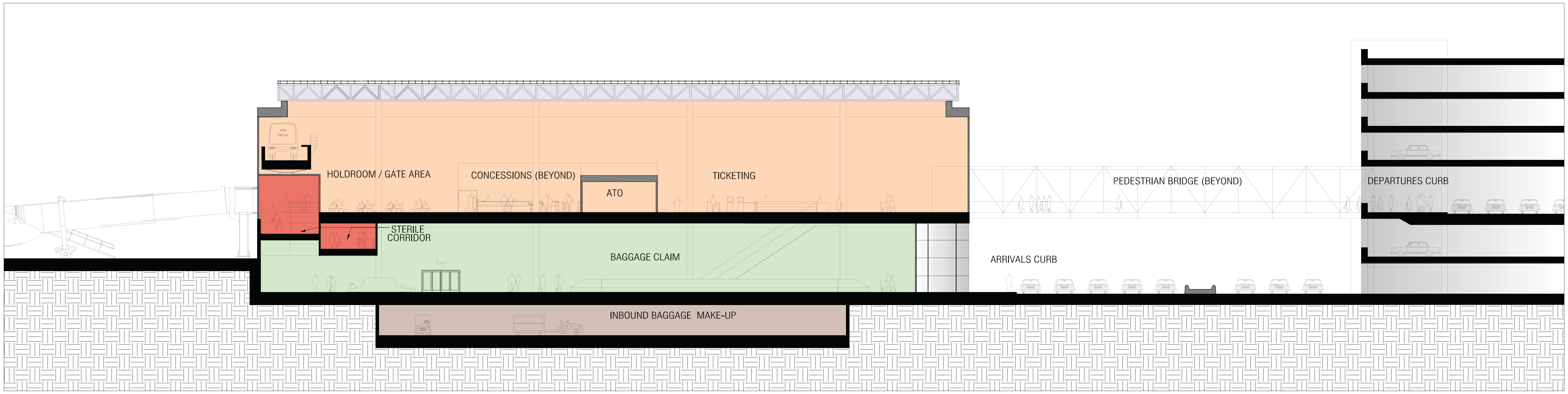
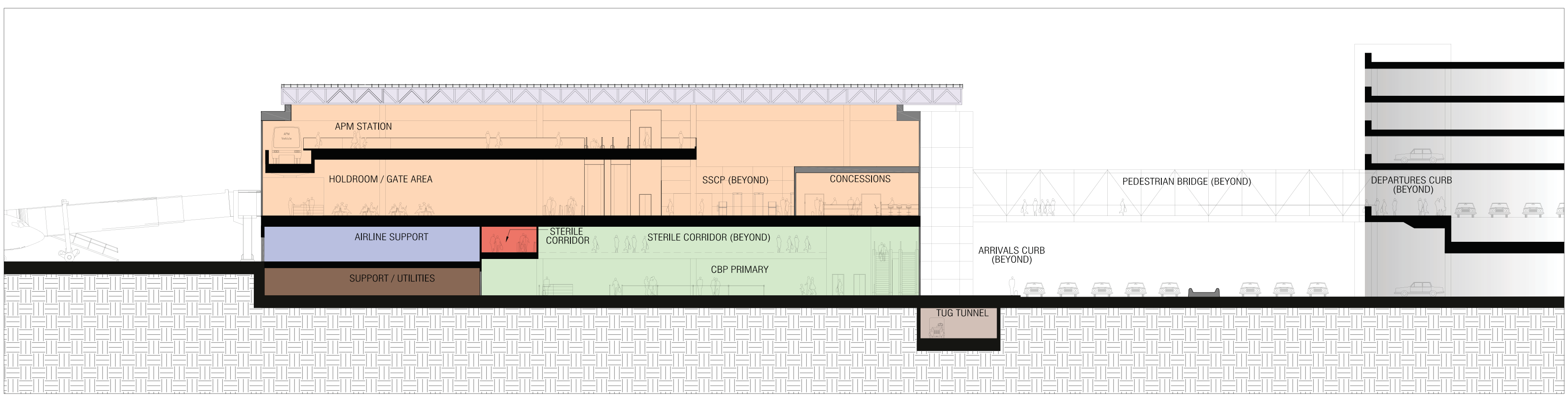
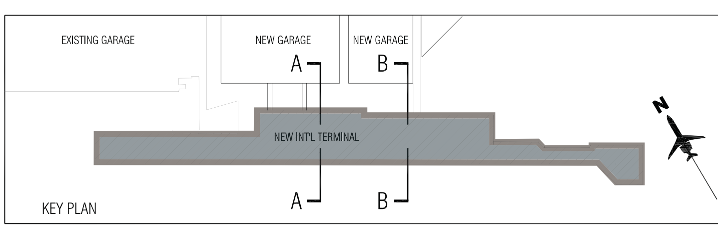


SECTION A-A



SECTION B-B



Departures Level
Arrivals Level
Sterile Corridor
Airline Support
Support / Utilities
Baggage Make-up

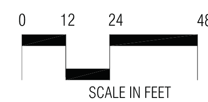


Figure 4-9
New Int'l Terminal - Sections

MINNEAPOLIS - ST. PAUL INTERNATIONAL
AIRPORT LONG TERM COMPREHENSIVE PLAN

HNTB

4.3.2 HUMPHREY TERMINAL

Two alternatives for expanding the Humphrey Terminal were evaluated. Both proposed the addition of six gates by extending the passenger boarding concourse to the northeast along Taxiway D and the addition of 20 gates by extending the passenger boarding concourse to the south along Taxiway S and the east along Taxilane S2. The two concepts differed only in their approach to providing passenger processing facilities such as ticketing, bag-claim and security screening. In the first concept, the existing passenger processor would be expanded to the north and south to accommodate ticketing, bag-claim, and security screening for all Humphrey Terminal passengers. In the second concept, a second passenger processing facility would be constructed to the southeast to provide more convenient access to the 20 new southeast gates. The recommended concept is to provide a second passenger processing facility to the southeast. This concept is illustrated in two figures:

- **Figure 4-10 - Humphrey Terminal Concept Phase I (2010-2015)**
- **Figure 4-11 - Humphrey Terminal Concept Phase II (2020-2025)**

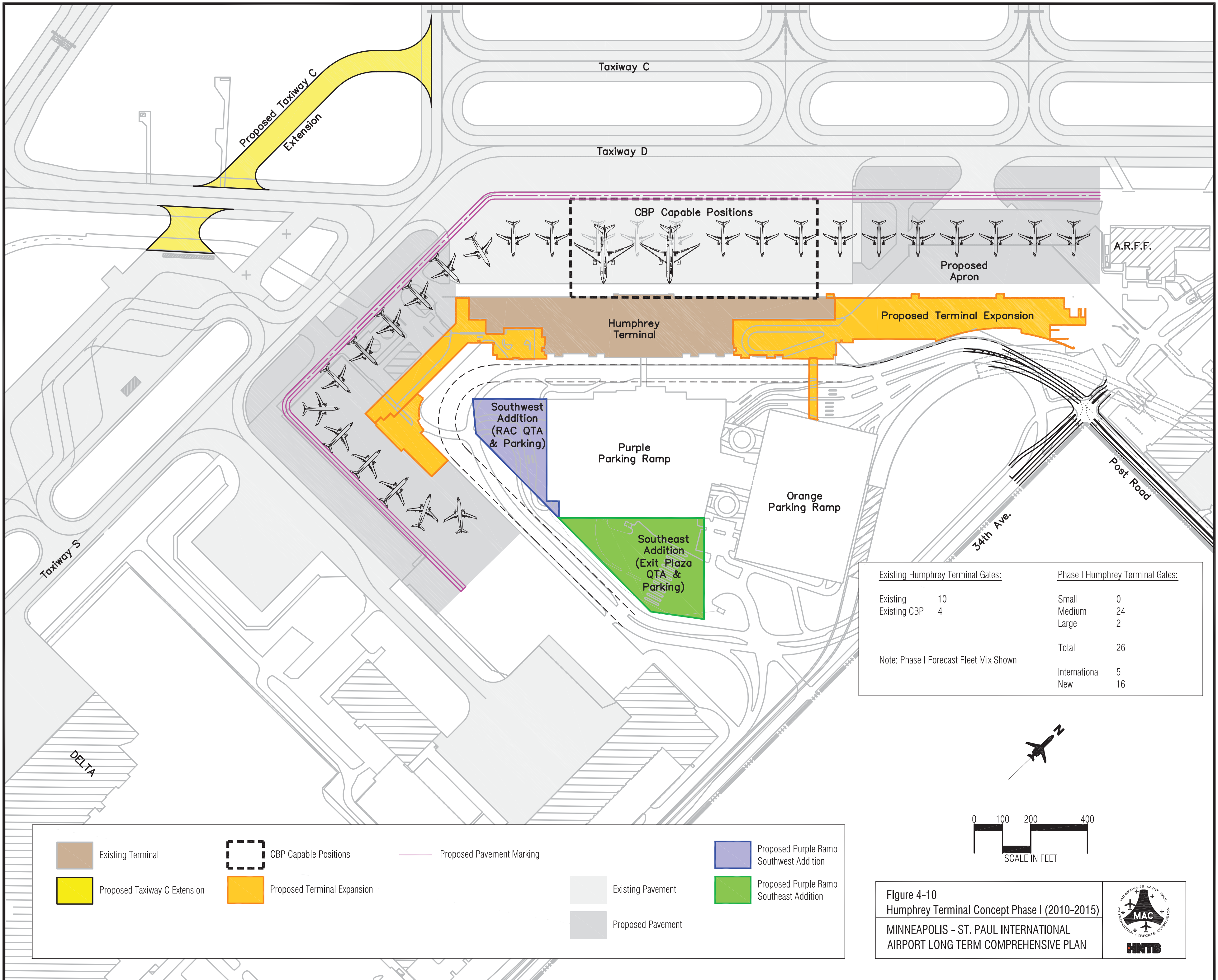
The proposed supplemental passenger processing facility can be seen in **Figure 4-11** along with its proximity to the 20-gate southeast expansion of the Humphrey Terminal. The advantage of this configuration is that most Humphrey Terminal passengers are either beginning or ending their trips at MSP as opposed to connecting. Therefore, proximity of the boarding gates to ticketing, bag-claim, security check points, curbs, and parking raises the level of service for each passenger. By providing two processing facilities at the Humphrey Terminal, the 20-gate southeast expansion maintains a level of convenience on par with the existing configuration. Build-out of the secondary passenger processing facility includes dual taxiways around the facility and will impact the existing run-up enclosure facility. Additional analysis of airline maintenance needs will be considered during this phase of development to address run-up enclosure facility requirements and relocation options. Relocation would take place in the immediate vicinity of the existing facility.

4.4 LANDSIDE AND GROUND TRANSPORTATION

The landside facilities include airport terminal access roads and curb fronts, parking, and rental car facilities. The inventory and facility requirements presented in Chapters 1 and 3 outlined the key challenges with the existing facilities and what improvements would be required. The facility requirements are dependent on the mix of airlines operating at each terminal. All concepts for landside facilities were developed with the assumption that all non-Delta/SkyTeam airlines would relocate to an expanded Humphrey Terminal by 2015, when the Lindbergh Terminal would no longer meet demand for aircraft gates and processing. Concepts for landside improvements are presented independently for each terminal.

4.4.1 LINDBERGH TERMINAL

After 2015, it is assumed that the Lindbergh Terminal will service Delta Air Lines and its SkyTeam partners exclusively. Though the facility would serve only one airline and its partners, the facility requirements presented in Chapter 3 show that additional improvements to and expansion of access roadways and curb front, additional parking, and rental car facilities would be required.



Existing Humphrey Terminal Gates:

Existing	10
Existing CBP	4

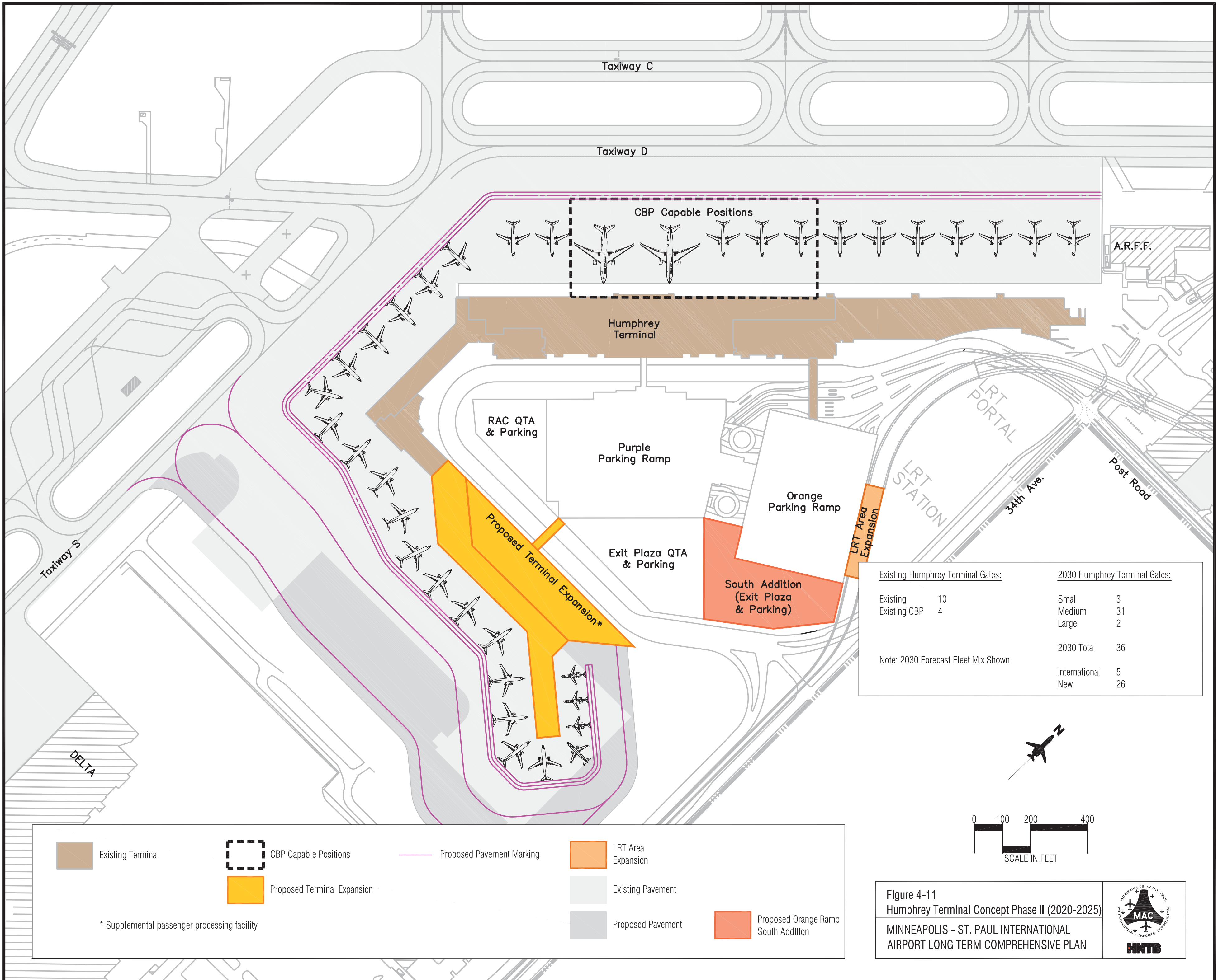
Note: Phase I Forecast Fleet Mix Shown

Phase I Humphrey Terminal Gates:

Small	0
Medium	24
Large	2
Total	26
International	5
New	16

Figure 4-10
Humphrey Terminal Concept Phase I (2010-2015)

MINNEAPOLIS - ST. PAUL INTERNATIONAL AIRPORT LONG TERM COMPREHENSIVE PLAN



Existing Humphrey Terminal Gates:	
Existing	10
Existing CBP	4

Note: 2030 Forecast Fleet Mix Shown

2030 Humphrey Terminal Gates:	
Small	3
Medium	31
Large	2
2030 Total	36
International	5
New	26

Figure 4-11
Humphrey Terminal Concept Phase II (2020-2025)

MINNEAPOLIS - ST. PAUL INTERNATIONAL
AIRPORT LONG TERM COMPREHENSIVE PLAN

Airport Access / Curb Front

Glumack Drive provides access for all vehicles to the Lindbergh Terminal. The roadway operates with relative efficiency today but will require relocation to accommodate other airport improvements including a crossover taxiway that will bridge the road just west of Minnesota Highway 5. The redevelopment concept for Glumack Drive, illustrated in **Figure 4-12 – Realign Glumack Drive,** includes rebuilding the interchange with Highway 5 and relocating the roadway to the southwest in a more central location between the two parallel runways. The MAC will work with all appropriate agencies to implement these necessary interchange modifications, including preliminary environmental scoping and analysis, and work to include these improvements in the region's fiscally-constrained 2030 highway plan. Access would then be provided to the Lindbergh Terminal along the existing alignment while new access would be provided to the international arrivals facility and a potential airport hotel and conference center. Access would also be provided to two new parking ramps using the existing helixes.

The existing Lindbergh Terminal curb front is heavily congested at the lower level where commercial vehicles operate. A concept for improving the Lindbergh Terminal arrivals curb area is illustrated in **Figure 4-13 – Lindbergh Terminal Ground Transportation Center**. Because the curb front can't be readily lengthened due to Concourses G and C at each end, the concept for improving capacity includes providing an outer curb with pedestrian crosswalks traversing the inner curb area, potentially at grade. (Currently, the outer curb does not provide direct access to the terminal facility.) This would effectively double the available curb front but would require some passengers to traverse the inner curb.

The proposed plan would re-route commercial vehicles such as taxicabs and multi-passenger vans to a reconfigured staging area adjacent to the existing taxi staging area.

Parking

An additional 10,100 parking spaces are required at the Lindbergh Terminal by 2030. The only feasible alternative that provides parking directly at the terminal would be to construct two new garages to the southeast of the existing Lindbergh Terminal parking garages. These garages would be accessed using the existing helixes.

Rental Cars

A consolidated rental car facility was considered and rejected due to the high level of customer convenience realized by accommodating rental car ready facilities and return facilities directly within the parking facilities at each terminal. Therefore, the proposed expansion of parking garages would also accommodate the required expansion of rental car ready return facilities and allow them to continue operating within the airport garages at each terminal.

On-Site Hotel

A site has been identified that would be appropriate for hotel development.

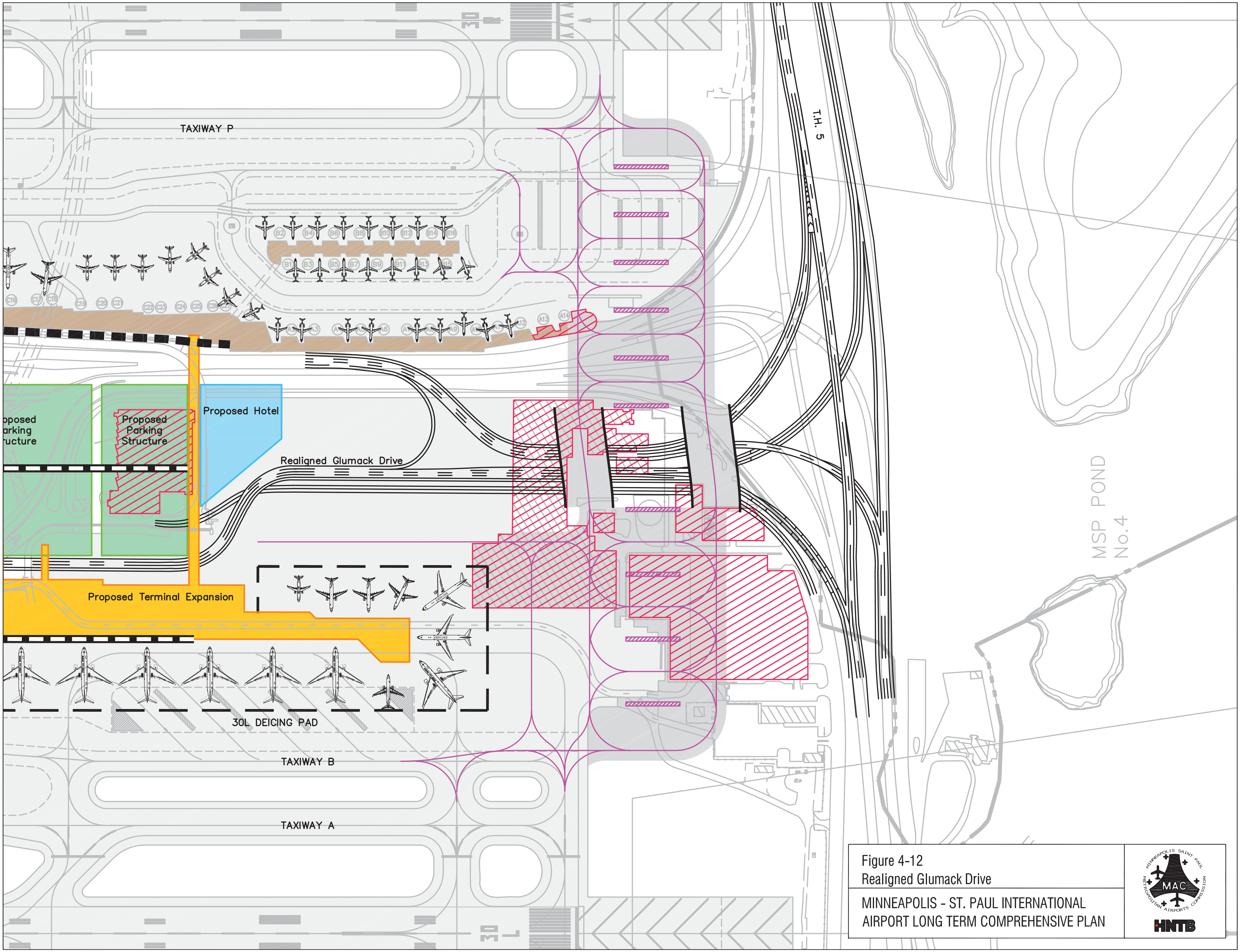


Figure 4-12
Realigned Glumack Drive

MINNEAPOLIS - ST. PAUL INTERNATIONAL
AIRPORT LONG TERM COMPREHENSIVE PLAN

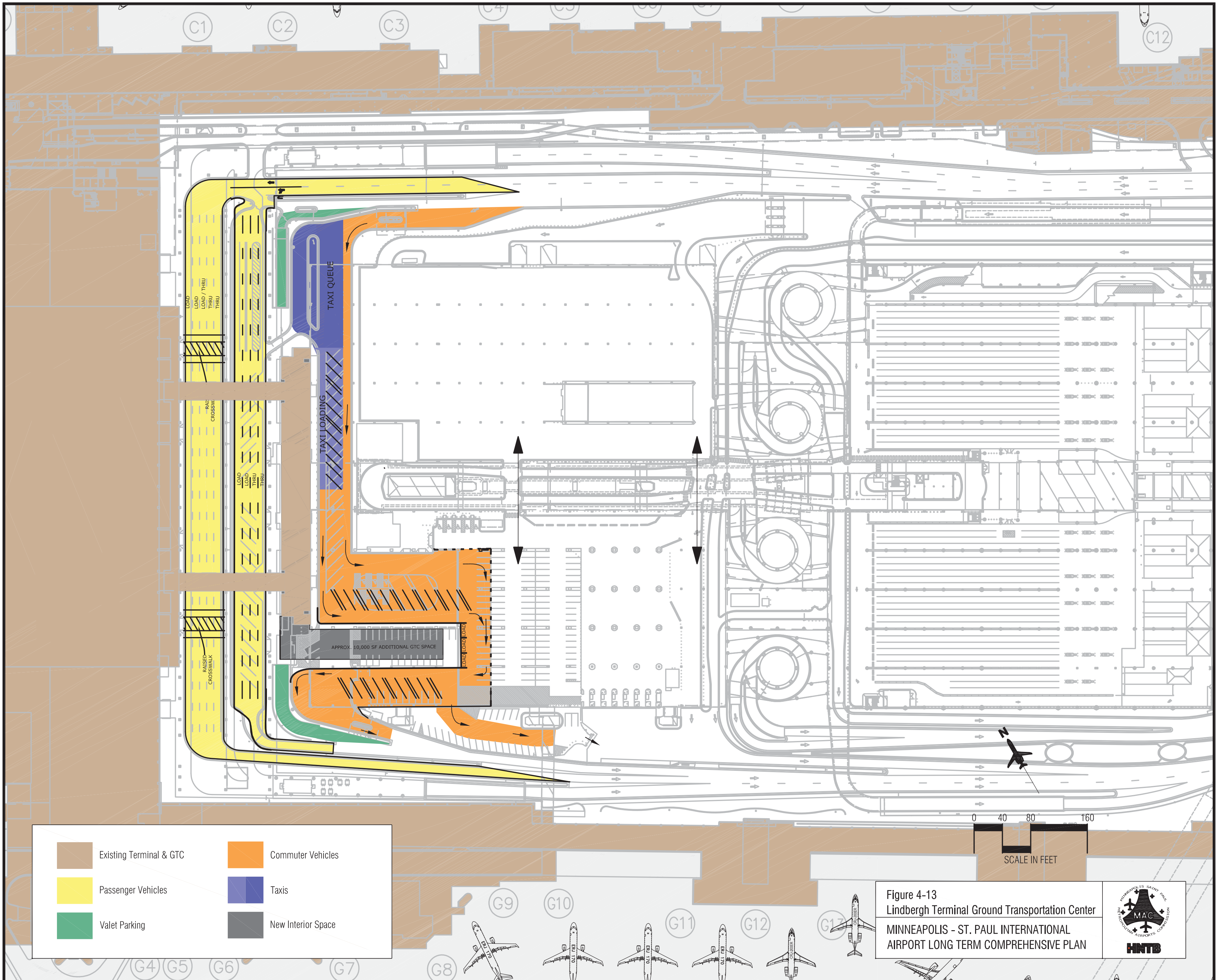


Figure 4-13
Lindbergh Terminal Ground Transportation Center

MINNEAPOLIS - ST. PAUL INTERNATIONAL
AIRPORT LONG TERM COMPREHENSIVE PLAN

4.4.2 HUMPHREY TERMINAL

It is assumed that, after 2015, the Humphrey Terminal will accommodate all airlines except Delta Air Lines and its SkyTeam partners. The facility requirements presented in Chapter 3 show that additional improvements to and expansion of access roadways and curb front, additional parking, and rental car facilities would be required.

