4.0 AIRFIELD DEMAND/CAPACITY ANALYSIS AND REQUIREMENTS

The previous Master Plan for GMIA was initiated in 1988 and adopted by the Milwaukee County Board of Supervisors in 1993. That Master Plan identified the need for various airfield capacity improvements, including:

- *Realignment and extension of runway 7L/25R (completed)*
- *Construction of a 1,000-foot extension to runway 7R/25L*
- *Construction of a 2,850-foot extension to runway 1R/19L (500 feet to the north and 2,350 feet to the south)*
- *Decommissioning runway 13/31*

Additionally, a new runway to provide capacity during Instrument Meteorological Conditions (IMC) was investigated. Several alternatives were evaluated for the location of a future runway. Alternative C-1, a 7,000-foot runway parallel to and 3,540 feet south of runway 7R/25L, was recommended and ultimately adopted as part of the Airport Layout Plan.

This Master Plan Update Study evaluates the capacity of the existing airfield to serve the projected activity described in Chapter 3.0, *Activity Projections*. Future capacity problems are identified and delays are calculated. This, in turn, will establish the timing of the need for the "C-1 Runway", as it has come to be known. Also, the runway extensions included in the previous master plan are re-evaluated for the changes in the aircraft fleet mix projected over the 20-year planning period.

Assessments of airfield demand/capacity and requirements are presented in the following sections:

- *Theoretical Capacity Analysis*
- *Airfield Simulation Analysis*

- *Geometric Design Requirements*
- *Runway Length Requirements*
- *Runway Width Requirements*
- *Airfield Safety Areas Requirements*

4.1 THEORETICAL CAPACITY ANALYSIS

The ability of an airfield to accommodate projected air traffic is an important element of every master plan study. Airfield facilities require a significant amount of land. The layout of the airfield must adhere to federal requirements, minimize the opportunity for incursions, and facilitate air traffic management as best possible. Also, the configuration of an airfield is a major determinant of an airport's impact on surrounding communities.

An extensive analysis was undertaken to evaluate the capacity and capabilities of the airfield at the Airport. The capacity of the airfield to accommodate projected levels of activity was evaluated by first assessing the theoretical capacity of the airfield, i.e., the number of operations that the current runway and taxiway configuration could be expected to accommodate. Computer simulations, presented in Section 4.2, were then performed to provide a more detailed assessment of congestion points and levels of aircraft delay.

Airfield capacity has been defined in two ways. One definition, used extensively in the United States in the past, is that capacity is the number of aircraft operations during a specified time corresponding to a level of average delay. This is referred to as practical capacity. Under another definition, capacity is the number of aircraft operations that an airfield can accommodate during a specified time while there is a continuous demand for service. Continuous demand for service means that there are always aircraft ready to take off or land. This definition has been referred to in several ways: as ultimate capacity, saturation capacity, or maximum throughput rate. An important difference between these two measures of capacity is that one is defined in terms of delay, while the other is not.

Capacity is most often expressed in hourly or annual measures. For long-range planning efforts, such as this Master Plan Update Study, the annual operating capacity or annual service volume (ASV) is used to measure an airport's ability to process existing and future demand levels. Hourly capacity is also analyzed, in order to identify any peak-period issues that may arise.

The generally accepted methodology for calculating airfield capacity is based on the FAA's *Airport Capacity and Delay Manual* (FAA Advisory Circular 150/5060-5). The methodology incorporated in the FAA's Advisory Circular and computer model relies upon two general concepts for determining airport capacity: hourly capacity and annual service volume. Hourly capacity is defined as the maximum number of aircraft operations that can take place on a runway system with a specific runway use configuration in a one-hour period. ASV is defined as a reasonable estimate of the annual number of aircraft operations that an airport can accommodate. ASV accounts for differences in runway use configurations, aircraft fleet mix, weather conditions, operational peaking, etc., that would be encountered over a period of one year.

Many factors influence the capacity of an airport, and some are more significant than others. In general, the capacity depends on the configuration of the airfield, the environment in which aircraft operate availability and sophistication of aids to navigation, and air traffic control facilities and procedures.

The airfield capacity analysis conducted for this Master Plan Study considers the following elements:

- *Airfield layout*
- *Meteorology (weather conditions)*
- *Aircraft operational fleet mix*
- *Percentage of arrivals*
- *Touch-and-go operations*
- *Peak hour airfield capacity*

- *Annual service volume (ASV)*

Factors such as runway configuration, weather, and fleet mix were reviewed to determine their influence on operational capacity. Calculated capacity was compared to projected demand to assess the potential need for airfield improvements.