Airport Access Roadways / Curb Front

Access to the Humphrey Terminal is provided by both Post Road and 34th Avenue. Both existing roadways will be incapable of providing the required traffic volumes to Humphrey Terminal in future years. The concept for improving this condition, as illustrated in **Figure 4-1**, includes routing all inbound traffic for the Humphrey Terminal to Post Road and routing all outbound traffic to 34th Avenue. This concept would require several improvements, including widening Post Road. To address this issue, the MAC will work with all appropriate agencies to implement the necessary interchange modifications, including preliminary environmental scoping and analysis, and work to include these improvements in the region's fiscally-constrained 2030 highway plan.

The Humphrey Terminal curb area has sufficient capacity for existing demand levels and can be extended to accommodate an expansion of the existing passenger processor.

Parking

An additional 5,900 parking spaces will be required at the Humphrey Terminal by 2030. The existing parking garages can be expanded in place to accommodate this level of demand.

Rental Cars

As noted for the Lindbergh Terminal, a consolidated rental car facility was considered and rejected due to the high level of customer convenience realized by accommodating rental car ready facilities and return facilities directly within the parking facilities at each terminal. Therefore, the proposed expansion of parking garages would also accommodate the required expansion of rental car ready return facilities and allow them to continue operating within the airport garages at each terminal.

4.5 PREFERRED ALTERNATIVES SUMMARY

4.5.1 LINDBERGH TERMINAL

- ADDITIONAL GATES - Extending Concourse G would provide new gates capable of accommodating domestic or international flights.

- EXPANDED INTERNATIONAL ARRIVALS (CUSTOMS AND BORDER PATROTECTION) FACILITY - New, larger facilities will be provided as part of the Concourse G expansion to accommodate forecasted growth in demand for international flights to MSP.

- SECURITY SCREENING - Reconfiguration of security screening areas would improve efficiency and reduce wait times.

- BAGGAGE CLAIM - The existing baggage claim hall would be reconfigured with larger, modern baggage claim systems.

- PARKING - Additional parking garages would be constructed adjacent to the existing garages to accommodate existing and future parking demand.

- ARRIVALS CURB - Enhancements to the curb area would improve capacity and efficiency for arriving passengers to reach shuttles, taxis, and private vehicles.

- HOTEL - A site has been identified that would be appropriate for hotel development.

4.5.2 HUMPHREY TERMINAL

- ADDITIONAL GATES - New gates would be added by extending the passenger concourses to the north and south accommodating up to 26 additional gates.

- PASSENGER PROCESSING - Ticketing and baggage claim facilities would be expanded to accommodate additional airlines and passengers.

- PARKING - Existing garages would be expanded to accommodate future parking demand.

- RENTAL CAR FACILITIES - Accommodations for rental cars would be provided by developing facilities in expanded existing parking garages.

- ACCESS ROADS - Post Road and 34th Avenue would be improved and signed to accommodate increasing traffic volumes and simplify circulation.

CHAPTER 5: ENVIRONMENTAL CONSIDERATIONS

CHAPTER 5: ENVIRONMENTAL CONSIDERATONS

5.1 AIRPORT AND AIRCRAFT ENVIRONMENTAL CAPABILITY

An integral part of the airport planning process focuses on the manner in which the airport and any planned enhancements to the facility pose environmental impacts. This chapter evaluates the major environmental implications of the planned operation and development of the Minneapolis-St. Paul International Airport.

The larger tables referenced in this chapter are included in Appendix B of this report.

5.2 AIRCRAFT NOISE

5.2.1 QUANTIFYING AIRCRAFT NOISE

Basics of Sound

Sound is a physical disturbance in a medium, a pressure wave moving through air. A sound source vibrates or otherwise disturbs the air immediately surrounding the source, causing variations in pressure above and below the static (at-rest) value of atmospheric pressure. These disturbances force air to compress and expand, setting up a wavelike movement of air particles that move away from the source. Sound waves, or fluctuations in pressure, vibrate the eardrum creating audible sound.

The decibel, or dB, is a measure of sound pressure level that is compressed into a convenient range, that being the span of human sensitivity to pressure. Using a logarithmic relationship and the ratio of sensed pressure compared against a fixed reference pressure value, the dB scale accounts for the range of hearing with values from 0 to around 200. Most human sound experience falls into the 30 dB to 120 dB range.

Decibels are logarithmic and thus cannot be added directly. Two identical noise sources each producing 70 dB do not add to a total of 140 dB, but add to a total of 73 dB. Each time the number of sources is doubled, the sound pressure level is increased 3 dB.

Baseline:	70 dB
2 sources:	70 dB + 70 dB = 73 dB
4 sources:	70 dB + 70 dB + 70 dB + 70 dB = 76 dB
8 sources:	70 dB + 70 dB + 70 dB + 70 dB + 70 dB + 70 dB + 70 dB + 70 dB = 79 dB

The just-noticeable change in loudness for normal hearing adults is about 3 dB. That is, changes in sound level of 3 dB or less are difficult to notice. A doubling of loudness for the average listener of A-weighted sound is about 10 dB.[3] Measured, A-weighted sound levels changing by 10 dBA effect a subjective perception of being “twice as loud”.[4]

[3] A-weighted decibels represent noise levels that are adjusted relative to the frequencies that are most audible to the human ear.
[4] Peppin and Rodman, Community Noise, p. 47-48; additionally, Harris, Handbook, Beranek and Vér, Noise and Vibration Control Engineering, among others.

Day-Night Average Sound Level (DNL)

In 1979 the United States Congress passed the Aviation Safety and Noise Abatement Act. The Act required the Federal Aviation Administration (FAA) to develop a single methodology for measuring and determining airport noise impacts. In January 1985 the FAA formally implemented the Day-Night Average Sound Level (DNL) as the noise metric descriptor of choice for determining long-term community noise exposure in the airport noise compatibility planning provisions of 14 C.F.R. Part 150. Additionally, FAA Order 1050.1, *"Environmental Impacts: Policies and Procedures"* and FAA Order 5050.4, *"National Environmental Policy Act (NEPA) Implementing Instructions for Airport Actions,"* outlines DNL as the noise metric for measuring and analyzing aircraft noise impacts.

As detailed above, the FAA requires the DNL noise metric to determine and analyze noise exposure and aid in the determination of aircraft noise and land use compatibility issues around United States airports. Because the DNL metric correlates well with the degree of community annoyance from aircraft noise, the DNL has been formally adopted by most federal agencies dealing with noise exposure. In addition to the FAA, these agencies include the Environmental Protection Agency, Department of Defense, Department of Housing and Urban Development, and the Veterans Administration.

The DNL metric is calculated by cumulatively averaging sound levels over a 24-hour period. This average cumulative sound exposure includes the application of a 10-decibel penalty to sound exposures occurring during the nighttime hours (10:00 PM to 7:00 AM). Since the ambient, or background, noise levels usually decrease at night the night sound exposures are increased by 10 decibels because nighttime noise is more intrusive.

The FAA considers the 65 DNL contour line to be the threshold of significance for noise impact. As such, sensitive land use areas (e.g., residential) around airports that are located in the 65 or greater DNL contours are considered by the FAA as incompatible structures.

Integrated Noise Model (INM)

The FAA-established mechanism for quantifying airport DNL noise impacts is the Integrated Noise Model (INM). The FAA's Office of Environment and Energy (AEE-100) has developed the INM for evaluating aircraft noise impacts in the vicinity of airports. The INM has many analytical uses, such as assessing changes in noise impact resulting from new or extended runways or runway configurations and evaluating other operational procedures. The INM has been the FAA's standard tool since 1978 for determining the predicted noise impact in the vicinity of airports. Statutory requirements for INM use are defined in FAA Order 1050.1, *"Environmental Impacts: Policies and Procedures"* and FAA Order 5050.4, *"National Environmental Policy Act (NEPA) Implementing Instructions for Airport Actions,"* and Federal Aviation Regulations (FAR) Part 150, *"Airport Noise Compatibility Planning."*

The model utilizes flight track information, runway use information, operation time of day data, aircraft fleet mix, standard and user-defined aircraft profiles, and terrain as inputs. Quantifying aircraft-specific noise characteristics in the INM is accomplished through the use of a comprehensive noise database that has been developed under the auspices of Federal Aviation Regulations (FAR) Part 36. As part of the airworthiness certification process, aircraft manufacturers are required to subject an aircraft to a battery of noise tests. Through the use of federally adopted and endorsed algorithms, this aircraft-specific noise information is used in the generation of INM DNL contours. Justification for such an approach is rooted in national standardization of noise quantification at airports.

The INM produces DNL noise exposure contours that are used for land use compatibility maps. The INM program includes built-in tools for comparing contours and utilities that facilitate easy export to commercial Geographic Information Systems. The model also calculates predicted noise at specific sites such as hospitals, schools or other sensitive locations. For these grid points, the model reports detailed information for the analyst to determine which events contribute most significantly to the noise at that location. The model supports 16 predefined noise metrics that include cumulative sound exposure, maximum sound level and time-above metrics from both the A-Weighted, C-Weighted and the Effective Perceived Noise Level families.

The INM aircraft profile and noise calculation algorithms are based on several guidance documents published by the Society of Automotive Engineers (SAE). These include the SAE-AIR-1845 report titled *"Procedure for the Calculation of Airplane Noise in the Vicinity of Airports,"* as well as others which address atmospheric absorption and noise attenuation. The INM is an average-value-model and is designed to estimate long-term average effects using average annual input conditions. Because of this, differences between predicted and measured values can occur because certain local acoustical variables are not averaged, or because they may not be explicitly modeled in the INM. Examples of detailed local acoustical variables include temperature profiles, wind gradients, humidity effects, ground absorption, individual aircraft directivity patterns and sound diffraction, terrain, buildings, barriers, etc.

The noise contours for the 2030 Preferred Alternative were calculated using INM version 7.0b, which is the most current version released by the Federal Aviation Administration. The noise contours developed for the 2008 base case, as developed in the Metropolitan Airports Commission's 2009 Annual Noise Contour Report, were calculated using INM version 7.0a. The input data developed in the 2009 Annual Noise Contour Report were re-run in the latest version of the INM and compared. The slight differences in the contours due to changes implemented in the latest version of the model did not justify reproducing the 2008 noise contour analysis contained in the 2009 Annual Noise Contour Report. Moreover, by using the 2008 actual noise contour that was developed in the 2009 Annual Noise Contour Report, the comparative noise assessment between the base case and forecast noise contours are conservative in this document.

The 2030 noise contour, which shows potential impacts, generated considerable discussion with adjacent communities during the Metropolitan Council's LTCP approval process. To address these concerns and to fully understand the noise impacts associated with increased aircraft operations, the MAC should initiate an FAA Part 150 study update, in consultation with the MSP Noise Oversight Committee (NOC), when the forecast level of operations five years into the future exceeds the levels of mitigation in the Consent Decree (582,366 annual operations). The results of this study should be incorporated into the first subsequent LTCP Update.

5.3 MSP BASE CASE 2008 NOISE CONTOURS

5.3.1 2008 BASE CASE AIRCRAFT OPERATIONS AND FLEET MIX

The past seven years have presented many challenges to the aviation industry. From a local perspective, operational levels and the aircraft fleet mix at MSP have been subject to lingering effects from the events of September 11, 2001, high fuel prices, a flurry of bankruptcy filings by several legacy airlines including Northwest Airlines, an economic recession and overall market forces that appear to be favoring consolidation, as indicated by Delta Air Lines' acquisition of

Northwest Airlines in 2008. These developments have had profound effects on airline and airport operations. For example, the actual 2008 operational level at MSP was below the operational level documented at the airport over 13 years ago.

The total MSP operations numbers for this study were derived from Airport Noise and Operations Monitoring System (ANOMS) data. The ANOMS total operations number was 1.2% lower than the Federal Aviation Administration Air Traffic Activity Data System (ATADS) number. The slightly lower ANOMS number can be attributed to normal system data gaps that occur regularly on an annual basis. To rectify the numbers, Metropolitan Airports Commission staff adjusted the ANOMS data upward to equal the total 2008 FAA ATADS number. **Table 5.1** provides the total number of 2008 aircraft operations at MSP by operational category.

TABLE 5.1: 2008 TOTAL OPERATIONS NUMBERS

Operations Category	Number of Operations*
Scheduled Passenger Air Carrier (a)	402,347
Cargo	14,361
Charter	536
GA	29,708
Military	3,020
TOTAL	449,972

Notes:

(a) Includes both air carrier and regional carrier operations.

* Based on actual year-to-date 2008 ANOMS data adjusted to match FAA ATADS data (to account for unavailable ANOMS operations data).

The 2008 total operations number of 449,972 — in the context of historical annual operations at MSP, the 2008 operations level is the lowest annual operations at MSP since 1994.

In addition to the reduction in overall operations at MSP, the aircraft fleet mix at MSP is continuing to change. Considering the multi-faceted nature of the variables that are presently impacting the operational downturn at MSP, it is difficult to forecast long-term operational implications. All signs, however, seem to point to a fundamental change in the nature of airline operations at MSP, especially in the type of aircraft flown by all airlines. Specifically, operations by older aircraft such as the DC9 and B727 that have been “hushkitted” to meet the Stage 3 noise standard are decreasing. Following the events of September 11, 2001, the number of monthly Stage 3 hushkit operations dropped off significantly at MSP and has never returned to pre-9/11 levels. The number of monthly Stage 3 hushkit operations dropped to 9,450 in September 2001 and has continued to drop since. Stage 3 hushkit operations dropped to a low of 2,487 total monthly operations in September 2008. In January 2009 the number of monthly Stage 3 hushkitted operations dropped to an all-time low of 2,150. At the same time that older hushkit aircraft operations are declining, the use of newer and quieter manufactured Stage 3 aircraft is on the rise. The best examples at MSP of the increasing use of newer aircraft are the Airbus A320/319, Airbus 330, Canadair Regional Jets (CRJs), Boeing B757-200/300, and Boeing B737-800. These aircraft are replacing older hushkitted Stage 3 aircraft such as the DC10, DC9, and B727.

When comparing the DC9 hushkitted aircraft to the CRJ-200 regional jet (the CRJ is one of the replacement aircraft for the smaller DC9s at MSP), 43 CRJ operations would be required to generate the same noise impact as one DC9 operation. The CRJ-200 aircraft represents newer technology engine noise emission levels.

Table 5.2 provides a breakdown of the 2008 aircraft fleet mix at MSP.

TABLE 5.2: 2008 AIRCRAFT FLEET MIX AVERAGE DAILY OPERATIONS

Group	Aircraft Type	Day	Night	Total
Manufactured/	A300-622R	2.2	2.0	4.1
Re-engined	A310-304	0.3	1.0	1.2
Stage 3 Jet	A319-131	118.1	8.9	126.9
	A320-211	138.6	11.2	149.8
	A321-232	0.4	0.3	0.8
	A330	8.8	1.6	10.4
	B717-200	5.4	0.7	6.1
	B737-300	15.4	2.7	18.0
	B737-400	0.5	0.2	0.7
	B737-500	10.5	2.0	12.5
	B737-700	9.5	1.6	11.1
	B737-800	24.2	12.6	36.9
	B747-100	0.0	0.0	0.0
	B747-200	0.5	0.2	0.7
	B747-400	2.3	0.0	2.3
	B757-200	62.0	7.1	69.0
	B757-300	31.9	3.7	35.5
	B767-200	0.3	0.0	0.3
	B767-300	0.2	0.3	0.6
	B777-200	0.0	0.0	0.0
	CARJ/CL601	255.2	19.9	275.1
	CL600	2.3	0.2	2.5
	CNA500	1.4	0.1	1.5
	CNA650	3.1	0.3	3.4
	CNA750	5.1	0.5	5.6
	DC10	3.6	2.4	6.0
	DC820	0.0	0.0	0.0
	DC860	0.0	0.0	0.0
	DC870	0.6	1.0	1.6
	EMB145	31.3	3.3	34.5
	GIV	2.0	0.1	2.1
	GV	66.9	5.9	72.8
	IA1125	0.8	0.1	0.9
	L101	0.1	0.0	0.1
	LEAR35	7.0	2.8	9.8
	MD11GE	0.5	0.6	1.1
	MD81	28.0	4.9	32.9
	MD9025	0.5	0.2	0.7
	MU3001	8.5	0.6	9.1
	Total	847.8	99.0	946.8
Hushkit	727Q	1.7	2.9	4.6
Stage 3 Jet	737Q	0.1	0.0	0.1
	BAC111	0.0	0.0	0.0
	DC9Q	100.2	9.2	109.4
	Total	102.0	12.1	114.1
Stage 2	FAL20	1.1	0.1	1.1
less than	GII	1.9	0.2	2.1
75,000 lb.	GIII	0.3	0.0	0.3

MTOW	LEAR25	5.6	0.5	6.1
	Total	8.9	0.8	9.6
Propeller	1900D	4.2	0.7	4.9
	BEC58P	9.9	3.8	13.7
	C130	6.5	0.3	6.8
	CNA172	0.2	0.0	0.2
	CNA206	0.3	0.0	0.3
	CNA441	1.0	0.1	1.1
	DHC6	6.9	2.4	9.2
	DHC8	0.1	0.0	0.1
	GASEPF	1.6	1.7	3.3
	GASEPV	1.1	0.1	1.2
	HS748A	0.2	0.0	0.2
	PA28	0.1	0.0	0.1
	PA31	0.8	0.1	0.9
	SD330	0.1	0.0	0.2
	SF340	108.9	7.4	116.3
	Total	141.7	16.6	158.3
Helicopter	A109	0.0	0.0	0.0
	B206L	0.0	0.0	0.0
	B212	0.0	0.0	0.0
	B222	0.0	0.0	0.0
	S70	0.0	0.0	0.0
	Total	0.1	0.0	0.1
	C17	0.1	0.0	0.1
Military Jet	C9A	0.0	0.0	0.0
	F16GE	0.0	0.0	0.0
	F-18	0.0	0.0	0.0
	KC135	0.0	0.0	0.0
	T1	0.1	0.0	0.1
	T34	0.0	0.0	0.0
	T38	0.1	0.0	0.1
	U21	0.1	0.0	0.1
	Total	0.5	0.0	0.5
Total Ops.		1100.9	128.5	1229.4

5.3.2 2008 BASE CASE RUNWAY USE

The Federal Aviation Administration's control of runway use throughout the year for arrival and departure operations at MSP has a notable effect on the overall noise impact around the airport. The number of people and dwellings impacted by noise is a direct factor of the number of operations on a given runway and the land uses off the end of the runway.

Historically, prior to the opening of Runway 17-35, arrival and departure operations occurred on the parallel runways at MSP (12L-30R and 12R-30L) in a manner that resulted in approximately 50% of the arrival and departure operations occurring to the northwest over South Minneapolis and to the southeast over Mendota Heights and Eagan. As a result of the dense residential land uses to the northwest and the predominantly industrial/commercial land uses to the southeast of MSP, focusing arrival and departure operations to the southeast has long been the preferred configuration from a noise reduction perspective.

Since the introduction of Runway 17-35 at MSP, another opportunity exists to route aircraft over an unpopulated area – the Minnesota River Valley. With use of the Runway 17 Departure Procedure, westbound departure operations off Runway 17 are routed such that they avoid close-in residential areas southwest of the new runway. Thus, use of Runway 17 for departure operations is the second preferred operational configuration (after Runways 12L and 12R) for noise reduction purposes.

Table 5.3 provides the runway use percentages for 2008.

TABLE 5.3: 2008 RUNWAY USE

Op Type	Runway	Day	Night	Total
Arrivals	04	0.0%	0.0%	0.0%
	22	0.1%	0.0%	0.1%
	12L	22.5%	15.0%	21.7%
	30R	22.6%	21.9%	22.5%
	12R	21.1%	24.4%	21.4%
	30L	17.8%	37.2%	19.8%
	17	0.0%	0.0%	0.0%
	35	15.8%	1.5%	14.4%
	Total	100.0%	100.0%	100.0%
Departures	04	0.1%	0.1%	0.1%
	22	0.2%	0.1%	0.2%
	12L	13.2%	19.8%	14.0%
	30R	28.8%	24.9%	28.4%
	12R	6.6%	20.9%	8.2%
	30L	24.3%	20.4%	23.8%
	17	26.7%	13.8%	25.3%
	35	0.0%	0.0%	0.0%
	Total	100.0%	100.0%	100.0%
Overall	04	0.1%	0.1%	0.1%
	22	0.1%	0.0%	0.1%
	12L	17.9%	17.5%	17.9%
	30R	25.7%	23.4%	25.5%
	12R	13.9%	22.6%	14.8%
	30L	21.0%	28.5%	21.8%
	17	13.2%	7.2%	12.6%
	35	8.0%	0.7%	7.2%
	Total	100.0%	100.0%	100.0%

Note: Totals may not add up to 100% due to rounding.

Sources: MAC ANOMS data was used to calculate runway use for 2008.

5.3.3 2008 BASE CASE FLIGHT TRACKS

In large part, the 2008 Integrated Noise Model (INM) flight tracks are consistent with those used previously to develop the 2002 MSP Part 150 Update 2007 forecast mitigated noise contour, with the exception of Runways 17, 35, and 4 departure tracks. The Metropolitan Airports Commission (MAC) updated the INM departure tracks to conform to actual radar flight track data.

Figures 5-1 (a-h) provide the INM departure and arrival flight tracks that were used to develop the 2008 actual noise contour. **Table 5.4,** in Appendix B, provides the 2008 INM flight use percentages.

5.3.4 2008 BASE CASE ATMOSPHERIC CONDITIONS

The MAC gathered atmospheric data for the 2008 base case noise contour from the National Weather Service (NWS) and the Minnesota State Climatologist's Office. The MAC used the NWS's 2008 annual average temperature of 44.7 degrees Fahrenheit and 2008 average annual wind speed of 7.6 Kts. in the INM modeling process. The MAC also used a 2008 average annual pressure of 29.98 inches and a 2008 annual average relative humidity of 74%, as reported by the Minnesota State Climatologist's Office.

5.3.5 2008 MODELED VERSUS MEASURED DNL LEVELS

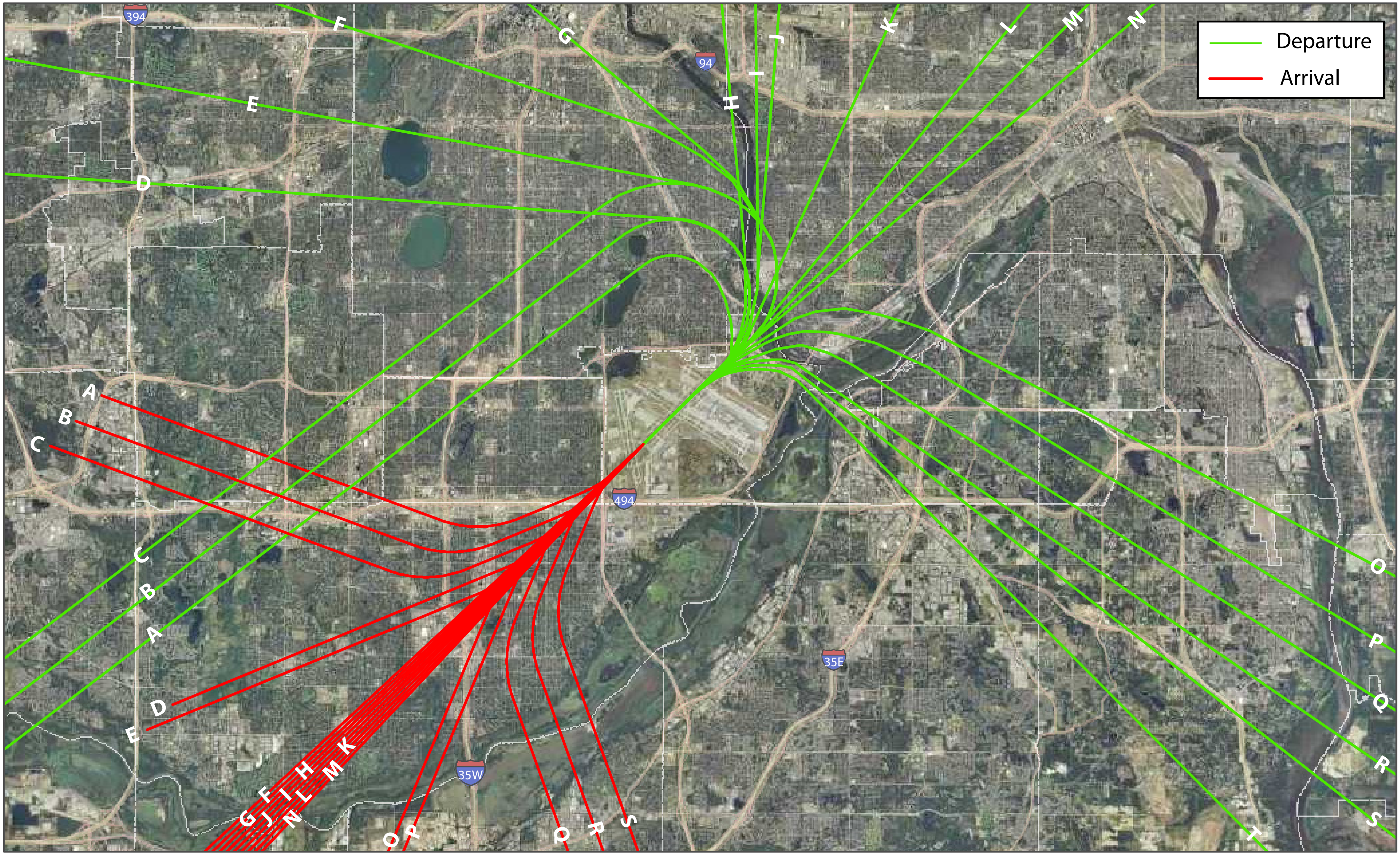
As part of the 2008 base case noise contour development process, a correlation analysis was conducted comparing the INM-developed 2008 base case DNL noise contours to actual measured aircraft noise levels at the 39 Airport Noise and Operations Monitoring System (ANOMS) Remote Noise-Monitoring Towers (RMTs) around MSP in 2008. An INM grid point analysis was conducted to determine the model's predicted 2008 DNL noise levels at each of the RMT locations (determined in INM by the latitude and longitude coordinates of each RMT).

Table 5.5 provides a comparison of the INM grid point analysis at each RMT site, based on the 2008 base case noise contour as produced with INM, and the actual ANOMS monitored aircraft DNLs at those locations in 2008.

The average absolute difference between the modeled and measured DNLs was 1.9 dB. The median difference was 1.1 dB. The ANOMS RMTs, on average, reported higher DNL levels than the INM model generated. The MAC believes that this is due in part to the inclusive approach MAC staff has taken in tuning the ANOMS noise-to-track matching parameters. This conservative approach, along with the increasing number of quieter jets operating at the airport, results in increased instances of community-driven noise events being attributed to quieter aircraft operating at further distances from the monitoring location.

INM Flight Tracks
Runway 04

Figure 5-1a

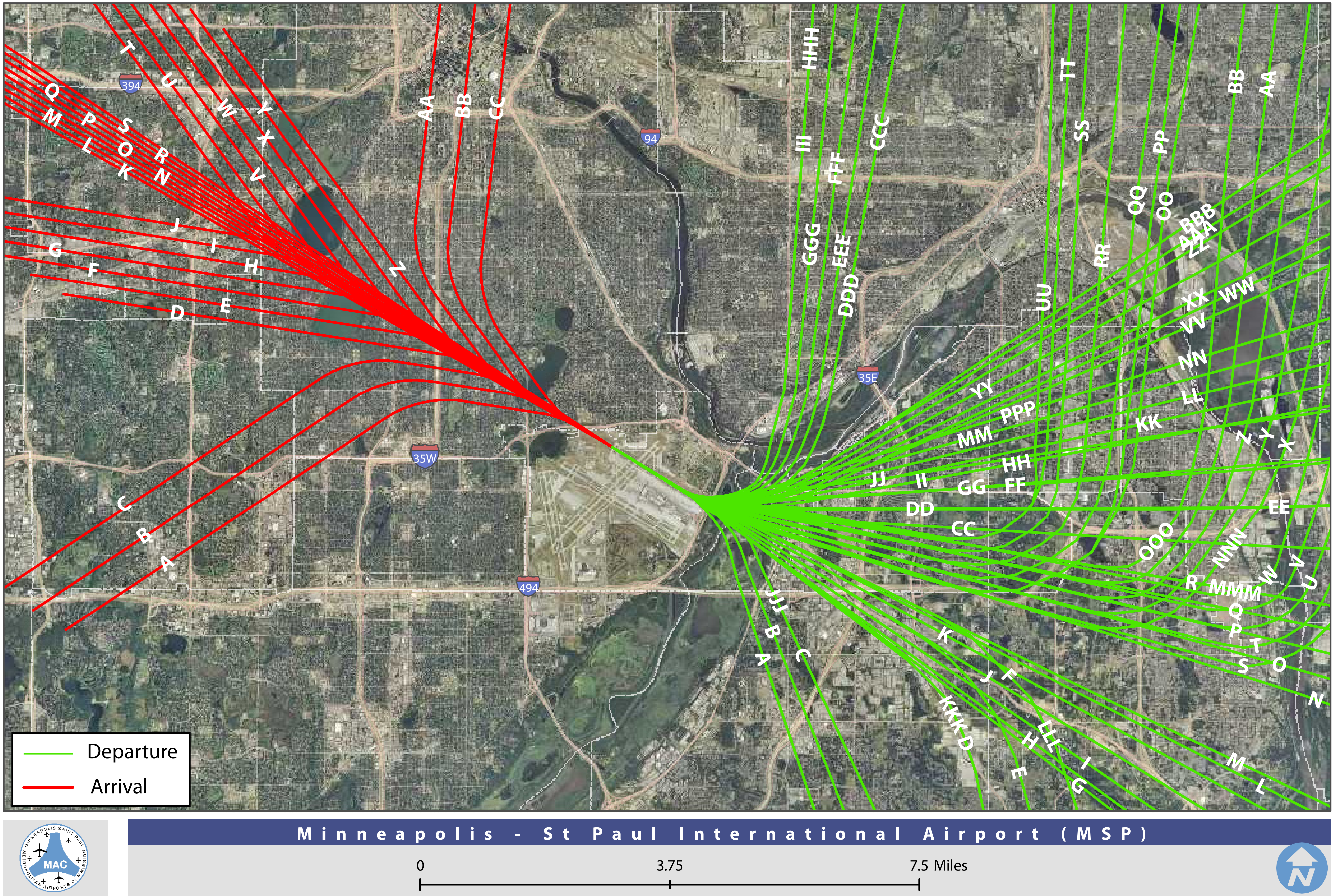


Minneapolis - St Paul International Airport (MSP)

0 2 4 Miles

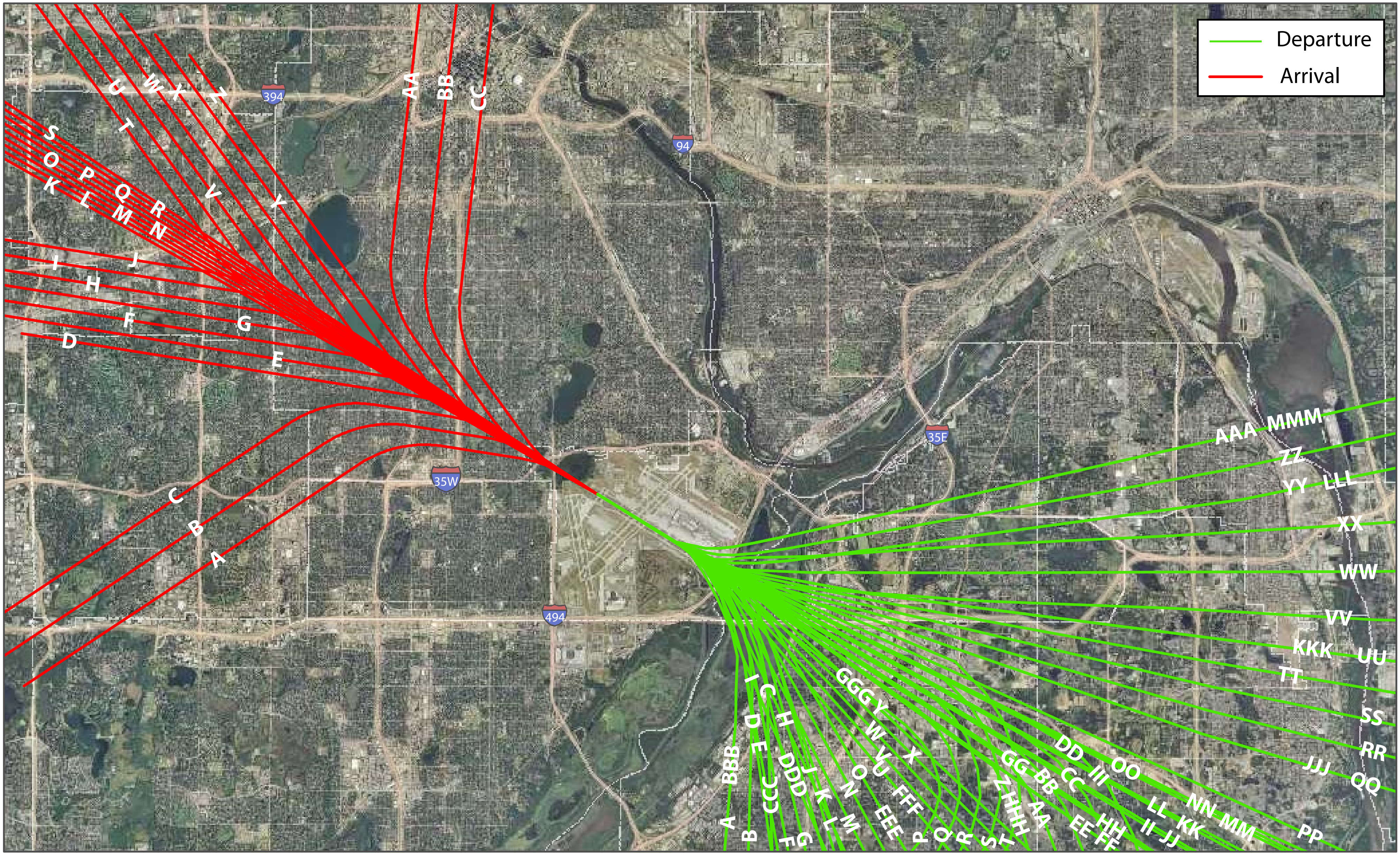
INM Flight Tracks
Runway 12L

Figure 5-1b



INM Flight Tracks
Runway 12R

Figure 5-1c

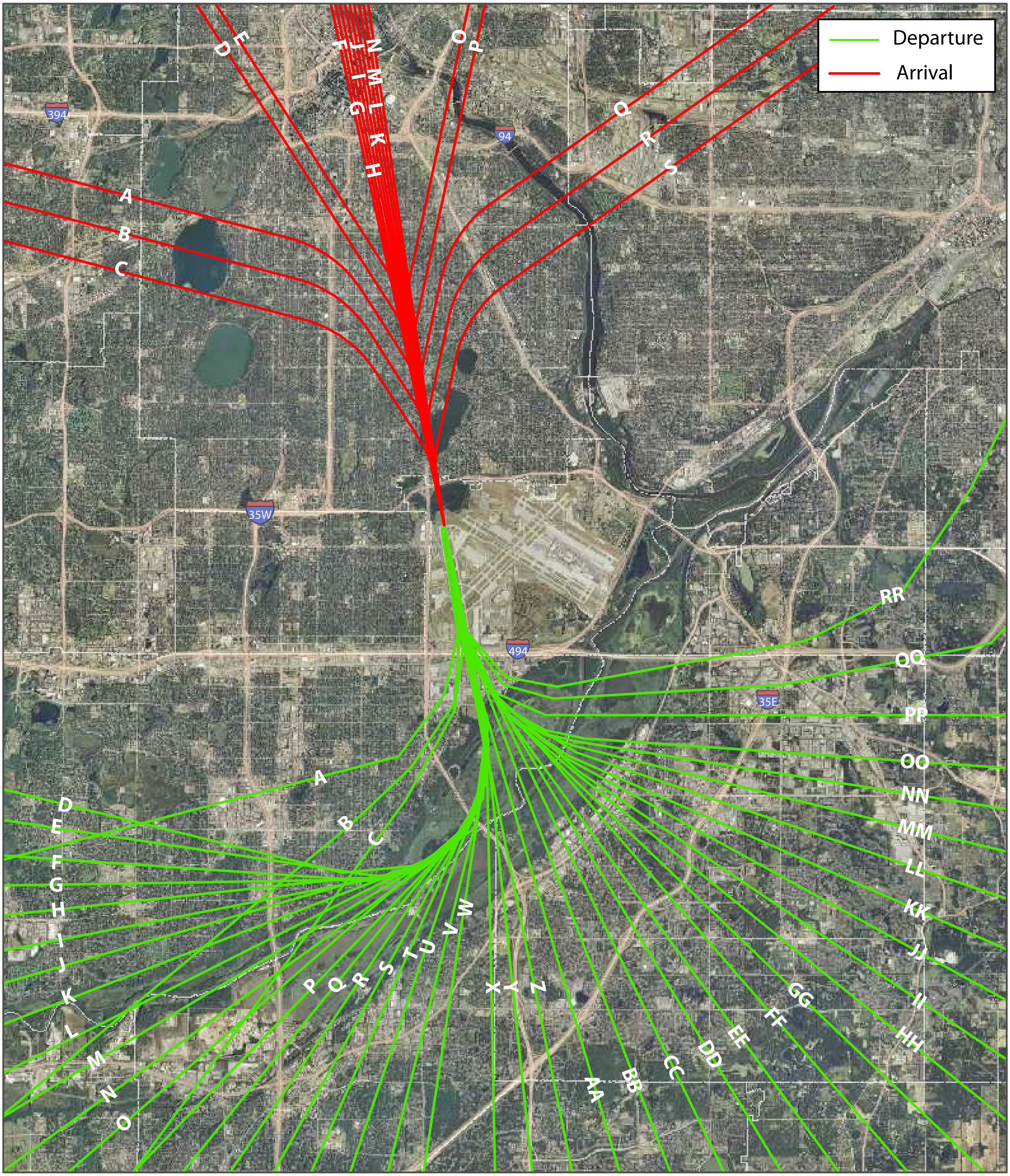


Minneapolis - St Paul International Airport (MSP)

0 3.75 7.5 Miles

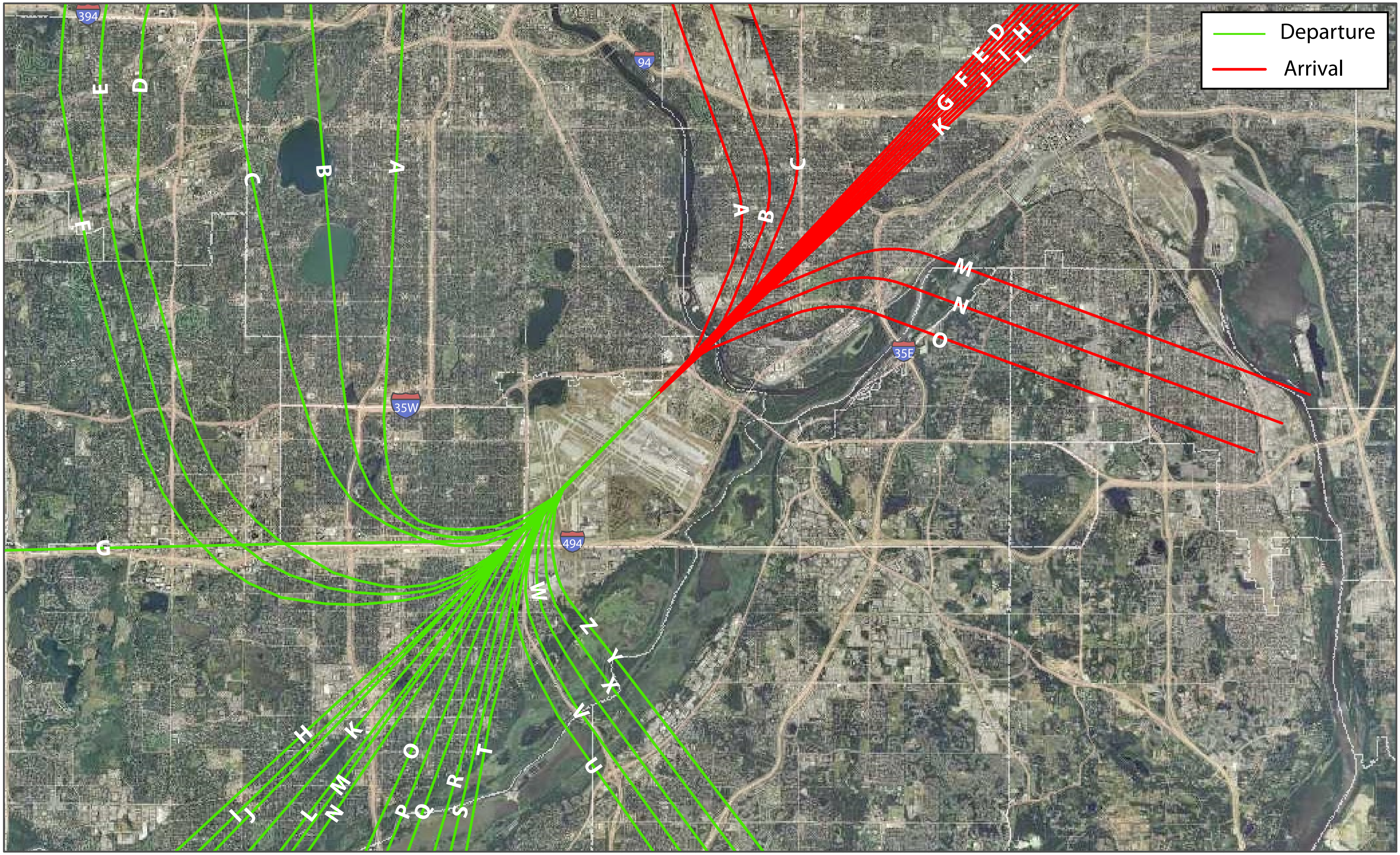
INM Flight Tracks
Runway 17

Figure 5-1d



INM Flight Tracks
Runway 22

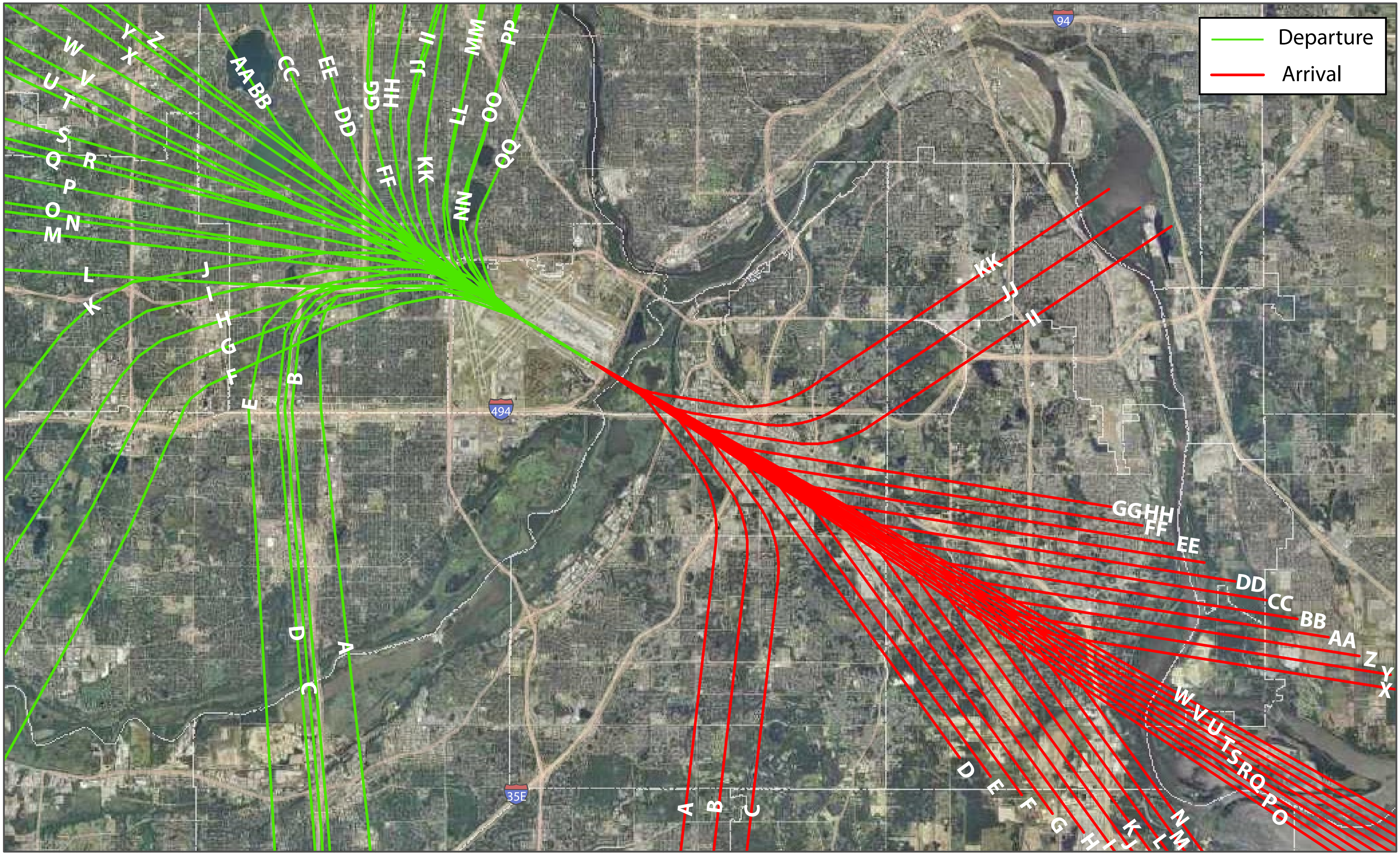
Figure 5-1e



Minneapolis - St Paul International Airport (MSP)

INM Flight Tracks
Runway 30L

Figure 5-1f

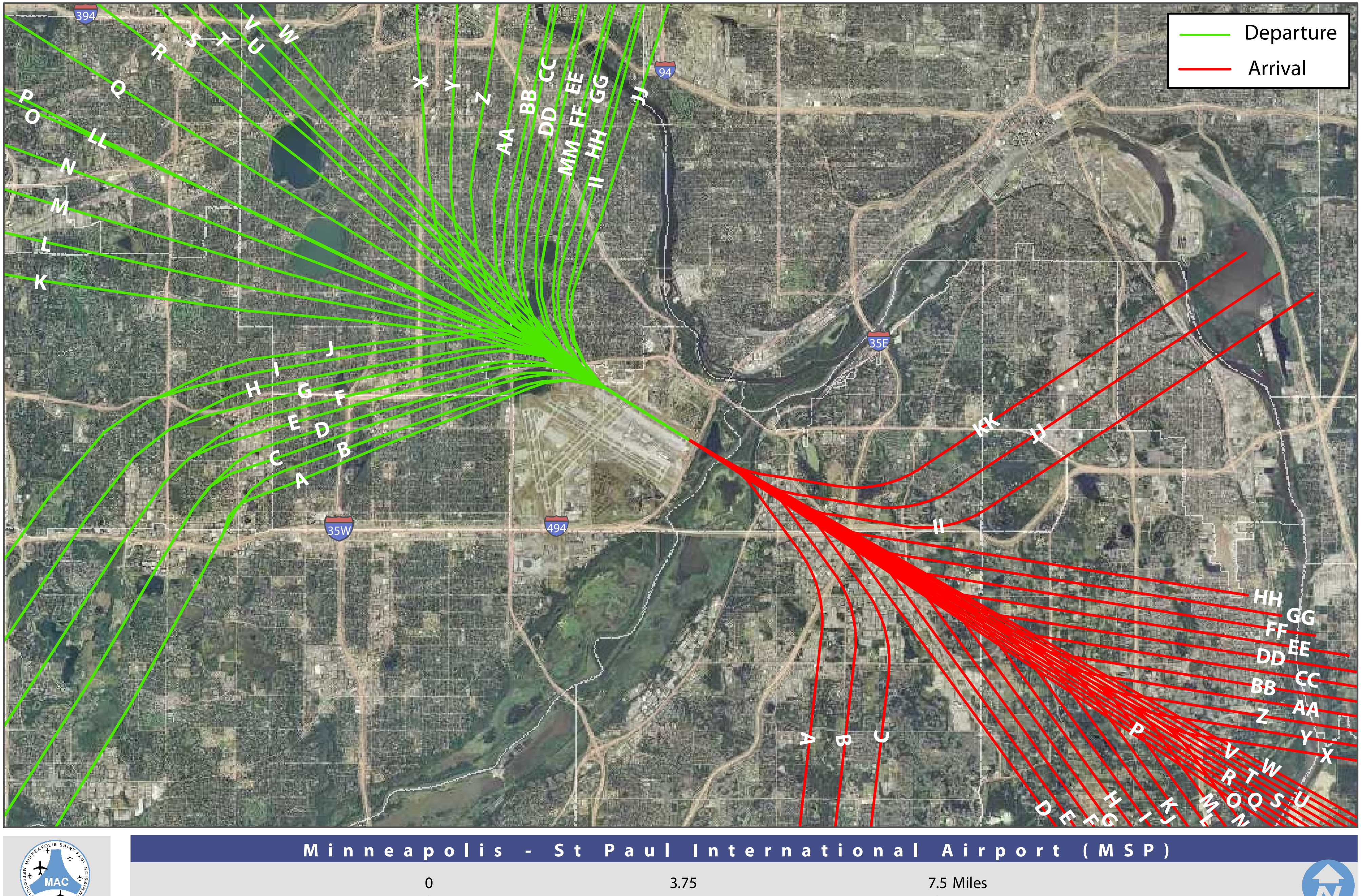


Minneapolis - St Paul International Airport (MSP)

0 4 8 Miles

INM Flight Tracks
Runway 30R

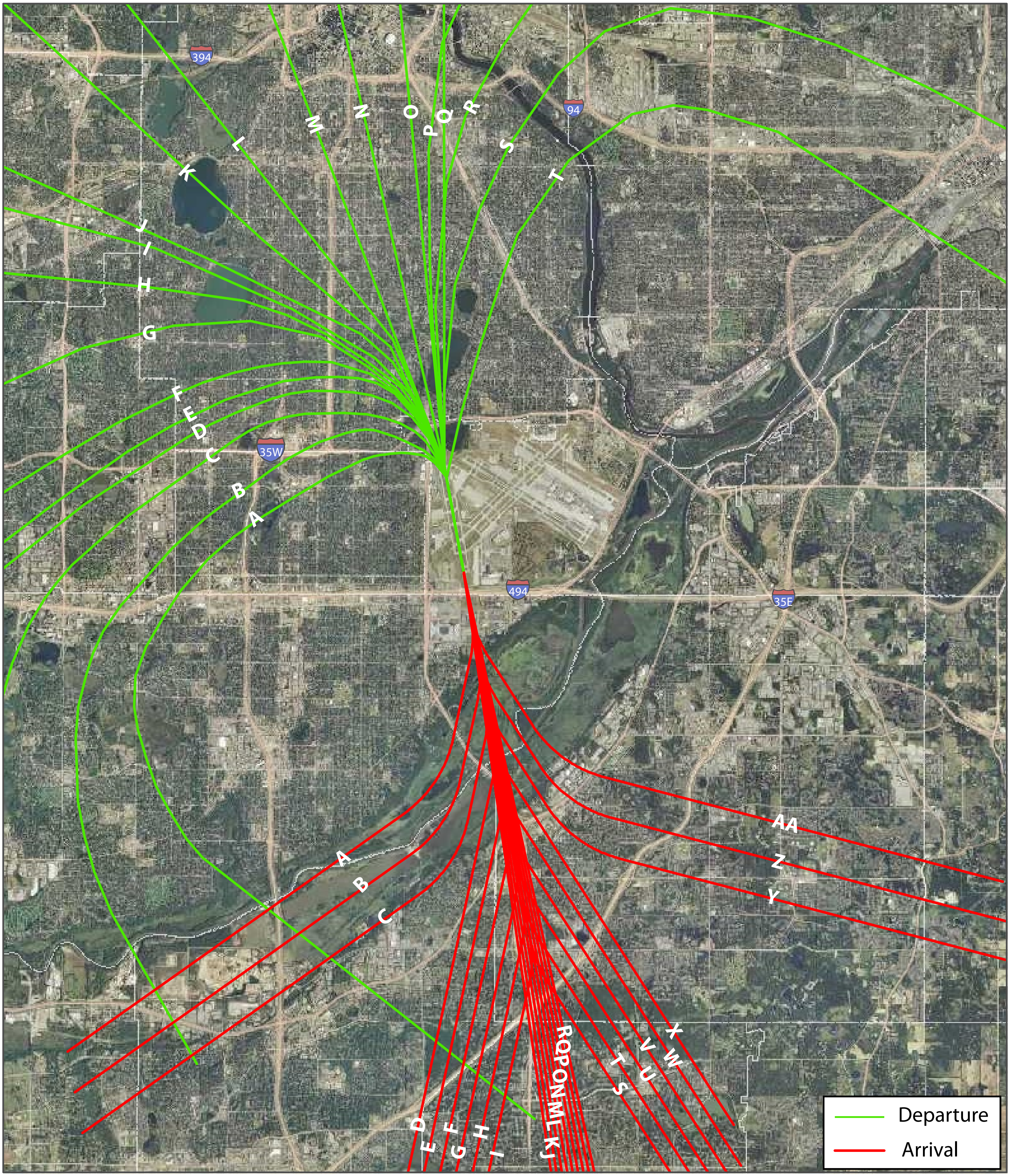
Figure 5-1g



Minneapolis - St Paul International Airport (MSP)

INM Flight Tracks
Runway 35

Figure 5-1h



0 2.5 5 Miles

The use of **Figure 5-1a** absolute values provides a perspective of total difference between the INM-modeled values and the measured DNL values provided by the ANOMS in 2008. The median is considered the most reliable indicator of correlation when considering the data variability across modeled and monitored data.

Overall, the small variation between the actual ANOMS monitored aircraft noise levels and the INM-modeled noise levels provides additional external system verification that the INM is providing an accurate assessment of the aircraft noise impacts around MSP.

TABLE 5.5: 2008 MEASURED VERSUS INM DNL VALUES AT ANOMS RMT LOCATIONS

RMT Site	2008 Annual Measured DNL (a)	2008 Modeled DNL	Difference (Modeled minus Measured)	
			Sign	Absolute
1	57.0	55.9	-1.1	1.1
2	58.9	57.1	-1.8	1.8
3	62.9	62.6	-0.3	0.3
4	61.5	61.2	-0.3	0.3
5	69.4	69.1	-0.3	0.3
6	71.3	68.9	-2.4	2.4
7	60.6	60.5	-0.1	0.1
8	59.0	58.7	-0.3	0.3
9	43.6	42.9	-0.7	0.7
10	48.6	49.5	0.9	0.9
11	44.3	45.6	1.3	1.3
12	39.3	48.1	8.8	8.8
13	54.1	55.8	1.7	1.7
14	62.0	61.4	-0.6	0.6
15	57.5	56.8	-0.7	0.7
16	65.4	63.9	-1.5	1.5
17	49.5	48.2	-1.3	1.3
18	57.9	58.8	0.9	0.9
19	53.7	54	0.3	0.3
20	48.3	50.2	1.9	1.9
21	51.1	52.1	1.0	1.0
22	56.0	56.9	0.9	0.9
23	62.9	61.6	-1.3	1.3
24	60.1	59.9	-0.2	0.2
25	51.5	56.3	4.8	4.8
26	54.8	52.6	-2.2	2.2
27	55.3	56.3	1.0	1.0
28	59.5	61.3	1.8	1.8
29	54.7	54.4	-0.3	0.3
30	62.6	61.2	-1.4	1.4
31	47.9	49.9	2.0	2.0
32	44.9	47.3	2.4	2.4
33	47.7	50.8	3.1	3.1
34	44.8	49.2	4.4	4.4
35	54.2	54.2	0.0	0.0
36	53.5	52.4	-1.1	1.1
37	47.9	49.5	1.6	1.6
38	50.4	51.5	1.1	1.1
39	51.7	53.2	1.5	1.5
Logarithmic Difference			**Average**	**1.9**
			Median	**1.1**

Notes:
All units in dB DNL
(a) computed from daily DNLs

Source: MAC RMT data

5.3.6 2008 BASE CASE NOISE CONTOUR IMPACTS

Based on the 449,972 total operations in 2008, approximately 5,716.5 acres are in the 65 DNL noise contour and approximately 12,975.5 acres are in the 60 DNL noise contour. **Table 5.6** contains the count of single-family (one unit per structure) and multi-family (greater than one unit per structure) dwelling units in the 2008 actual noise contours. The MAC based the counts on the parcel intersect methodology where all parcels that are within or touched by the noise contour are counted.

The 2008 count of residential units within the actual 60 DNL noise contour that have not received noise mitigation around MSP is 4,865. There are no unmitigated homes in the 2008 actual 65 DNL noise contour around MSP.

A depiction of the 2008 actual noise contour is provided in **Figure 5.2**.

TABLE 5.6: SUMMARY OF 2008 ACTUAL DNL NOISE CONTOUR SINGLE-FAMILY AND MULTI-FAMILY UNIT COUNTS

City	Count	Single-Family					Multi-Family				
		60-64	65-69	70-74	75+	Total	60-64	65-69	70-74	75+	Total
Bloomington	Completed	57				57	129	620			749
	Additional										
	Total	57				57	129	620			749
Eagan	Completed	269	1			270					
	Additional										
	Total	269	1			270					
Mendota Heights	Completed	45	1			46	7				7
	Additional										
	Total	45	1			46	7				7
Minneapolis	Completed	6207	2241	116		8564	1905	746	6		2657
	Additional	105				105	4				4
	Total	6312	2241	116		8669	1909	746	6		2661
Richfield	Completed	916	205			1121	284				284
	Additional										
	Total	916	205			1121	284				284
All Cities	Completed	7494	2448	116		10058	2325	1366	6		3697
	Additional	105				105	4				4
	Total	7599	2448	116		10163	2329	1366	6		3701

Note: Parcel intersect method, completed includes all parcels mitigated or eligible for mitigation.

2008 Base Case Contours

Figure 5-2

Minneapolis - St Paul International Airport (MSP)

5.4 2030 PREFERRED ALTERNATIVE FORECAST NOISE CONTOURS

As is detailed in Chapter 4 there are a number of development elements included in the preferred 2030 alternative. Although these developments include additional gates and terminal amenities, because no additional runway capacity is being developed there are no substantive impacts on the forecast noise contours resulting from the proposed developments.

5.4.1 2030 AIRCRAFT OPERATIONS AND FLEET MIX

The forecast information provided in Chapter 2 was the principal source of operations information used in the preparation of the 2030 day/night fleet mix projections. **Table 5.7** provides the total operations summary for 2030.

TABLE 5.7: 2030 TOTAL OPERATIONS NUMBERS

Operations Category	Number of Operations
Scheduled Passenger Air Carrier (a)	576,682
Cargo	18,834
Charter	218
GA (b)	32,988
Military	2,115
Total	**630,837**

Notes:

(a) Includes both air carrier and regional carrier operations

(b) Includes True Air Taxi

This analysis also included the development of detailed fleet mix and stage length information for most of the aircraft operations projected for 2030. Additional analysis utilizing ANOMS and other data sources was required to generate the day/night splits and refine the fleet mix estimates for the general aviation and military operations. **Table 5.8** provides a detailed breakdown of the forecasted 2030 fleet mix at MSP.

TABLE 5.8: 2030 AIRCRAFT FLEET MIX AVERAGE DAILY OPERATIONS

Group	Aircraft Type	Day	Night	Total
Manufactured/Re-engined Stage 3 Jet	737300	0.0	0.0	0.0
	737400	1.8	5.2	7.0
	737700	0.6	0.1	0.7
	737800	227.3	33.3	260.6
	747400	2.1	0.1	2.2
	757300	0.0	0.0	0.0
	757RR	4.4	5.6	10.1
	767300	13.3	3.2	16.5
	767CF6	13.4	1.5	14.9
	777200	8.3	0.5	8.9
	777300	6.4	0.1	6.5
	A300-622R	3.1	2.7	5.9
	A310-304	0.1	0.4	0.5
	A319-131	82.5	9.6	92.1
	A320-211	134.0	15.2	149.3
	A320-232	51.7	5.7	57.4
	A321-232	40.6	5.0	45.6
	A330-301	7.1	0.6	7.7
	A330-343	9.7	0.1	9.8
	CIT3	7.9	0.8	8.7
	CL600	4.2	0.4	4.6
	CL601	251.6	19.5	271.1
	CNA500	2.7	0.2	3.0
	CNA55B	1.1	0.1	1.2
	CNA750	6.1	0.6	6.7
	DC1010	0.4	0.3	0.7
	DHC6	3.6	0.8	4.4
	DHC8	0.1	0.7	0.8
	DHC830	139.0	9.0	147.9
	DO328	0.1	0.0	0.1
	ECLIPSE500	0.5	0.0	0.5
	EMB145	29.9	3.5	33.3
	F10062	0.9	0.1	1.0
	GIV	7.8	0.8	8.5
	GV	271.5	23.4	294.8
	HS748A	0.2	0.0	0.2
	IA1125	0.9	0.1	1.0
	LEAR35	8.6	1.5	10.1
	MD11GE	0.5	0.6	1.1
	MD81	0.1	0.0	0.1
	MD9025	28.7	2.3	31.0
	MU3001	7.0	0.7	7.7
	Total	**1380.0**	**154.2**	**1534.1**

Stage 2 less than 75,000 lbs	FAL20	2.2	0.2	2.4
	GII	1.0	0.1	1.1
	GIIB	0.1	0.0	0.2
	LEAR25	6.5	0.6	7.2
	Total	**9.9**	**1.0**	**10.9**
Propeller	1900D	4.9	0.9	5.8
	BEC58P	14.7	4.5	19.3
	C130	0.1	0.0	0.1
	C-130E	5.0	0.2	5.2
	CNA172	0.1	0.0	0.1
	CNA208	0.8	1.6	2.5
	CNA441	0.8	0.1	0.9
	PA31	0.3	0.1	0.4
	GASEPF	2.1	0.1	2.3
	GASEPV	0.6	0.0	0.6
	Total	**29.5**	**7.7**	**37.1**
Hushkit Stage 3 Jet	737QN	132.0	13.5	145.4
	Total	**132.0**	**13.5**	**145.4**
Helicopter	A109	0.0	0.0	0.1
	B206L	0.1	0.0	0.1
	H500D	0.0	0.0	0.0
	S70	0.0	0.0	0.0
	Total	**0.1**	**0.0**	**0.1**
Military Jet	C17	0.1	0.0	0.1
	C5A	0.0	0.0	0.0
	F16GE	0.0	0.0	0.0
	F-18	0.0	0.0	0.0
	KC-135	0.0	0.0	0.0
	T1	0.1	0.0	0.1
	T34	0.0	0.0	0.0
	T-38A	0.1	0.0	0.1
	U21	0.0	0.0	0.0
	Total	**0.4**	**0.0**	**0.4**
Total Operations		**1551.8**	**176.3**	**1728.1**

Source: ops_calc.dbf from INM Version 7.0b

Notes: Differences may exisit due to rounding

This is the modeled INM fleet mix and due to aircraft substitutions,

it will not exactly match the fleet mix in the LTCP

In summary, a total of 630,837 annual operations, which equates to approximately 1,728 daily operations, are forecasted for 2030.

5.4.2 2030 RUNWAY USE

Table 5.9 shows the 2030 modeled runway use.

TABLE 5.9: 2030 RUNWAY USE

Op Type	Runway	Day	Night	Total
Arrivals	04	0.0%	0.0%	0.0%
	22	0.3%	0.3%	0.3%
	12L	18.6%	17.6%	18.5%
	30R	20.7%	13.2%	19.9%
	12R	22.6%	24.8%	22.8%
	30L	10.4%	10.6%	10.4%
	17	0.0%	0.0%	0.0%
	35	27.5%	33.6%	28.1%
	Total	**100.0%**	**100.0%**	**100.0%**
Departures	04	0.2%	0.0%	0.2%
	22	0.1%	0.1%	0.1%
	12L	15.4%	16.5%	15.5%
	30R	20.9%	20.0%	20.8%
	12R	8.1%	10.9%	8.4%
	30L	24.6%	26.9%	24.8%
	17	30.8%	25.6%	30.3%
	35	0.0%	0.0%	0.0%
	Total	**100.0%**	**100.0%**	**100.0%**
Overall	04	0.1%	0.0%	0.1%
	22	0.2%	0.2%	0.2%
	12L	17.0%	17.0%	17.0%
	30R	20.8%	16.7%	20.4%
	12R	15.3%	17.6%	15.6%
	30L	17.4%	19.0%	17.6%
	17	15.4%	13.2%	15.1%
	35	13.8%	16.2%	14.1%
	Total	**100.0%**	**100.0%**	**100.0%**

The runway use modeled for the scheduled and un-scheduled aircraft operations in the development of the forecasted 2030 noise contour is the same as the runway use included in the July 2005 MSP 2015 Terminal Expansion Environmental Assessment. This was determined based on discussions with the MAC and the Federal Aviation Administration related to how the proposed alternatives at MSP would impact the use of the airfield in 2030. The data used were extracted from Table B.2.2 – 2015 Estimated Average Annual Runway Use for the 2015 Proposed Project located in Appendix B, Page B.2.5 of the July 2005 MSP 2015 Terminal Expansion EA.

The runway use modeled for the military operations forecasted in 2030 is based on the runway use modeled in the 2008 base case noise analysis.

The use of the helicopter pads was limited to the six pads modeled in the 2008 base case noise analysis. The operations were distributed evenly across the six pads.

For the purposes of this analysis the runway use for the scheduled and un-scheduled operations was applied to the fleet mix based on aircraft operational categories. This is consistent with the methodology used in the analysis included in the July 2005 MSP 2015 Terminal Expansion EA.

5.4.3 2030 FLIGHT TRACKS

The flight track layout and associated use for all the modeled operations were derived from the 2008 base case noise contour analysis. The Integrated Noise Model (INM) flight tracks used for the 2030 noise contour are the same as those used for the 2008 base case noise contour as provided in **Figures 5.1 (a-h).** The 2030 INM track usage percentages are provided in **Table 5.10** in Appendix B. As with the runway use, the flight track use for scheduled and un-scheduled operations was also applied to the fleet mix by a secondary aircraft operational category. To this end, the fleet mix modeled was categorized by Heavy (H), Passenger (P), Regional (R) and Propeller (P). The 2030 fleet mix was then assigned the corresponding operational categories, so as to assign the aircraft to the appropriate track, to and from the runway, being used for each operation.

The military operations were assigned to the appropriate tracks in the same manner as was done in the 2008 base case noise contour analysis. The helicopter operations were distributed evenly across the tracks associated with the six pads modeled in the 2008 base case noise contour analysis.

5.4.4 2030 ATMOSPHERIC CONDITIONS

The weather data that were used in the 2030 noise contour modeling were derived from the July 2005 MSP 2015 Terminal Expansion EA. This assumes an annual average temperature of 47.7 degrees Fahrenheit, an average annual pressure of 29.9 inches, an average annual humidity of 64% and a 5.3 knot operational headwind.

5.4.5 2030 NOISE CONTOUR IMPACTS

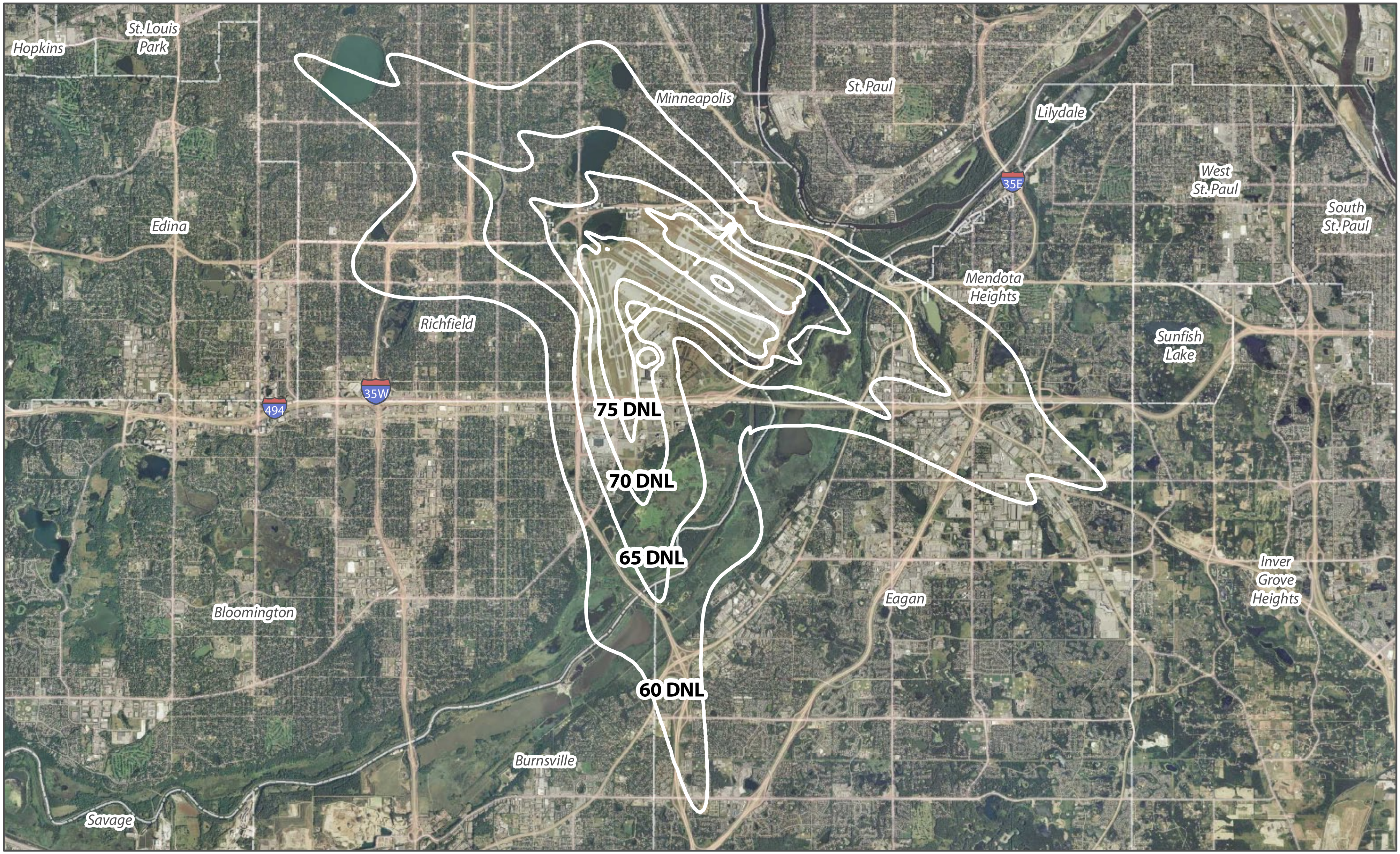
Based on the 630,837 total operations forecasted in 2030, approximately 8,540 acres are in the 65 DNL noise contour (an increase of 2,823.5 acres from the 2008 base case noise contour) and approximately 21,185.1 acres are in the 60 DNL noise contour (an increase of 7,209.7 acres from the 2008 base case noise contour).

Table 5.11 contains the counts of single-family (one unit per structure) and multi-family (greater than one unit per structure) dwelling units in the forecast 2030 noise contour. The counts are based on the parcel intersect methodology where all parcels that are within or touched by the noise contour are counted.

A depiction of the 2030 actual noise contour is provided in **Figure 5-3.**

2030 Preferred Alternative Contours

Figure 5-3



Minneapolis - St Paul International Airport (MSP)

0 3 6 Miles

The forecast 2030 and 2008 base case noise contours are provided in **Figure 5-4**. The 2030 65 DNL noise contour is 49.4% larger than the 2008 base case 65 DNL noise contour, and the 2030 base case 60 DNL noise contour is 55.6% larger than the 2008 base case 60 DNL noise contour.

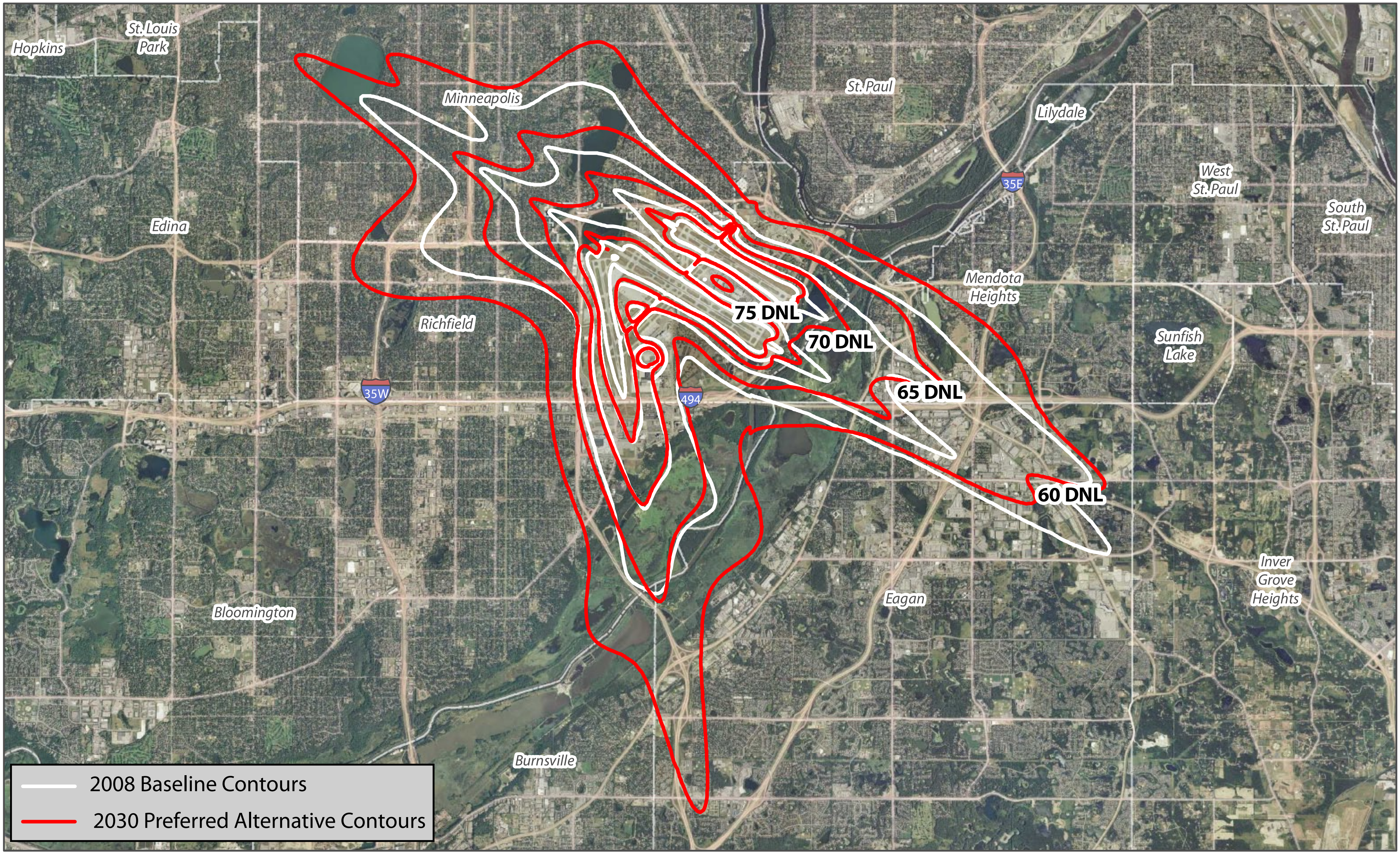
TABLE 5.11: SUMMARY OF 2030 FORECAST DNL NOISE CONTOUR SINGLE-FAMILY AND MULTI-FAMILY UNIT COUNTS

City	Count	Dwelling Units Within DNL (dB) Interval									
		Single-Family					Multi-Family				
		60-64	65-69	70-74	75+	Total	60-64	65-69	70-74	75+	Total
Bloomington	Completed	306	98	0	0	404	666	447	620	0	1733
	Additional	45	0	0	0	45	24	50	0	0	74
	Total	351	98	0	0	449	690	497	620	0	1807
Burnsville	Completed	0	0	0	0	0	0	0	0	0	0
	Additional	29	0	0	0	29	0	0	0	0	0
	Total	29	0	0	0	29	0	0	0	0	0
Eagan	Completed	194	0	0	0	194	0	0	0	0	
	Additional	342	0	0	0	342	104	0	0	0	104
	Total	536	0	0	0	536	104	0	0	0	104
Mendota	Completed	0	0	0	0	0	0	0	0	0	0
	Additional	13	0	0	0	13	0	0	0	0	0
	Total	13	0	0	0	13	0	0	0	0	0
Mendota Heights	Completed	66	4	0	0	70	49	0	0	0	49
	Additional	13	0	0	0	13	226	0	0	0	226
	Total	79	4	0	0	83	275	0	0	0	275
Minneapolis	Completed	6548	3966	784	0	11298	2513	606	525	0	3644
	Additional	3600	2	0	0	3602	1556	0	0	0	1556
	Total	10148	3968	784	0	14900	4069	606	525	0	5200
Richfield	Completed	1172	545	69	0	1786	1407	218	0	0	1625
	Additional	1578	0	0	0	1578	1252	4	0	0	1256
	Total	2750	545	69	0	3364	2659	222	0	0	2881
All Cities	Completed	8286	4613	853	0	13752	4635	1271	1145	0	7051
	Additional	5620	2	0	0	5622	3162	54	0	0	3216
	Total	13906	4615	853	0	19374	7797	1325	1145	0	10267

Note: Parcel intersect method, completed includes all parcels mitigated or eligible for mitigation.

2008 Base Case Contours and 2030 Preferred Alternative Contours

Figure 5-4



Minneapolis - St Paul International Airport (MSP)

0 3 6 Miles

5.5 AIR QUALITY

5.5.1 AIRCRAFT EMMISSIONS

This analysis details the data inputs used to develop the emissions inventory for use in the Long Term Comprehensive Plan Update (LTCP) at Minneapolis St. Paul International Airport (MSP) and the results of the analysis. The purpose of this analysis is to determine the aircraft-related emissions for National Ambient Air Quality Standard (NAAQS) criteria pollutants at MSP for the years 2008 and 2030.

Pollutants Considered

Air pollutants associated with emissions include major criteria pollutants. The US Environmental Protection Agency has established National Ambient Air Quality Standards (NAAQS) and identified six “criteria pollutants” that cause or contribute to air pollution and could endanger the public’s health and welfare. The NAAQS criteria pollutants and/or their precursors included in this study are: Carbon Monoxide (CO), Particulate Matter (PM-10, PM-2.5), Sulfur Dioxide (SO_X), Nitrogen Dioxide (NO_X), Volatile Organic Compounds (VOCs) and lead.

Operational Pollutant Sources

Aircraft operations that potentially contribute to pollutant concentrations on the ground include departure taxiing, queuing, takeoff, climb-out, approach, landing and arrival taxiing. Other aircraft-related emissions included in this emission inventory are aircraft ground support equipment (GSE) and Auxiliary Power Units (APUs) that provide power and air-conditioning to aircraft when the engines are not running.

Aircraft Operations

Annual landing and takeoff aircraft operational levels were determined from the 2008 Integrated Noise Model (INM) operations database file generated and provided by the MAC and the operations database file for the 2030 noise contours. **Tables 5.12** and **5.13** provide the INM and Emissions and Dispersion Modeling System (EDMS) fleet mix modeled and annual landing takeoff operations (LTOs) for 2008 and 2030, respectively. It should be noted that EDMS total operations vary slightly from INM total operations due to rounding functions within the EDMS model.

TABLE 5.12: FLEET MIX AND LTO ANNUAL OPERATIONS – 2008

INM Type	EDMS Type	LTO Annual
F16GE	Lockheed Martin F-16 Fighting Falcon	7.6
GASEPF	Cessna 172 Skyhawk	607.4
GASEPV	Cessna 182	215.3
A109	Agusta A-109	3.5
A300-622R	Airbus A300B4-600 series	755.3
A310-304	Airbus A310-300 series	228.0
A319-131	Airbus A319-100 series	23,163.9
A320-211	Airbus A320-200 series	27,343.8
A321-232	Airbus A321-200 series	137.5
A330-301	Airbus A330-300 series	1,890.8
IA1125	Israel IAI-1125 Astra	168.3
B206L	Bell 206 JetRanger	6.1
B212	Bell UH-1 Iroquois	0.5
B222	Agusta A109	1.0
737N17	Boeing 737-200 series	10.1
737N9	Boeing 737-200 series	7.6
BAC111	BAC 1-11 300/400	2.0
BEC58P	Raytheon Beech Baron 58	2,493.1
1900D	Raytheon Beech 1900-D	885.6
717200	Boeing 717-200 series	1,106.6
737300	Boeing 737-300 series	3,290.5
737400	Boeing 737-400 series	123.9
737500	Boeing 737-500 series	2,282.1
737700	Boeing 737-700 series	2,023.7
737800	Boeing 737-800 with winglets	6,730.0
747100	Boeing 747-100 series	2.0
747200	Boeing 747-200 series	126.4
747400	Boeing 747-400 series	417.6
757PW	Boeing 757-200 series	12,597.1
757300	Boeing 757-300 series	6,486.6
767CF6	Boeing 767-200 series	51.1
767300	Boeing 767-300 series	101.6
777200	Boeing 777-200-ER	5.1
C-130E	Lockheed C-139 Hercules	1,246.3
C17	Boeing C-17A	20.2
C9A	Boeing DC-9-10 series	1.0
CNA172	Cessna 172 Skyhawk	31.8
CNA206	Cessna 206	56.6
CNA500	Cessna 501 Citation I SP	274.5
CIT3	Cessna 500 Citation 1	618.3

INM Type	EDMS Type	LTO Annual
CNA750	Cessna 750 Citation X	1,013.1
CL600	Bombardier Challenger 600	668.8
CL601	Bombardier Challenger 601	50,210.2
CNA441	Cessna 441 Conquest II	222.4
DHC6	DeHavilland DHC-6-300 Twin Otter	1,686.4
DHC8	DeHavilland DHC-8-100	19.2
DC1010	Boeing DC-10-10 series	1,103.6
DC820	Boeing DC-8- series 50	1.5
DC860	Boeing DC-8 series 60	1.0
DC870	Boeing DC-8 series 70	295.3
DC93LW	Boeing DC-9-30 series	9,967.0
DC9Q9	Boeing DC-9-30 series	28.2
DC95HW	Boeing DC-9-50 series	9,972.1
EMB145	Embraer ERJ145-ER	6,299.6
F-18	Boeing F/A-18 Hornet	4.5
727EM1	Boeing 727-100 series	1.0
727EM2	Boeing 727-200 series	840.2
GII	Gulfstream II	380.7
GIIB	Gulfstream II-B	56.6
GIV	Gulfstream IV-SP	388.2
GV	Gulfstream G500	13,286.0
HS748A	Hawker HS748-2	29.8
KC-135	Boeing KC-135 Stratotanker	9.1
L1011	Lockheed L-1011 Tristar	12.1
LEAR25	Bombardier Learjet 25	1,131.8
LEAR35	Bombardier Learjet 36	1,791.5
MD11GE	Boeing MD-11	208.8
MD81	Boeing MD-81	6,003.3
MD9025	Boeing MD-90	132.5
MU3001	Mitsubishi MU-300 Diamond	1,660.1
PA31	Piper PA-31 Navajo	137.5
PA28	Piper PA-28 Cherokee series	7.1
S70	Sikorsky UH-60 Black Hawk	1.0
SD330	Shorts 330-200 series	27.8
SF340	Saab 340-B	21,222.3
T1	Rockwell T-2 Buckeye	19.2
T34	Raytheon Beech Bonanza 36	1.0
U21	Raytheon King Air 90	10.6
Grand Total		224,371.4

Source: MAC INM Input files for 2008 DNL contour; HNTB Analysis, 2009.

TABLE 5.13: FLEET MIX AND LTO ANNUAL OPERATIONS – 2030

INM Type	EDMS Type	LTO Annual
GASEPF	Cessna 172 Skyhawk	413.8
GASEPV	Cessna 182	109.7
A109	Agusta A-109	9.3
A300-622R	Airbus A300B4-600 series	1,073.7
A310-304	Airbus A310-300 series	95.3
A319-131	Airbus A319-100 series	16,800.0
A320-211	Airbus A320-200 series	27,240.2
A320-232	Airbus A320-200 series	10,474.4
A321-232	Airbus A321-200 series	8,319.1
A330-301	Airbus A330-300 series	1,409.3
A330-343	Airbus A330-300 series	1,786.2
IA1125	Israel IAI-1125 Astra	174.7
B206L	Bell 206 JetRanger	11.6
BEC58P	Raytheon Beech Baron 58	3,513.6
1900D	Raytheon Beech 1900-D	1,055.6
737QN	Beoing 737-200 series	26,543.6
737300	Boeing 737-300 series	5.4
737400	Boeing 737-400 series	1,275.7
737700	Boeing 737-700 series	123.3
737800	Boeing 737-800 with winglets	47,566.7
747400	Boeing 747-400 series	397.2
757RR	Boeing 757-200 series	1,836.6
757300	Boeing 757-300 series	6.4
767CF6	Boeing 767-200 series	2,718.5
767300	Boeing 767-300 series	3,020.1
777200	Boeing 777-200-ER	1,617.7
777300	Boeing 777-300 series	1,178.9
C-130E	Lockheed C-139 Hercules	952.2
C130	Lockheed C-139 Hercules	22.5
C17	Boeing C-17A	15.0
C5A	Lockheed C-5 Galaxy	3.8
CNA172	Cessna 172 Skyhawk	26.7
CNA208	Cessna 208 Caravan	449.3
CNA55B	Cessna 550 Citation II	213.9
CNA500	Cessna 500 Citation 1	542.1
CIT3	Cessna 500 Citation 1	1,581.7
CNA750	Cessna 750 Citation X	1,229.2
CL600	Bombardier Challenger 600	838.6
CL601	Bombardier Challenger 601	49,481.4
CNA441	Cessna 441 Conquest II	161.1

INM Type	EDMS Type	LTO Annual
DHC6	DeHavilland DHC-6-300 Twin Otter	795.2
DHC8	DeHavilland DHC-8-100	149.6
DHC830	DeHavilland DHC-8-300	26,998.8
DC1010	Boeing DC-10-10 series	122.3
DO328	Donier 328-100 series	21.9
ECLIPSE500	Piper PA-42 Cheyenne Series	99.9
EMB145	Embraer ERJ145-ER	6,085.2
F10062	Fokker F100	188.2
F16GE	Lockheed Martin F-16 Fighting Falcon	6.0
F-18	Boeing F/A-18 Hornet	5.3
FAL20	Dassault Falcon 20-D	445.1
GII	Gulfstream II	205.8
GIIB	Gulfstream II-B	27.9
GIV	Gulfstream IV-SP	1,553.7
GV	Gulfstream G500	53,806.2
H500D	Hughes 500D	2.3
HS748A	Hawker HS748-2	36.5
KC-135	Boeing KC-135 Stratotanker	5.3
LEAR25	Bombardier Learjet 25	1,309.0
LEAR35	Bombardier Learjet 36	1,840.6
MD11GE	Boeing MD-11	194.1
MD81	Boeing MD-81	22.9
MD9025	Boeing MD-90	5,660.3
MU3001	Mitsubishi MU-300 Diamond	1,400.1
PA31	Piper PA-31 Navajo	68.9
S70	Sikorsky UH-60 Black Hawk	2.3
T1	Rockwell T-2 Buckeye	10.5
T34	Raytheon Beech Bonanza 36	0.8
T-38A	T-38 Talon	14.3
U21	Raytheon King Air 90	6.8
Grand Total		315,379.3

Source: HNTB Analysis, 2009.

Table 5.14 identifies the taxi times used in the EDMS model for each year.

TABLE 5.14: TAXI TIMES (MINUTES)

Year	Taxi-out	Taxi-in
2008	19.2	8.2
2030	18.1	10.7

Source: ASPM Data extracted 11/4/2009, HNTB Analysis, 2005.

The following assumptions were made in development of the inventory:

- Default ground support equipment (GSE) and times for equipment assigned by EDMS were used for individual aircraft types.
- Default auxiliary power unit (APU) values were used (EDMS uses 13 minutes of APU for arrival and departure, a total of 26 minutes).

Version 5.1.1 of EDMS (the latest version) was used to determine aircraft-related emissions.

Results

Tables 5.15 and **5.16** provide the air pollutant emissions in tons per year from aircraft, GSE, and APU operations in 2008 and 2030, respectively. It should be noted that the 2030 GSE pollutants are much lower than 2008 due to EDMS technology assumptions for 2030 GSE. The EDMS model assumes that emission factors (EF) for equipment such as gasoline baggage tractors will be significantly reduced by the year 2030. An example of the CO EF for a baggage tractor in 2008 is 125.6 (grams/hp/hr) and in 2030 CO EF is reduced to 14.0 (grams/hp/hr). These reductions provide a significant decrease in the amount of pollutants created from GSE.

TABLE 5.15: 2008 EMISSIONS INVENTORY (TONS/YEAR)

	Pollutant					
Category	CO	VOC	NOx	SOx	PM-10	PM-2.5
Aircraft	2,210.42	369.82	2,112.56	233.22	34.23	34.23
GSE	2,265.40	79.01	267.33	7.27	8.03	7.71
APUs	99.18	4.83	66.52	8.72	8.00	8.00
Grand Total	4,574.99	453.66	2,446.41	249.20	50.25	49.94

Source: HNTB Analysis, 2009.

TABLE 5.16: 2030 EMISSIONS INVENTORY (TONS/YEAR)

	Pollutant					
Category	**CO**	**VOC**	**NOx**	**SOx**	**PM-10**	**PM-2.5**
Aircraft	3,161.21	441.15	3,260.18	351.11	48.58	48.58
GSE	416.08	17.00	37.91	4.35	2.59	2.41
APUs	108.72	5.68	104.67	13.07	10.64	10.64
Grand Total	3,686.01	463.83	3,402.77	368.54	61.82	61.64

Source: HNTB Analysis, 2009.

5.5.2 ROADWAY AND PARKING EMISSIONS – MSP 2008 AND 2030

Roadway and parking emissions are estimated for existing (2008) vehicle volumes and projected 2030 volumes, assuming development occurs as described in this Long Term Comprehensive Plan Update.

Because the Twin Cities Metropolitan Region is a designated maintenance area for carbon monoxide (CO), the primary pollutant of concern from vehicular traffic is CO. The Minnesota Pollution Control Agency generated CO emission factors from the US Environmental Protection Agency data. However, for this assessment, all criteria pollutants addressed by the EDMS model have also been evaluated.

Default CO emission rates used in the EDMS model were compared with those used by the Minnesota Pollution Control Agency and the Metropolitan Council and found to inadequately represent regional CO emissions. Some reasons for these differences are: the default EDMS evaluation month is July while the Minnesota evaluation month is January, when assumed minimum and maximum temperatures are more than 30 degrees lower; the Reid Vapor Pressure assumed in Minnesota is almost 70% higher than the EDMS default value; the EDMS model uses a national default average vehicle mix, while a vehicle mix unique to the Twin Cities Metropolitan Area is used by the Metropolitan Council. The EDMS default Mobile 6.2 input files do include, however, various fuel-related factors that are not assumed in the Minnesota model since these do not affect CO emissions. Pollutant emission rate predictions for 2008 and 2030 were therefore generated using the Mobile 6.2 emissions model with merged Minnesota and EDMS inputs rather than using the EDMS model directly. In this way, the model reflects regional vehicle registration and age data for the Twin Cities Metropolitan Area and Minnesota temperature and fuel-related parameters, along with fuel-related assumptions in the EDMS model for calculating non-CO emission rates. A range of predicted speeds from 2.5 mph to 65 mph was used in this evaluation for predictions in parking ramps, arterial/collector roads and freeways.

Roadway Emissions

Roadway emissions are based upon traffic forecasts provided by the Metropolitan Council, for public roadways on and surrounding MSP. Traffic estimates on these roadways associated with the Lindbergh Terminal and the Humphrey Terminal parking ramps were generated for 2009 and for 2030 without the MSP 2030 improvements. The increase in background traffic between these two years was small; it is therefore reasonable to assume that 2009 volumes can be used for 2008. The 2030 public roadway volumes were adjusted upwards to account for the MSP 2030 plan using the Average Daily Traffic volume growth on Glumack Drive projected in Section 3.6. This growth factor, based on **Table 3.3**, is 1.366.

The allocation of traffic on Lindbergh Terminal roadways developed in the MSP 2015 Terminal Expansion Environmental Assessment was assumed in this study but with volumes adjusted upward using the growth factor noted above. Limited growth was assumed on the airport road servicing the air cargo area.

An estimate of criteria pollutant emissions on major roadways around the perimeter of MSP and within the airport was made for each roadway segment for which traffic volumes were available.

Emissions were based upon daily travel volumes, average travel speed, and emission factors. As noted above, emission factors were generated with the Mobile 6.2 model for the Twin Cities Metropolitan Area. Annual traffic volumes were estimated from daily traffic, assuming traffic occurs 365 days per year. Summaries of roadway emissions for 2008 and 2030 are presented below in **Table 5.17** and **Table 5.18**, respectively.

TABLE 5.17: ROADWAY CRITERIA POLLUTANTS EMISSIONS 2008 (SHORT TONS PER YEAR)

Roadway Segment	Length (mi)	MPH	ADT	CO	NMHC	VOC	TOG	NOx	SOx	PM-10	PM-2.5
34th Avenue	0.985	40	43,154	298.52	13.01	13.17	14.09	27.74	0.15	0.82	0.53
West Service Road	1.924	35	1,245	16.37	0.75	0.76	0.82	1.53	0.01	0.05	0.03
I-494 (TH77 to 24th Ave)	0.454	60	37,104	133.33	4.76	4.82	5.14	14.53	0.06	0.32	0.21
I-494 (24th Ave to 34TH Ave)	0.727	60	46,599	267.91	9.57	9.68	10.32	29.20	0.12	0.65	0.43
I-494 (34th Ave to TH5)	0.454	65	37,251	138.30	4.73	4.78	5.09	16.18	0.06	0.33	0.21
Lindbergh Exit	0.660	35	34,371	154.96	7.14	7.22	7.74	14.49	0.08	0.44	0.29
Lindbergh Entrance	0.614	35	34,371	143.99	6.63	6.71	7.19	13.47	0.07	0.40	0.27
Post Road	1.298	40	34,371	101.04	4.40	4.46	4.77	9.39	0.05	0.28	0.18
Terminal Roadways	0.677	20	10,243	96.18	5.04	5.11	5.51	9.30	0.05	0.25	0.17
TH 5 (TH55 to Entrance)	1.119	65	50,255	459.18	15.70	15.88	16.90	53.72	0.20	1.08	0.71
TH 5 (Entrance to 34th Ave)	0.510	65	43,839	182.38	6.24	6.31	6.71	21.34	0.08	0.43	0.28
TH 5 (34th Ave to I-494)	0.946	65	37,179	287.12	9.82	9.93	10.57	33.59	0.12	0.68	0.44
TH 55 (TH62 to TH5)	0.900	55	22,961	158.17	5.93	6.00	6.40	16.40	0.07	0.40	0.26
TH 62 (TH77 to 28th Ave)	0.441	60	12,468	43.49	1.22	1.28	1.21	1.52	0.02	0.07	0.04
TH 62 (36th Ave to TH55)	0.820	60	13,212	85.59	2.40	2.52	2.38	2.99	0.04	0.14	0.08
TH 77 (I-494 to 66th St)	1.470	55	4,659	52.45	1.97	1.99	2.12	5.44	0.02	0.13	0.09
TH77 (66th St to TH62)	0.849	55	4,055	26.35	0.99	1.00	1.07	2.73	0.01	0.07	0.04
Roadway Emissions (2008)				2645.33	100.30	101.62	108.01	273.56	1.22	6.53	4.25

TABLE 5.18: ROADWAY CRITERIA POLLUTANT EMISSIONS 2030 (SHORT TONS PER YEAR)

Roadway Segment	Length (mi)	MPH	ADT	CO	NMHC	VOC	TOG	NOx	SOx	PM-10	PM-2.5
34th Avenue	0.985	40	58,948	267.23	7.28	7.37	7.96	8.14	0.21	0.66	0.31
West Service Road	1.924	35	1,700	14.64	0.42	0.42	0.46	0.45	0.01	0.04	0.02
I-494 (TH77 to 24th Ave)	0.454	60	50,246	118.62	2.72	2.76	2.96	3.73	0.08	0.26	0.12
I-494 (24th Ave to 34TH Ave)	0.727	60	63,029	238.08	5.45	5.54	5.95	7.48	0.17	0.52	0.25
I-494 (34th Ave to TH5)	0.454	65	51,613	125.94	2.78	2.83	3.04	4.05	0.08	0.27	0.13
Lindbergh Exit	0.660	35	47,401	139.87	4.00	4.06	4.37	4.31	0.11	0.35	0.17
Lindbergh Entrance	0.614	35	47,401	129.97	3.71	3.77	4.06	4.01	0.11	0.33	0.16
Post Road	1.298	40	47,401	88.24	2.40	2.43	2.63	2.69	0.07	0.22	0.10
Terminal Roadways	0.677	20	13,650	86.44	2.82	2.87	3.11	2.78	0.07	0.21	0.10
TH 5 (TH55 to Entrance)	1.119	65	68,190	409.48	9.04	9.20	9.87	13.18	0.28	0.86	0.41
TH 5 (Entrance to 34th Ave)	0.510	65	60,666	165.87	3.66	3.73	4.00	5.34	0.11	0.35	0.17
TH 5 (34th Ave to I-494)	0.946	65	52,411	266.01	5.87	5.97	6.41	8.56	0.18	0.56	0.27
TH 55 (TH62 to TH5)	0.900	55	30,904	139.79	3.33	3.38	3.63	4.32	0.10	0.32	0.15
TH 62 (TH77 to 28th Ave)	0.441	60	16,049	36.78	0.84	0.86	0.92	1.16	0.03	0.08	0.04
TH 62 (36th Ave to TH55)	0.820	60	17,137	72.94	1.67	1.70	1.82	2.29	0.05	0.16	0.08
TH 77 (I-494 to 66th St)	1.470	55	5,917	43.74	1.04	1.06	1.14	1.35	0.03	0.10	0.05
TH77 (66th St to TH62)	0.849	55	5,211	22.23	0.53	0.54	0.58	0.69	0.02	0.05	0.02
Roadway Emissions (2030)				2365.86	57.58	58.51	62.91	74.53	1.70	5.33	2.55

Parking Emissions

Parking emissions are estimated from the major parking facilities on the airport that are shown in **Table 5.19**. No parking was assumed for the Econo-Lot and the Delta F Ramp.

TABLE 5.19: MAJOR MSP PARKING FACILITIES ANALYZED

Parking Area	2008 Parking Spaces	2030 Parking Spaces
Lindbergh Ramp	14,400	24,500
Humphrey Ramp	9,200	15,100
Delta B Ramp	1,700	1,700
Delta C South Lot	2,300	2,300
Delta C North Lot	1,500	1,500
Total Spaces	29,100	45,100

Emissions are not related directly to the number of parking spaces, but are related to the vehicular activity within each parking area, the average travel speed of vehicles on access roads to and from the ramp and within the ramp, and the average idling time within the ramp. Detailed activity in the Lindbergh Terminal and Humphrey Terminal ramps was developed for the MSP 2015 Terminal Expansion Environmental Assessment and has been assumed in this study. This activity (hourly inbound and outbound vehicle volumes by time of day and day of week) has not changed and is therefore still relevant for this analysis.

Assumed travel distance on ramp access roads and within the ramp, average travel speed and vehicle activity per 24-hour day are shown in **Table 5.20**. Travel distance includes the ramp access road that is separated from the terminal roadway. A speed of 35 mph is assumed along these roadways at the Lindbergh Terminal and Humphrey Terminal ramps with a ramp speed of 5 mph. Delta's (formerly Northwest's) parking demand was reduced to account for an expected reduction in work force at MSP although use of these spaces remains uncertain.

TABLE 5.20: PARKING FACILITY PARAMETERS ASSUMED FOR THE EMISSIONS ANALYSIS

Parking	Travel	Speed	Veh/space	
Facility	(ft)	(mph)	Weekday	Weekend
Lindbergh	6800	35/5	0.988	0.697
Humphrey	4500	35/5	0.727	0.531
Delta B Ramp	400	10	2.55	0.638
Delta C South	800	10	1.656	0.414
Delta C North	700	10	1.787	0.447

Note: From EA-2015 Terminal Expansion Project, August 2005.

The average weekday and weekend activity in the combined Lindbergh Terminal general and short-term parking areas and in the Humphrey Terminal ramp is presented in **Table 5.21**.

TABLE 5.21: ASSUMED ENTRY PLUS EXIT MOVEMENTS

	Lindbergh Ramp		Humphrey Ramp	
	Weekday	Weekend	Weekday	Weekend
2008	12,406	8,749	4,465	3,496
2030	24,196	17,064	10,975	8,014

Note: Adjusted from EA-2015 Terminal Expansion Project, August 2005.

For the Lindbergh ramp, the number of vehicles entering and exiting is essentially the same on weekdays and weekends. This may also be true for the Humphrey ramp in 2030 but data from actual activity were deemed more reliable.

The resulting carbon monoxide emission estimates for parking facilities in 2008 and 2030 are presented in **Table 5.22** to demonstrate the relative contributions of each ramp. Relative contributions of other pollutants are similar.

TABLE 5.22: PARKING CARBON MONOXIDE EMISSIONS (SHORT TONS/YEAR)

Parking Area	2008	2030
Lindbergh Ramp	137.88	172.87
Humphrey Ramp	34.70	53.89
Delta B Ramp	5.42	3.41
Delta C South Lot	9.22	4.30
Delta C North Lot	5.65	2.84
All spaces	192.86	237.30
Net Change		44.44

Combined Roadway and Parking Emissions

A comparison of the combined roadway and parking emissions for 2008 and 2030 is presented in **Table 5.23**.

TABLE 5.23: COMBINED ROADWAY AND PARKING CARBON MONOXIDE EMISSIONS (TONS)

	CO	NMHC	VOC	TOG	NOx	SOx	PM-10	PM-2.5
2008								
Roadway	2645.33	100.30	101.62	108.01	273.56	1.22	6.53	4.25
Parking	192.86	12.80	12.65	13.87	18.40	0.07	0.40	0.26
Total	2838.19	113.10	114.27	121.88	291.96	1.29	6.93	4.51
2030								
Roadway	2365.86	57.58	58.51	62.91	74.53	1.70	5.33	2.55
Parking	237.30	9.83	9.68	10.74	7.77	0.14	0.45	0.22
Total	2603.17	67.41	68.19	73.65	82.30	1.84	5.78	2.77
Change	-235.02	-45.69	-46.09	-48.23	-209.66	0.55	-1.14	-1.74

The change in emissions resulting from the implementation of the 2030 Long Term Comprehensive Plan Update is a decrease of 235 tons of carbon monoxide emissions and 210 tons of NOx. This result is based upon an evaluation of traffic changes in the immediate vicinity of the airport combined with parking changes on the airport. The lower emissions in 2030 are due primarily to reductions in pollutant emissions from motor vehicles that are significant enough to overcome the projected increase in airport-related vehicle volumes.

Therefore, a reduction in overall traffic and parking emissions is predicted in the immediate airport area, and no regional adverse impacts on air quality is anticipated with implementation of the 2030 Long Term Comprehensive Plan Update.

Infrastructure Emissions

Infrastructural emissions are primarily associated with heating of terminal facilities. Other point sources include vehicle fueling, paint, generators and solvents. Actual emissions from these sources for 2008 are listed below in **Table 5.24**.

According to an analysis completed by Michaud Cooley Erickson, the Metropolitan Airports Commission’s energy consultant, the extension of the G Concourse at the Lindbergh Terminal is expected to generate an additional 54% of demand on the heating system. The current system has the capability to absorb the majority of this load; however, additional boiler capacity will need to be added or greater efficiencies will need to be incorporated into the building envelope to reduce the demand. The Humphrey Terminal is scheduled for significant development and will require an additional 178% of demand capacity over the existing system per this same analysis. Other sources are not anticipated to change significantly. A comparison of the 2008 and 2030 infrastructure emissions is presented in **Table 5.24**.

TABLE 5.24: INFRASTRUCTURE EMISSIONS

	CO	VOC	Lead	NOx	SOx	PM-10	PM-2.5
2008 (tons/year)							
Lindbergh Terminal	14.690	0.962	0.000	17.488	0.105	1.329	1.329
Humphrey Terminal	1.273	0.083	0.000	1.516	0.009	0.115	0.115
Other Sources	4.227	2.845	0.000	6.396	0.496	3.556	2.120
Total MAC	20.19	3.890	0.000	25.4	0.610	5.000	3.564
2030 (tons/year)							
Lindbergh Terminal	22.623	1.481	0.000	26.932	0.162	2.047	2.047
Humphrey Terminal	3.539	0.231	0.000	4.214	0.025	0.320	0.320
Other Sources	4.227	2.845	0.000	6.396	0.496	3.556	2.120
Total MAC	30.389	4.557	0.000	37.542	0.683	5.922	4.486
Change	10.199	0.667	0.000	12.142	0.073	0.922	0.922

The 2030 Long Term Comprehensive Plan Update (LTCP) terminal expansions represent an opportunity to incorporate a significant number of building efficiency improvements to address the anticipated energy needs. The Metropolitan Airports Commission may consider LEED-certified buildings, green roof designs and a number of energy sources such as solar, geothermal and wind technologies to incorporate renewable energy advancements. The above emissions estimate is expected to be a worst-case scenario, using current efficiencies and system management controls. The increase in emissions in 2030 is due to increased terminal square footage and no incorporation of energy conservation technologies.

Emissions Summary

The emissions analysis conducted for this LTCP included an evaluation of aircraft, Ground Service Equipment (GSE), Auxiliary Power Unit, roadway and parking emissions as well as infrastructure. During this planning period there will be an increase in emissions associated with infrastructure development. However, US Environmental Protection Agency and Federal Aviation Administration model assumptions incorporate significant carbon monoxide (CO) emission reductions associated with GSE and vehicles. As previously stated, the Twin Cities Metropolitan Region is a designated maintenance area for CO. The estimated reduction in CO with the 2030 development is in excess of 1100 tons.

5.6 SANITARY SEWER AND WATER

5.6.1 SANITARY SEWER

Wastewater discharges from MSP are conveyed to the Metropolitan Council Environmental Services (MCES) Metro Plant on Childs Road. This plant has a design capacity of 250 million gallons per day (MGD). The proposed projects are expected to increase passenger loads by approximately 50% between 2008 and 2030. This passenger growth will be accompanied by an approximately equivalent increase in wastewater discharges.

Wastewater is discharged to the Metro Plant through the MCES sewer interceptor system. Discharges from MSP are conveyed to the interceptor system through three different sewer systems. The majority is discharged from the airport to a tunnel near the Mississippi River that discharges into the interceptor system. A small volume of wastewater is discharged into the City of Minneapolis sewer system prior to reaching the MCES interceptors. Wastewater from the southwest portion of MSP is discharged through the City of Richfield sewer system prior to reaching the MCES interceptors.

The estimated 50% increase in passenger loads is predicted to increase the daily sanitary discharge volume by approximately 0.35 MGD. This increase would be conveyed through the tunnel and Richfield systems. Assuming a 2.5 peak loading factor, this would amount to a peak addition of approximately 37,000 gallons per hour. This increase in loading is not expected to be an issue with the Metro Plant's total capacity, because the increase amounts to less than 0.2% of the plant's daily treatment capacity. However, there could be issues with the wet-weather conveyance capacity of the interceptor system from other municipal sources. The MCES has informed Metropolitan Airports Commission (MAC) staff and consultants that there is sufficient dry-weather capacity in the MCES interceptor system to handle the proposed increase in flow (see discussion below regarding wet-weather capacity). In addition, the Richfield system is oversized to provide options for the City of Bloomington to divert its discharges through the Richfield system to the Metro Plant if Bloomington's conveyance to the Seneca Treatment Facility is obstructed. Recent upgrades to the Bloomington conveyance system make Bloomington's use of the Richfield system unlikely. Therefore, the Richfield system should have adequate capacity.

Additionally, the City of Minneapolis and the MCES have been working diligently on a Combined Sewer Overflow (CSO) separation project that will return sewer capacity and reduce the CSO problems that exist within the sanitary sewer network. Although the issue is not unique to airport growth, the MAC is considering the timing and impact of these projects in future planning for MSP.

Whether or not the proposed Capital Improvement Program projects for MSP are implemented, the MAC-owned sanitary sewer infrastructure may require upgrades to convey the higher volume of wastewater from the Lindbergh and/or Humphrey Terminals (upstream of the “tunnel” and Richfield systems). As it makes development decisions, the MAC will evaluate the existing capacity of the MAC-owned sanitary sewer system to determine where and when capacity limitations may be encountered.

The MAC has reduced the use of municipality-supplied potable water by specifying and using high-efficiency fixtures/valves, such as automatic sensors, to reduce water usage and wastewater volumes. These measures have resulted in sanitary sewer flow reduction; therefore, capacity exists for the projects planned in the LTCP.

Any environmental concerns associated with this project activity are mitigated with the acquisition and the maintenance of appropriate permits.

5.6.2 WATER SUPPLY

As noted in Chapter 1, the MSP campus currently uses approximately one million gallons of potable water per day. The uses include restrooms, concessions, tenant facilities, facility cleaning, irrigation, cargo uses, and rental car wash facilities. The proposed projects in this LTCP document include expansions to concourses at both the Lindbergh and Humphrey Terminals. These expansions will include additional restrooms and concessions, along with other water using services. The proposed plan also includes a hotel, which would be a significant user of potable water.

By 2030, the proposed projects would increase water demand at the airport. As projects are reviewed for preliminary engineering and design, water usage and fire flow demands will be incorporated. It is not expected that water usage would exceed 1.5 million gallons per day based on the proposed projects in this LTCP document.

The City of Minneapolis currently provides 100% of the water used on campus. The city's current maximum capacity is 180 million gallons per day. The maximum peak usage in the city in 2007 was approximately 145 million gallons per day. Therefore, the MAC's increased usage will not require capacity enhancements in Minneapolis. The MAC has also studied the possibility of obtaining some of its water from either the City of Richfield or the City of St. Paul. While not proposed at this time, these are alternatives that could be reviewed as a part of future ways to meet increasing water demands.

5.6.3 SOLID WASTE

The quantities of waste generated by an increase in the traveling public cannot be identified with certainty at this time; however such an increase is not expected to have a significant impact on the airport's solid waste capacity. The MAC and MSP tenants will continue efforts in waste reduction and recycling, commensurate with increased awareness and participation on the part of the traveling public.

Any increases in solid waste generation are assumed to be within the capability of the regional solid waste management system.

5.7 WATER QUALITY

Based on a review of the anticipated projects identified in this LTCP Update, there will be a minor (2 %) increase in new impervious pavement. The MAC will evaluate each phase of construction and the associated storm water runoff from the new impervious surface with respect to the drainage areas previously discussed in Chapter 1. The various project sites are located primarily on previously-developed areas. Each drainage area and the associated pond will be evaluated during the environmental review process to minimize the impacts, and measures such as green roofs and emerging technologies will be used to manage the storm water flows. Based on these measures it is not anticipated that the storm water quality will be affected; therefore storm water runoff will be able to be to be handled by the current detention ponds. It should be noted, however, that storm water from the MSP detention ponds discharges to the Minnesota River, which then flows to the Mississippi River. Both of these rivers have been identified by the MPCA as water quality impaired for a number of pollutants and stressors.

The MAC is considering utilizing a green roof concept on some of the proposed terminal expansions. This initiative may result in a reduction in the amount and rate (peak flow) of runoff entering the storm water drainage system. The retained water would be available for use by the roof vegetation instead of being added to the storm drains.

As mentioned in Chapter 1, storm water runoff from nearly all of MSP is directed to one of three storm water detention pond systems. These ponds provide protection for the Minnesota River against fuel spills and, as designed, remove total suspended solids, phosphorus and other pollutants from the storm water.

There are no known groundwater impacts in the area of the LTCP Update projects. The projects may have minor short-term localized groundwater movement but are not expected to have a significant effect on hydro-geological conditions on the airport.

If groundwater impacts are encountered during project implementation or during site prep, mitigation of the impacted water will occur in accordance with Minnesota Pollution Control Agency (MPCA) permits and regulations. Under the construction dewatering National Pollutant Discharge Elimination System permit, groundwater is brought to a water management area and, if contaminated, is either treated through a carbon system for a surface water discharge or is routed to the municipal wastewater treatment system.

Expansion of the terminals will require an expansion of the existing fuel hydrant system. Although this will not affect the groundwater, it may create a potential source of groundwater impacts should the hydrant system have an unintended release. Leak detection equipment, system maintenance procedures and Best Management Practices currently employed with the airport hydrant system will be applied to a new system to ensure that the potential for unsought releases is minimized. Additionally, the MPCA will incorporate and review any additions to the hydrant fueling system as part of the Aboveground Storage Tank permitting process.

5.8 WETLANDS

As briefly discussed in Chapter 1, very few wetlands remain on the MSP campus, aside from Mother Lake. It is unlikely that any of the proposed projects will impacts remnant wetlands. There are no obvious wetland impacts identified for the projects proposed in this LTCP Update document. However, project locations will be reviewed in more detail as part of any environmental review document completed for specific projects, with any necessary impacts and corresponding mitigation identified.

CHAPTER 6: LAND USE COMPATIBILITY

CHAPTER 6: LAND USE COMPATIBILITY

6.1 INTRODUCTION

Planning for the maintenance and development of airport facilities is a complex process. Successfully developing airports requires insightful decision-making predicated on various facts that drive the need for the development of additional airport infrastructure. Airports cannot be developed in a vacuum; the development effort must consider the needs of the surrounding populations and the land uses in the area surrounding the airport.

Cities and airport operators are both responsible for the ongoing development of public assets. The development of United States airports, as well as city infrastructure, falls within the concept of conducting development predicated on the greater public interest. The responsible development of such community and airport infrastructure requires cooperative efforts on behalf of the airport proprietor and the community.

As city governments are responsible for the development and enhancement of city infrastructure, airport proprietors are responsible for the federally endorsed enhancement of our nation's airport system. Airport operators would be remiss in their duties if such efforts did not consider the land use consequences of decisions made regarding airport development.

This chapter evaluates the land use implications of the planned operation and development of the Minneapolis-St. Paul International Airport.

6.2 LAND USE COMPATIBILITY

The Federal Aviation Administration (FAA) has established Land Use Compatibility criteria in 14 C.F.R. Part 150 detailing acceptable land uses around airports by considering noise impacts in terms of Day-Night Sound Level (DNL). In the case of airports located in the Minneapolis-St. Paul Metropolitan Area additional criteria also must be evaluated in relation to noise exposure as established by the Metropolitan Council's Transportation Policy Plan (TPP).

6.2.1 FAA LAND USE COMPATIBILITY GUIDELINES

Federal guidelines for compatible land use that take into account the impact of aviation noise have been developed for land near airports. They were derived through an iterative process that started before 1972. Independent efforts by the FAA, US Department of Housing and Urban Development, US Air Force, US Navy, US Environmental Protection Agency and other Federal agencies to develop compatible land use criteria were melded into a single effort by the Federal Interagency Committee on Urban Noise (FICUN) in 1979, and resulted in the FICUN Guidelines document (1980). The Guidelines document adopted DNL as its standard noise descriptor, and the Standard Land Use Coding Manual (SLUCM) as its standard descriptor for land uses. The noise-to-land use relationships were then expanded for the FAA's Advisory Circular Airport-Land Use Compatibility Planning. The current individual agency compatible land use criteria have been, for the most part, derived from those in the FICUN Guidelines. Airport environments pertain only to certain categories of these guidelines.[5]

In 1985 the FAA adopted 14 C.F.R. Part 150 outlining land use compatibility guidelines around airports. **Table 6.1** provides the land use compatibility guidelines as established by the FAA.

According to FAA standards, areas with noise levels less than 65 DNL are considered compatible with residential development.

6.2.2 METROPOLITAN COUNCIL LAND USE COMPATIBILITY GUIDELINES

The Metropolitan Council has developed a set of land-use planning guidelines for responsible community development in the Minneapolis-St. Paul Metropolitan Area. The intent is to provide city governments with a comprehensive resource with regard to planning and community development in a manner that considers the adequacy, quality and environmental elements of planned land uses.

In 1976 the Minnesota Legislature enacted the Minnesota State Land Planning Act, the underlying law that requires local units of government to prepare a comprehensive plan and submit it for Metropolitan Council review. Under the 1976 legislation, communities designated land uses and defined the zoning applicable to the particular land use parcel. Zoning was the statute's priority. The land use measure was a request that local jurisdictions review existing zoning in Airport Noise Zones to determine consistency with the regional compatibility guidelines and rezone property for compatible development if consistent with other development factors. In 1977, the Metropolitan Council also updated the 1973 Aviation Chapter of the Metropolitan Development Guide. In 1983, the Metropolitan Council amended its Aviation Policy Plan to include "Land Use Compatibility Guidelines for Aircraft Noise."

In 1994 the Minnesota Legislature amended the Land Planning Act to require that communities update their comprehensive plans at least every 10 years. As a result, all Metropolitan Development Guide chapters were updated by December 1996. Under the amended Land Planning Act, communities determine the land use designation; zoning must be consistent with that designation. Thus, the communities had to re-evaluate designated use, permitted uses within the designation, zoning classifications and adequacy.

[5] Federal Interagency Committee On Noise (FICON), "Federal Agency Review of Selected Airport Noise Analysis Issues, " (1992), pp. 2-6 to 2-7.

TABLE 6.1: FAA AIRCRAFT NOISE AND LAND USE COMPATIBILITY GUIDELINES

Land Use	DNL Contour Interval (dB)					
	Less than 65	65-69	70-74	75-79	80-84	Greater than 85
Residential						
Residential, other than mobile homes and transient lodgings	Y	N(1)	N(1)	N	N	N
Mobile home park,	Y	N	N	N	N	N
Transient Lodgings	Y	N(1)	N(1)	N(1)	N	N
Public Use						
Schools	Y	N(1)	N(1)	N	N	N
Hospitals and nursing homes	Y	25	30	N	N	N
Churches, auditoriums, and concert halls	Y	25	30	N	N	N
Governmental services	Y	Y	25	30	N	N
Transportation	Y	Y	Y(2)	Y(3)	Y(4)	Y(4)
Parking	Y	Y	Y(2)	Y(3)	Y(4)	Y
Commercial Use						
Offices, business and professional	Y	Y	25	30	N	N
Wholesale and retail–building materials, Hardware and farm equipment	Y	Y	Y(2)	Y(3)	Y(4)	N
Retail trade–general	Y	Y	25	30	N	N
Utilities	Y	Y	Y(2)	Y(3)	Y(4)	N
Communication	Y	Y	25	30	N	N
Manufacturing and Production						
Manufacturing, general	Y	Y	Y(2)	Y(3)	Y(4)	N
Photographic and optical	Y	Y	25	30	N	N
Agriculture (except livestock) and forestry	Y	Y(6)	Y(7)	Y(8)	Y(8)	Y(8)
Livestock farming and breeding	Y	Y(6)	Y(7)	N	N	N
Mining and fishing, resource Production and extraction	Y	Y	Y	Y	Y	Y
Recreational						
Outdoor sports arenas and spectator sports	Y	Y(5)	Y(5)	N	N	N
Outdoor music shells, amphitheaters	Y	N	N	N	N	N
Nature exhibits and zoos	Y	Y	N	N	N	N
Amusements, parks, resorts and camps	Y	Y	Y	N	N	N
Golf courses, riding stables, and water recreation	Y	Y	25	30	N	N

See following page for Table Key and Notes.

Key

SLUCM	Standard Land Use Coding Manual.
Y(Yes)	Land use and related structures compatible without restrictions.
N(No)	Land use and related structures are not compatible and should be prohibited.
NLR	Noise Level Reduction (outdoor to indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure.
25, 30, or 35	Land use and related structures generally compatible; measures to achieve NLR of 25, 30, or 35 dB must be incorporated into design and construction of structure.

Notes

The designations contained in this table do not constitute a federal determination that any use of land covered by the program is acceptable or unacceptable under federal, state, or local law. The responsibility for determining the acceptable and permissible land uses and the relationship between specific properties and specific noise contours rests with the local authorities. FAA determinations under Part 150 are not intended to substitute locally determined land uses for those determined to be appropriate by local authorities in response to locally determined needs and values in achieving noise compatible land uses.

(1) Where the community determines that residential or school uses must be allowed, measures to achieve outdoor to indoor Noise Level Reduction (NLR) of at least 25 dB and 30 dB should be incorporated into building codes and be considered in individual approvals. Normal residential construction can be expected to provide a NLR of 20 dB, thus, the reduction requirements are often stated as 5, 10, or 15 dB over standard construction and normally assume mechanical ventilation and closed windows year round. However, the use of NLR criteria will not eliminate outdoor noise problems.

(2) Measures to achieve NLR of 25 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.

(3) Measures to achieve NLR of 30 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.

(4) Measures to achieve NLR of 35 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.

(5) Land use compatible provided special sound reinforcement systems are installed.

(6) Residential buildings require an NLR of 25.

(7) Residential buildings require an NLR of 30.

(8) Residential buildings not permitted.

Source: 14 CFR Part 150

In 2004 the Metropolitan Council incorporated its Aviation Policy Plan into the Transportation Policy Plan (TPP) of the Metropolitan Development Guide. It was updated in January 2009. Land use compatibility guidelines for all metropolitan system airports are included in the TPP. The TPP considered noise exposure associated with airports located in the Minneapolis-St. Paul Metropolitan Area and provided land use guidelines based on four noise zones around an airport. The following is the Metropolitan Council's description of each noise zone:

- **Zone 1** – Occurs on and immediately adjacent to the airport property. Existing and projected noise intensity in the zone is severe and permanent. It is an area affected by frequent landings and takeoffs and subjected to aircraft noise greater than 75 DNL. Proximity of the airfield operating area, particularly runway thresholds, reduces the probability of relief resulting from changes in the operating characteristics of either the aircraft or the airport. Only new, non-sensitive, land uses should be considered – in addition to preventing future noise problems the severely noise-impacted areas should be fully evaluated to determine alternative land use strategies including eventual changes in existing land uses.[6]

- **Zone 2** – Noise impacts are generally sustained, especially close to runway ends. Noise levels are in the 70 to 74 DNL range. Based upon proximity to the airfield the seriousness of the noise exposure routinely interferes with sleep and speech activity. The noise intensity in this area is generally serious and continuing. New development should be limited to uses that have been constructed to achieve certain exterior-to-interior noise attenuation and that discourage certain outdoor uses.[7]

- **Zone 3** – Noise impacts can be categorized as sustaining. Noise levels are in the 65 to 69 DNL range. In addition to the intensity of the noise, location of buildings receiving the noise must also be fully considered. Aircraft and runway use operational changes can provide some relief for certain uses in this area. Residential development may be acceptable if it is located outside areas exposed to frequent landings and takeoffs, is constructed to achieve certain exterior-to-interior noise attenuation, and is restrictive as to outdoor use. Certain medical and educational facilities that involve permanent lodging and outdoor use should be discouraged.[8]

- **Zone 4** – Defined as a transitional area where noise exposure might be considered moderate. Noise levels are in the 60 to 64 DNL range. The area is considered transitional since potential changes in airport and aircraft operating procedures could lower or raise noise levels. Development in this area can benefit from insulation levels above typical new construction standards in Minnesota, but insulation cannot eliminate outdoor noise problems.[9]

- **Noise Buffer Zones -** Additional area that can be protected at the option of the affected community; generally, the buffer zone becomes an extension of noise zone 4. At MSP, a one-mile buffer zone beyond the DNL 60 has been established to address the range of variability in noise impact, by allowing implementation of additional local noise mitigation efforts. A buffer zone, out to DNL 55 is optional at those reliever airports with noise policy areas outside the MUSA.[10]

[6] Metropolitan Council 2030 Transportation Policy Plan, Appendix L, January 2009.
[7] Ibid.
[8] Ibid.
[9] Ibid.
[10] Ibid.

The listed Metropolitan Council noise zones also use the DNL noise exposure metric. The Metropolitan Council Land Use Compatibility Guidelines for Aircraft Noise are provided in **Table 6.2.**

As outlined above, the Metropolitan Council developed the Aviation Chapter of the Metropolitan Development Guide, including the Builder's Guide and Model Ordinance for Aircraft Noise Attenuation, to provide a program framework for community adoption, pursuant to MSP Part 150 preventive land use measures.

The Model Ordinance and Builder's Guide are intended to ensure consistency with local land use planning practices in areas of infill development (e.g., building a home on a vacant lot on a residential block – including reconstruction and/or additions to existing structures) in known airport noise impact areas (2007 - 60+ DNL noise contours) around MSP. Specifically, the documents provide a mechanism for cities around MSP to adopt building material and construction standards to ensure that developments in the airport impact areas are constructed consistent with MSP Part 150 program goals.

In establishing noise reduction level requirements the March 2006 Metropolitan Council Builder's Guide states the following on page 20:

"The overall noise reduction level (NRL) required within a given noise zone can be determined by subtracting the desired level (45 dBA) from the highest noise level within that contour. For example, in Noise Zone 4 (60 to 64 dBA), the required reduction is calculated as 64 – 45 = 19 dBA."[11]

[11] The Metropolitan Council's NRL calculation approach is consistent with FAA's calculations in 14 C.F.R. Part 150.

TABLE 6.2: LAND USE COMPATIBILITY GUIDELINES

Metropolitan Council Land Use Compatibility Guidelines for Aircraft Noise										
	Noise Exposure Zones									
Type of Development	**New Development or Major Redevelopment**					**Infill - Reconstruction or Additions to Existing Structures**				
Land Use Category	1 DNL 75+	2 DNL 74-70	3 DNL 69-65	4 DNL 64-60	BZ	1 DNL 75+	2 DNL 74-70	3 DNL 69-65	4 DNL 64-60	BZ
Residential										
Single/Multiplex, with individual entrance	INCO	INCO	INCO	INCO		COND	COND	COND	COND	
Multiplex/Apartment, with shared entrance	INCO	INCO	COND	PROV		COND	COND	PROV	PROV	
Mobile Home	INCO	INCO	INCO	COND		COND	COND	COND	COND	
Educational, Medical, Schools, Churches, Hospitals, & Nursing Homes	INCO	INCO	INCO	COND		COND	COND	COND	PROV	
Cultural, Entertainment, & Recreation										
Indoor	COND	COND	COND	PROV		COND	COND	COND	PROV	
Outdoor	COND	COND	COND	COND		COND	COND	COND	COMP	
Office, Commercial, Retail	COND	PROV	PROV	COMP		COND	PROV	PROV	COMP	
Services										
Transportation - Passenger Facilities	COND	PROV	PROV	COMP		COND	PROV	PROV	COMP	
Transient Lodging	INCO	COND	PROV	PROV		COND	COND	PROV	PROV	
Other Medical, Health, and Education	COND	PROV	PROV	COMP		COND	PROV	PROV	COMP	
Other Services	COND	PROV	PROV	COMP		COND	PROV	PROV	COMP	
Industrial, Communication, & Utilities	PROV	COMP	COMP	COMP		PROV	COMP	COMP	COMP	
Agriculture, Land/Water Area, & Resource Extraction	COMP	COMP	COMP	COMP		COMP	COMP	COMP	COMP	

Table Key:

- **COMP** – "Compatible" – uses that are acoustically acceptable for both indoors and outdoors.
- **PROV** – "Provisional" – uses that should be discouraged if at all feasible; if allowed, must meet certain structural performance standards to be acceptable according to MS473.192 (metropolitan area Noise Attenuation Act). Structures built after December 1983 shall be acoustically constructed so as to achieve interior noise levels as follows:
    - Residential, Educational and Medical = 45 dBA Interior Sound Level
    - Cultural, Entertainment, Recreational, Office, Commercial, Retail and Services = 50 dBA Interior Sound Level
    - Industrial, Communications, Utility, Agricultural Land, Water Area, Resource Extraction = 60 dBA Interior Sound Level

  Each local governmental unit having land within the airport noise zones is responsible for implementing and enforcing the structural performance standards in its jurisdiction.
- **COND** – "Conditional" – uses that should be strongly discouraged; if allowed, must meet the structural performance standards, and requires a comprehensive plan amendment for review of the project under the Conditional Land Use Review Factors outlined in the Metropolitan Council's 2030 Transportation Policy Plan, Appendix H, Table 5.
- **INCO** – "Incompatible" – land uses that are not acceptable even if acoustical treatment were incorporated in the structure and outside uses restricted.

Source: Metropolitan Council 2030 Transportation Policy Plan, Appendix H – December 15, 2004.

Table 6.3 provides the Metropolitan Council's Structural Performance Standards (interior noise level goals).

TABLE 6.3: STRUCTURE PERFORMANCE STANDARDS[1]

Land Use	Typical Interior[2] Sound Level
Residential	45 dBA
Educational/Medical/Churches, etc.	45 dBA[3]
Cultural/Entertainment/Recreational	50 dBA
Office/Commercial/Retail	50 dBA
Services	50 dBA
Industrial/Communication/Utility	60 dBA
Agricultural Land/Water Area/Resource Extraction	60 dBA

[1] These performance standards do not apply to buildings, accessory buildings, or portions of buildings that are not normally occupied by people.
[2] The noise description used to delineate the appropriate noise policy zone is an annualized Ldn.
[3] Special attention is required for certain noise sensitive uses, such as concert halls.

Source: Metropolitan Council 2030 Transportation Policy Plan, Appendix L – January 2009.

6.3 RUNWAY SAFETY ZONING CONSIDERATIONS

At the Federal level, the Federal Aviation Administration (FAA) is the agency primarily responsible for land use compatibility around airports. Although the FAA does not play a direct role in the zoning and land use planning practices around United States airports, it provides critical land use planning guidance, technical assistance and funding to airports. In this capacity, the FAA issues a variety of regulations and guidance documents under federal law that affects land use planning around airports.

FAA land use guidance focuses on two areas: (1) runway protection zones; and (2) airspace protection.

6.3.1 FEDERAL RUNWAY PROTECTION ZONES

Runway Protection Zones (RPZs) are defined in FAA Advisory Circular 150/5300-13, *Airport Design*. RPZs are trapezoid shapes centered on the approximate extended runway centerline radiating from the end of a runway. The dimensions of an RPZ are a function of the type of aircraft using the runway and approach visibility minimums associated with the runway end. The intent of RPZs is to provide safety for people and property on the ground in the vicinity of runway ends at airports. The FAA accomplishes this goal through land use controls in RPZs designed to maintain areas near the ends of airport runways that are free of incompatible objects and activities.

6.3.2 FEDERAL AIRSPACE PROTECTION

Federal Aviation Regulation Part 77, *Objects Affecting Navigable Airspace*, establishes standards for determining obstructions to navigable airspace and the effects of such obstructions on the safe and efficient use of that airspace.

The height limitations associated with Part 77 are defined in terms of imaginary surfaces in the airspace surrounding an airport. These surfaces extend from about two to three miles from the airport, except for runways with precision instrument approaches, in which case the surfaces extend approximately 9.5 miles from the runway end. The various imaginary surfaces include the primary surface, transitional surface, horizontal surface, conical surface and the approach surface.

Under Part 77, the FAA has established a process for reviewing and evaluating proposed structures in the vicinity of airports. FAA Advisory Circular 7460 establishes an airspace review process and provides information to individuals wishing to erect or alter structures that may affect navigable airspace around an airport. In administering 14 CFR Part 77, the FAA's main objective is to ensure the safe and efficient use of navigable airspace around airports.

The FAA has established five different thresholds for evaluating whether a structure may affect navigable airspace around an airport. If any one of these thresholds is reached, the FAA requests that an individual wishing to erect or alter a structure seek its approval before commencing construction. One of the FAA thresholds applies if a structure is within "20,000 feet of an airport or seaplane base with at least one runway more than 3,200 feet in length and the object would exceed a slope of 100:1 horizontally (100 feet horizontally for each 1 foot vertically) from the nearest point of the nearest runway."[12]

After receiving a request for approval, the FAA will typically issue one of the following three determinations:

- **Determination of No Hazard to Air Navigation** – "The subject construction does not exceed obstruction standards and marking/lighting is not required."
- **Conditional Determination** – "The proposed construction/alteration would be acceptable contingent upon implementing mitigating measures (marking and lighting etc.)."
- **Objectionable** – "The proposed construction/alteration is determined to be a hazard and is thus objectionable. The reasons for this determination are outlines to the proponent."

By establishing threshold criteria and then requiring a detailed airspace hazard analysis, the FAA process provides a safety buffer. In certain circumstances, the FAA's detailed airspace hazard analysis results in FAA approval for developments near airports that may be in excess of the general height limitations set forth in 14 CFR Part 77.

6.3.3 STATE MODEL ZONING ORDINANCE

On January 1, 1946, the State of Minnesota enacted its first model airport zoning ordinance. By 1958 the State designated Safety Zones A, B and C as part of the model airport zoning standard. In 1973, local protective airport zoning was made a condition for receiving federal and state funds. Minnesota is one of the few states that has land use safety controls for airports that go beyond the requirements of FAA regulations.

[12] Federal Aviation Administration Advisory Circular 70/7460.2k, pg 2.

State Runway Safety Zones

The State Safety Zone A is a trapezoidal shape at the end of a runway, beginning at the edge of the primary surface and flaring outward to a distance of approximately 2/3 of the runway length. State Safety Zone B is a trapezoidal shape, with the same flare as Zone A, extending outward from the end of Zone A to a distance of approximately 1/3 of the runway length. The extent of State Safety Zone C is coincidental with the extent of the horizontal airspace surface.

Under Minnesota law, Zone A must not contain buildings, temporary structures, exposed transmission lines, or other similar above-ground land use structural hazards. Land uses in Zone A are restricted to those uses that will not create, attract, or bring together an assembly of persons. Permitted uses in Zone A include, but are not limited to, agriculture (seasonal crops), horticulture, animal husbandry, raising of livestock, wildlife habitat, light outdoor recreation (non-spectator), cemeteries, and automobile parking.

Zone B uses are restricted as follows:

- Each use must be on a site whose area is not less than 3 acres.
- Each use must not create, attract, or bring together a site population that would exceed 15 times that of the site acreage.
- Each site must have no more than one building plot upon which any number of structures may be erected.
- A building plot must be a single, uniform, and non-contrived area, whose shape is uncomplicated and whose area must not exceed minimum ratios with respect to the total site area.
- The following uses are specifically prohibited in Zone B: Churches, hospitals, schools, theaters, stadiums, hotels, motels, trailer courts, campgrounds, and other places of frequent public or semi-public assembly.

In Zone C no use may be made of any land that creates or causes interference with the operations of radio or electronic facilities on the airport or with radio or electronic communications between the airport and aircraft. In addition, Zone C prohibits land uses that make it difficult for pilots to distinguish between airport lights and other lights, result in glare in the eyes of pilots using the airport, impair visibility in the vicinity of the airport, or otherwise endanger the landing, taking off, or maneuvering of aircraft. All structure heights in Zone C are limited to 150 feet above the primary surface at the airport.

State Model Zoning Ordinance Airspace Protection

The State Model Zoning Ordinance height restrictions are predicated directly on the FAA's Part 77 imaginary airspace surfaces.

6.4 MSP ZONING ORDINANCE

Minnesota Statutes establish that airports in the state must adopt airport zoning ordinances. To do this, the statutes spell out the formation of a Joint Airport Zoning

Board comprised of two members from each jurisdiction with land use control in the areas affected by airport zoning, as well as the airport proprietor.

The MSP Joint Airport Zoning Board met to discuss and recommend a revised MSP zoning ordinance in light of the construction of Runway 17-35. An important part of this process was balancing the land use controls needed to provide safety while at the same time considering the social and economic impacts related to prospective land use controls. Minn. Stat. §360.066, subd. 1 is particularly instructive when addressing the question of zoning around complex urbanized airports such as MSP. The statute also addresses the concept of "reasonableness" when balancing the variables to be considered in the zoning process. Specifically, Minn. Stat. §360.066, subd. 1 states:

> "Reasonableness Standards of the commissioner defining airport hazard areas and the categories of uses permitted and airport zoning regulations adopted under sections 360.011 to 360.076, shall be reasonable, and none shall impose a requirement or restriction which is not reasonably necessary to effectuate the purposes of sections 360.011 to 360.076. In determining what minimum airport zoning regulations may be adopted, the commissioner and a local airport zoning authority shall consider, among other things, the character of the flying operations expected to be conducted at the airport, the location of the airport, the nature of the terrain within the airport hazard area, the existing land uses and character of the neighborhood around the airport, the uses to which the property to be zoned are planned and adaptable, and the social and economic costs of restricting land uses versus the benefits derived from a strict application of the standards of the commissioner."

Consistent with the guidance provided in Minn. Stat. §360.066, subd. 1, the MSP Joint Airport Zoning Board focused its discussion on the land use controls that were necessary to ensure a reasonable degree of safety around MSP. Based on the substantial property development and/or structural modification restrictions that would be placed on the largely urbanized and developed areas around the airport, the MSP Joint Airport Zoning Board turned its focus to safety. The MSP Joint Airport Zoning Board directed staff to conduct a risk analysis to provide the Board with further clarification on the question of zoning requirements necessary to ensure a "reasonable standard of safety."

In short, the analysis found that within State Zones A and B but outside the federal RPZ, the accident probability at MSP was less than the FAA standard of one accident in 10 million operations. Additionally, based on the accident rate calculations, the MSP Joint Airport Zoning Board determined that the likelihood of a fatality from an accident in State Safety Zones A and B outside the RPZ is extremely remote or extremely improbable, based on FAA criteria.

In addition to the risk analysis, the MSP Joint Airport Zoning Board focused on addressing the economic considerations as the statute requires. The Board relied on the analyses and information that were provided by the respective cities with jurisdiction over the land uses, and concluded that there were significant financial costs associated with implementation of the State Model Zoning Ordinance.

In summary, based on the findings of the Safety Study and the Economic Analysis, the Board adopted the following changes to the State Model Zoning Ordinance:

- Safety Zone A – is co-terminus with the Federal Runway Protection Zone (RPZ).
- Safety Zone B – use restrictions do not include site acre/structure limitations and site-area-to-building-plot-area ratios and population criteria.
- Exemption for Established Residential Neighborhoods – allows for the improvement, expansion and development of new residential uses in and adjacent to Established Residential Neighborhoods in Safety Zone B.

In 2004 the Commissioner of Transportation for the State of Minnesota approved the MSP Joint Airport Zoning Board's recommended ordinance.

6.5 LAND USE COMPATIBILITY ANALYSIS

The Minneapolis-St. Paul International Airport (MSP) is located in Hennepin County. The airport is bordered to the northwest by the City of Minneapolis, to the west by the City of Richfield, south by the City of Bloomington, to the southeast by the cities of Eagan and Mendota Heights and to the north by the City of St. Paul. The airport is bordered by residential land uses to the north, northwest, and west. A combination of mixed-use industrial, commercial and single-family residential exists to the south and southeast of the airport.

The following sections detail land use considerations in the context of existing and planned land uses around MSP focusing on airport noise and runway safety zones.

6.5.1 EXISTING CONDITION LAND USE COMPATIBILITY

In general, the area around the airport is primarily residential to the north, northwest, and east and to the south and southeast a combination of commercial/industrial and park/open space land uses. The Runway Protection Zones (RPZ) and State Safety Zones for MSP are shown on **Figure 6-1**.

<u>Land Use Compatibility and Airport Noise Considerations</u>

As detailed in Chapter 5, Section 5.3.6, the 2008 baseline noise contours around MSP contain 10,163 single-family homes and 3,701 multi-family units in the 60 and greater DNL noise contours, and 2,564 single-family homes and 1,372 multi-family units in the 65 and greater DNL noise contours. The 70 and greater DNL contours contained 116 single family homes and six multi- family units. The 75 and greater DNL does not contain any residential units.

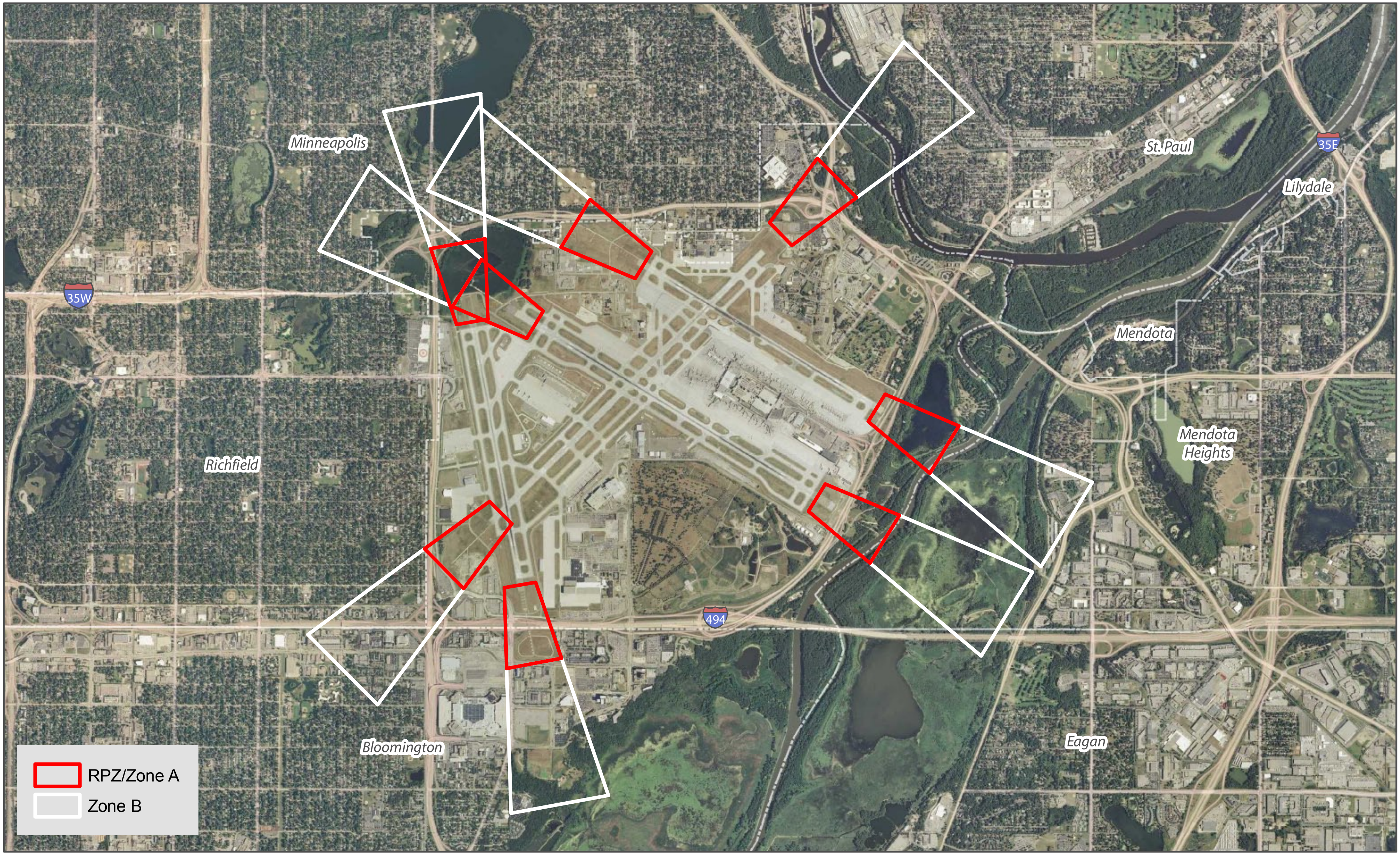
Figure 6-2 provides the 2008 base case 60 and greater DNL noise contours around MSP with 2005 land use data provided by the Metropolitan Council.

<u>Land Use Compatibility and Existing Runway Protection/Safety Zones</u>

The existing RPZs and State Safety Zones A and B at MSP are depicted in **Figure 6-3** with the existing land uses around the airport.

RPZs and State Zones

Figure 6-1

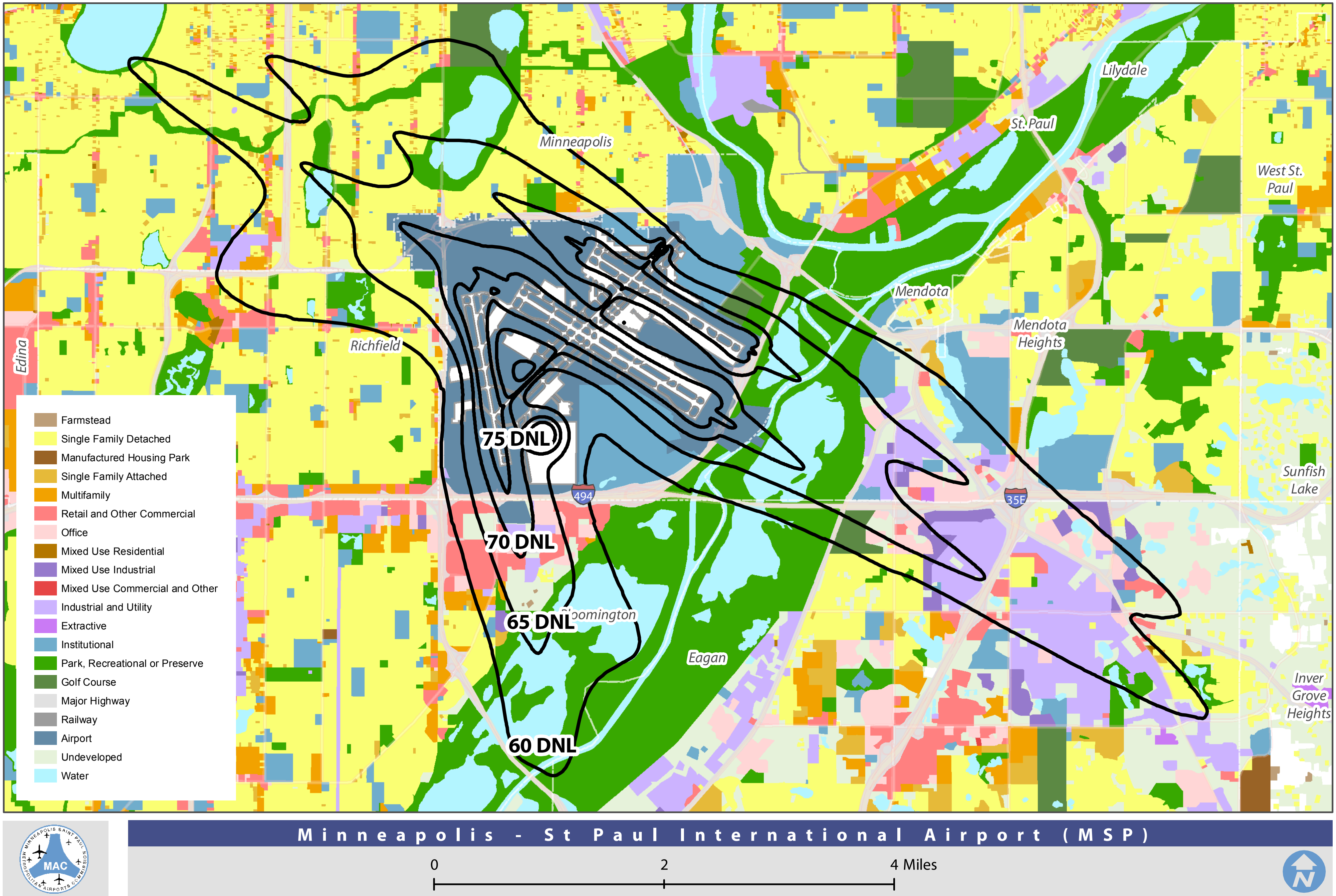


Minneapolis - St Paul International Airport (MSP)

0 1.5 3 Miles

2008 Base Case Contours with 2005 Land Use

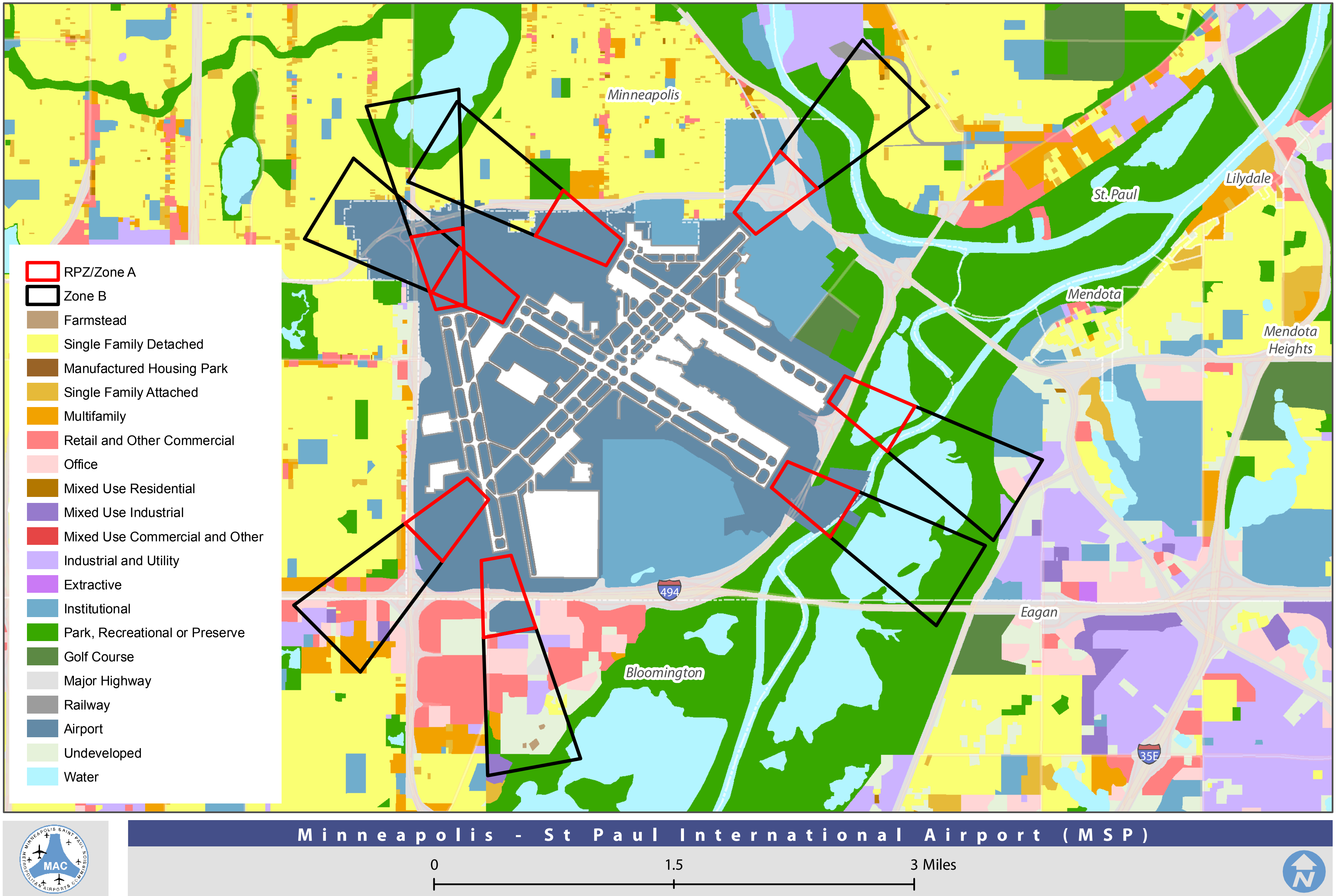
Figure 6-2



Minneapolis - St Paul International Airport (MSP)

RPZs and State Zones with 2005 Land Use

Figure 6-3



Minneapolis - St Paul International Airport (MSP)

The Runway 4 RPZ/State Zone A is 78.85 acres total and encompasses 76.97 acres of airport property, 1.87 acres of major highway and 0.01 acres of single-family attached land use. Zone B covers 250.3 acres: 17.55 acres of airport property, 15.25 acres of industrial and utility land use, 0.58 acres institutional, 53.80 acres major highway, 8.33 acres mixed use industrial, 40.77 acres multi-family land use, 22.94 acres office, 10.2 acres of park land, 40.92 acres retail and other commercial land use, 4.18 acres single-family attached, 30.49 acres single-family detached and 5.30 acres undeveloped land. State Zone B contains 113 single-family homes and 706 multi-family units.

The RPZ/State Zone A for Runway 17 is 78.85 acres and is entirely on airport property. Zone B covers 250.3 acres: 32.93 acres are airport property, 1.91 acres institutional, 11.42 acres major highway, 60.32 acres park land, 0.91 acres retail and other commercial, 3.48 acres single-family attached, 64.35 acres single-family detached, and 74.99 acres water. State Zone B contains 341 single-family homes and 32 multi-family units.

The Runway 22 RPZ/ State Zone A encompasses 78.85 acres: 46.26 acres major highway, 31.69 acres institutional land use, and 0.90 acres airport property. State Zone B is 250.3 acres total and covers 100.69 acres park land, 81.47 acres single-family detached, 25.51 acres institutional, 16.24 acres water, 8.85 acres railway, 8.55 acres major highway, 3.23 acres industrial and utility, 2.52 acres single-family attached, 2.16 acres multi-family, and 1.08 acres mixed use residential. State Zone B contains two single-family homes.

The Runway 35 RPZ/State Zone A is 78.85 acres total and covers 58.94 acres airport, 14.44 acres major highway, 4.08 acres undeveloped, 1.30 acres retail and other commercial, and 0.08 acres industrial and utility land use. Zone B encompasses 250.3 acres: 86.93 acres undeveloped land, 36.37 acres retail and other commercial, 34.87 acres park, 26.41 acres industrial and utility, 25.94 acres office, 10.01 acres mixed use industrial, 8.48 acres major highway, 6.59 acres multi-family, 6.07 acres single-family detached 4.21 acres water, 2.83 acres farmstead, and 1.60 acres airport. State Zone B contains two multi-family units.

The Runway 12L RPZ/State Zone A encompasses 78.85 acres: 70.45 acres airport property, 6.87 acres major highway, 1.42 acres park, and 0.10 acres multi-family. Zone A contains 12 multi-family units. State Zone B covers 250.3 acres: 137.58 acres single-family detached, 43.97 acres park, 22.05 acres airport, 20.23 acres water, 19.31 acres major highway, 5.06 acres institutional, 1.84 acres single-family attached, and 0.27 acres undeveloped land. State Zone B contains 759 single-family homes and 24 multi-family units.

The RPZ/State Zone A for Runway 12R is 78.85 acres and is entirely on airport property. Zone B encompasses 250.3 acres: 171.55 acres airport, 70.66 acres single-family detached, 4.16 acres major highway, 3.52 acres single-family attached, 0.17 acres undeveloped land, 0.13 acres retail and other commercial, 0.05 acres industrial and utility, and 0.05 acres park land. State Zone B contains 390 single-family homes and 40 multi-family units.

The Runway 30L RPZ/Zone A covers 78.85 acres: 72.04 acres airport, 4.29 acres park land, 1.44 acres water, and 1.07 acres major highway. State Zone B encompasses

250.3 acres: 133.32 acres water, 104.37 acres park, 6.97 acres airport, and 5.65 acres major highway.

The RPZ/State Zone A for Runway 30R covers 78.85 acres: 45.91 acres water, 17.18 acres park, 8.45 acres major highway, and 7.30 acres airport property. Zone B encompasses 250.3 acres: 109.27 acres park, 92.38 acres water, 14.63 acres office, 12.51 acres industrial and utility, 12.16 acres undeveloped land, 9.06 acres institutional, and 0.28 acres major highway.

6.5.2 PREFERRED ALTERNATIVE LAND USE COMPATIBILITY

The preferred development alternative at MSP maintains the existing runway infrastructure. The increase in overall operations and increase in larger jet operations results in larger noise contours around MSP.

Forecast Land Use Compatibility and Airport Noise Considerations

As detailed in Chapter 5, Section 5.4.5, the 2030 preferred alternative forecast 60 and greater DNL noise contours around MSP contains 19,374 single-family homes and 10,267 multi-family units. The 65 DNL and greater contours contain 5,468 single-family homes and 2,470 multi-family units and the 70 DNL and greater contours contain 853 single-family homes and 1,145 multi-family units. The 75 and greater contours do not contain any residential units.

Figure 6-4 provides the 2030 preferred alternative forecast 60 and greater DNL noise contours around MSP with 2005 land use data provided by the Metropolitan Council.

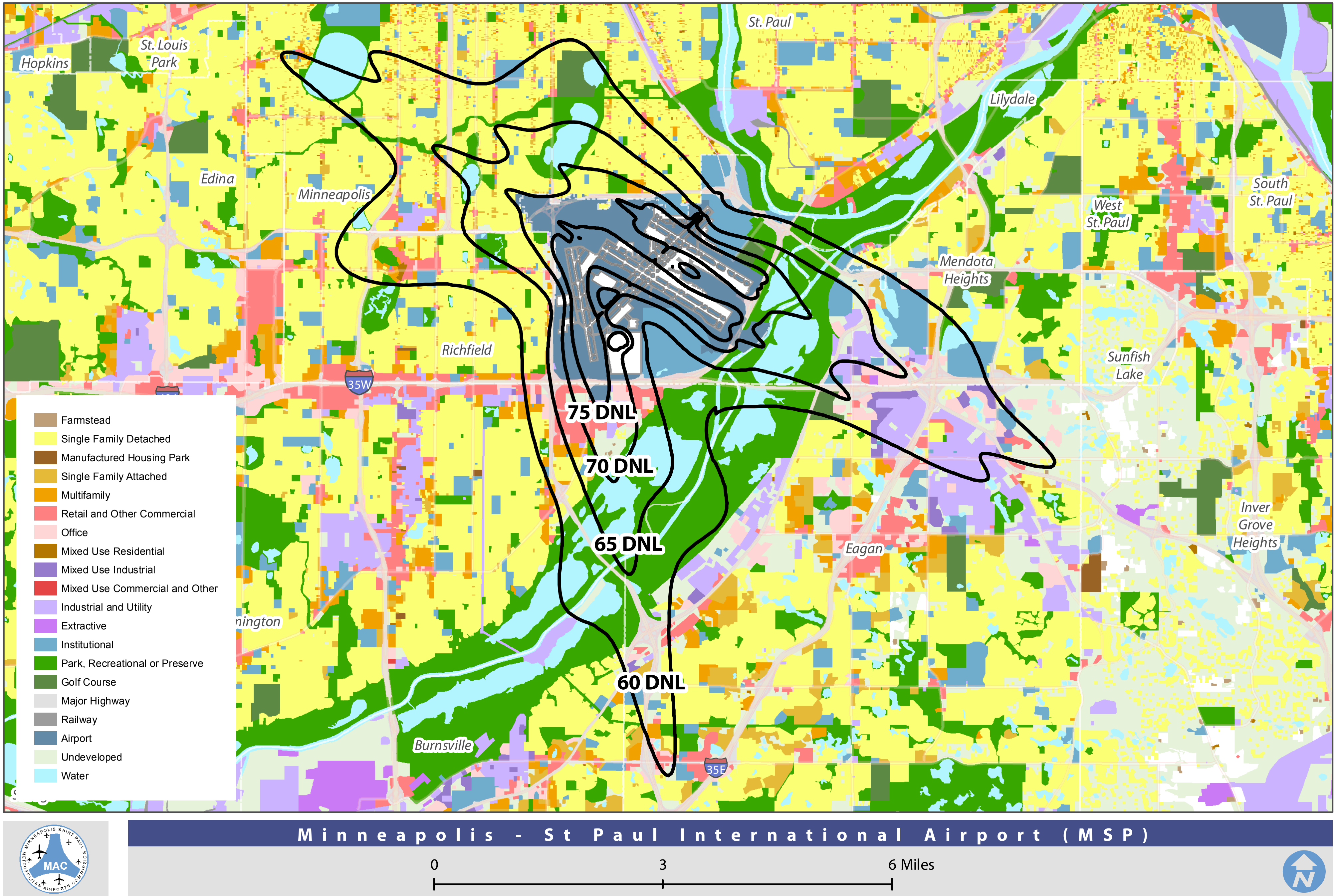
Land Use Compatibility and Preferred Alternative Runway Protection/Safety Zones

The 2030 preferred alternative RPZs and State Safety Zones A and B at MSP are the same as the 2008 RPZs and zones. They are depicted in **Figure 6-4** with existing land uses around the airport.

Additional analysis was conducted relative to the planned 2020 land uses around MSP as provided by the Metropolitan Council. The only substantive proposed changes occur in State Zone B of Runway 35 where undeveloped land becomes commercial land use and in State Zone B off Runway 30R where undeveloped land changes to industrial land use.

2030 Preferred Alternative Contours with 2005 Land Use

Figure 6-4



Minneapolis - St Paul International Airport (MSP)

CHAPTER 7: FACILITY IMPLEMENTATION SCHEDULE AND COST

CHAPTER 7: FACILITY IMPLEMENTATION SCHEDULE AND COST

7.1 IMPLEMENTATION STRATEGY

Below is a summary of the overall physical and operational development phasing over the next 20 years.

PHASE I: 2010 – 2015

- Construct 16 new gates at the Humphrey Terminal including jet bridges, apron improvements, hydrant fueling, and site utility improvements
- New explosive detection system
- Humphrey Terminal auto rental facility
- Humphrey Terminal parking expansion
- Humphrey Terminal roadway system improvements including 34th Ave / I-494 interchange improvements

PHASE II: 2015 – 2020

- Lindbergh Terminal curbside expansion
- Lindbergh Terminal remodeling including Concourse E, ticketing, and baggage claim
- Phase I expansion of Concourse G including jet bridges, apron improvements, hydrant fueling, and site utility improvements
- Lindbergh Terminal parking expansion

PHASE III: 2020 – 2025

- Construct 10 new gates at the Humphrey Terminal including jet bridges, apron improvements, hydrant fueling and site improvements
- Humphrey Terminal roadway access improvements, including reconstruction of the Post Road/Highway 5 intersection, the 70th Street/34th Avenue intersection and improvements to Post Road/70th Street
- Humphrey Parking Orange Ramp expansion
- Lindbergh Terminal in/outbound roadway improvements including demolition of the Maroon ramp and Delta Hangar, relocation of the Xcel substation and realignment of the in/outbound roadways
- Phase II expansion of Concourse G including jet bridges, apron improvements, hydrant fueling, and site improvements
- MSP Hotel
- Delta overnight package express relocation
- Airline flight kitchen replacement

PHASE IV: 2025 – 2030

- Crossover taxiway construction
- Lindbergh Terminal parking expansion
- Loading dock facility relocation
- Post Office retail operation relocation

7.2 COST ESTIMATES

Conceptual "order of magnitude" cost estimates have been prepared to get a general sense of the cost of implementing the 20-year Long Term Comprehensive Plan for MSP as envisioned in this document. These cost estimates have been prepared using planning level concepts and the projects are considered to be "Demand-Driven Capital Improvement Projects" that will be undertaken only if demand exists for such projects. The Commission anticipates financing these projects through a combination of proceeds from General Airport Revenue Bonds, Passenger Facility Charges (PFCs) (either on a pay-as-you-go basis or PFC secured bonds), Federal and State grants, and other available revenues of the Commission.

These estimates should not be used for budgeting purposes. More accurate estimates will be possible once a preliminary decision has been made to move forward with these projects and conduct more detailed planning, programming, and preliminary design. A summary of these "order of magnitude" cost estimates is shown in **Table 7.1**. Additional information can be found in Appendix C of this report.

TABLE 7.1: LTCP IMPLEMENTATION COSTS

Phase I: 2010-2015	**Cost Range (in Millions)**
Humphrey Terminal Gates	$224 - $264
Explosive Detection System	$47 - $55
Humphrey Terminal Auto Rental Facility	$53 - $62
Humphrey Terminal Parking Expansion	$27 - $32
Humphrey Terminal Roadway Improvements	$26 - $31
Phase I Total	***$380 - $445***
Phase II: 2015-2020	
Lindbergh Terminal Curbside Expansion	$100 - $117
Lindbergh Terminal Remodeling	$9 - $10
Lindbergh Terminal Concourse G Expansion Phase I	$500 - $600
Lindbergh Terminal Parking Expansion Phase I	$200 - $233
Phase II Total	***$810 - $960***
Phase III: 2020-2025	
Humphrey Terminal Gates	$216 - $254
Humphrey Terminal Roadway Access Improvements	$80 - $95
Humphrey Terminal Parking Expansion	$50 - $60
Lindbergh Terminal In/Outbound Roadway	$144 - $169
Lindbergh Terminal Concourse G Expansion Phase II	$158 - $186
MSP Hotel	Funding by Others
Delta Overnight Package Express	$3 - $3.5
Airline Flight Kitchen	$14 - $16
Phase III Total	***$665 - $783***
Phase IV: 2025-2030	
Crossover Taxiway	$65 - $77
Lindbergh Terminal Parking Expansion	$118 - $138
Loading Dock Relocation	$6 - $7
Post Office Retail Relocation	$1 - $2
Phase IV Total	***$190 - $225***

Note: All costs are in 2009 dollars and include a 15% construction contingency and a 15% design and administration contingency.