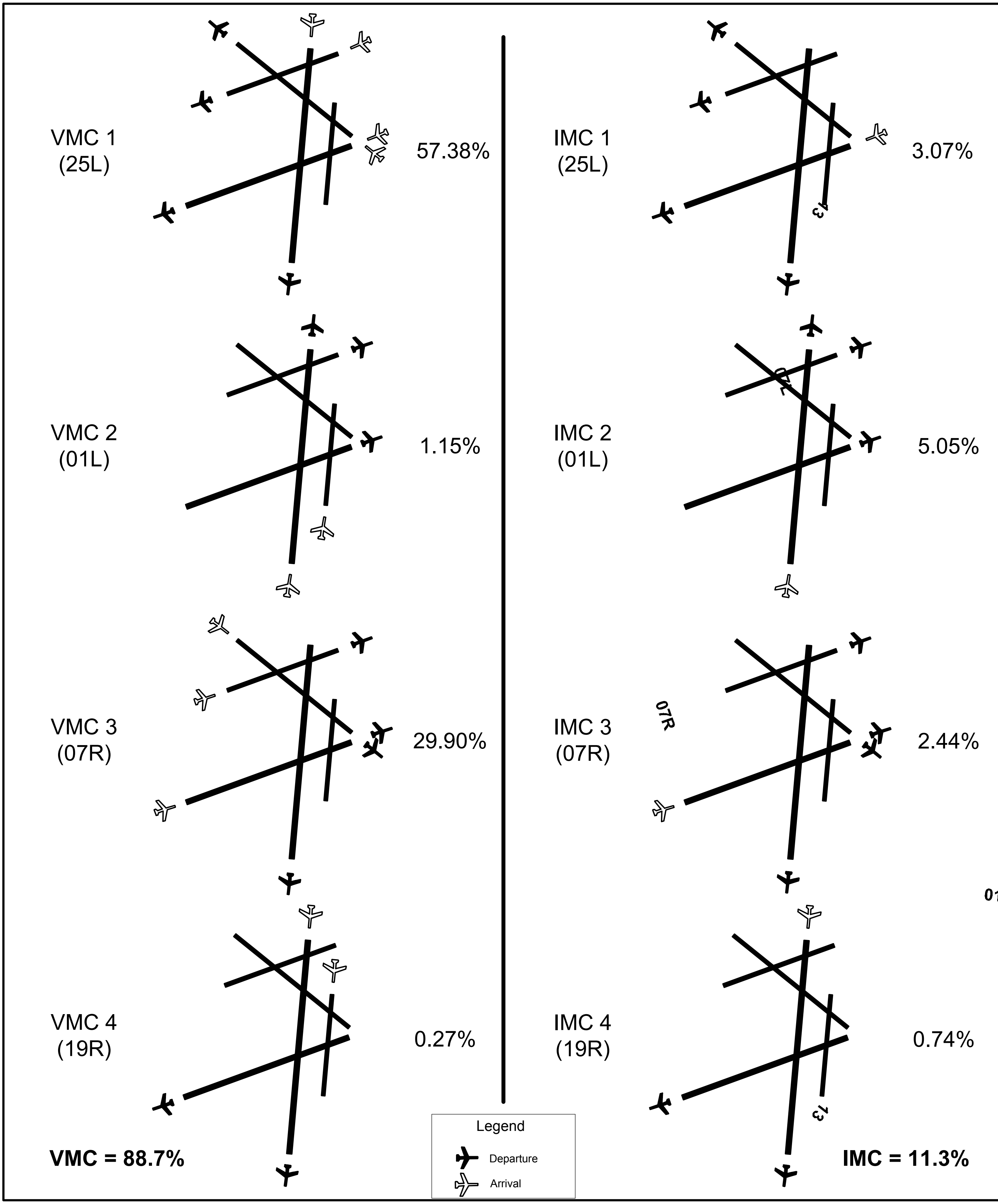
4.1.1 Airfield Layout

The runway/taxiway configuration is described by the physical layout including the number of runways, their orientation, and their locations relative to each other and to other landside facilities. Each runway/taxiway configuration has a different capacity due to operational limitations and restrictions. Capacity differs for each additional runway, depending on its wind coverage and location relative to other existing runways.

Exhibit 4.1-1 shows the runway layout and the predominant runway-operating configuration used at GMIA. GMIA has five runways. Two are sets of parallel runways: runways 7L/25R and 7R/25L, which have a separation of 3,680 feet, and runways 1L/19R and 1R/19L, which have a separation of 1,000 feet. Runway 13/31, a crosswind runway, makes up the remainder of the runway system.

Runway 1L/19R is 9,690 feet long by 200 feet wide. Runway 1R/19L is 4,183 feet long by 150 feet wide. Runway 7L/25R is 4,800 feet long by 100 feet wide. Runway 7R/25L is 8,012 feet long by 150 feet wide. Runway 13/31 is 5,868 feet long by 150 feet wide.

Runway 7L/25R is restricted to non-jet aircraft and to aircraft with wingspans less than 79 feet (FAA Airplane Design Group II). This restriction was the outcome of an Environmental Impact Statement (EIS) for realigning and lengthening runway 7L/25R. Runway 13/31 is closed to turbojet aircraft operations, although there are exceptions to



G E N E R A L MITCHELL INTERNATIONAL AIRPORT MASTER PLAN UPDATE

RUNWAY USE CONFIGURATIONS

EXHIBIT 4.1-1

this restriction with prior permission from the Airport. Additionally, turbojet departures from runway 1R are prohibited.

Another runway characteristic considered in the airfield capacity analysis is the availability of taxiway exits within an optimal distance from the threshold. For the primary runways, the exits are located as follows:

- *Runway 19R/1L has seven exits: beginning with the 19R end, the exits are located at the threshold, 1,000, 2,900, 3,700, 4,800, 6,400, 8,200, and 9,600 feet.*

- *Runway 7R/25L has five exits: beginning with the 25L end, the exits are located at the threshold, 2,800, 3,400, 4,000, 4,900, 5,500, 6,650 and 8,000 feet.*

The optimal exiting distance varies depending on the aircraft that use the runway (i.e., the fleet mix). Strategically located exits reduce runway occupancy time, and therefore increase capacity.

A brief explanation for each runway use configuration shown in Exhibit 4.1-1 is described in the following sections and is summarized in **Table 4.1-1**.

TABLE 4.1-1

General Mitchell International Airport

RUNWAY USE CONFIGURATIONS

Runway Use Configuration	Annual Percentage	Arrival Runways	Departure Runways
VMC1	57.38%	25L, 19R, 25R, 31	25L, 19R, 25R, 31
VMC2	1.15%	1L, 1R	1L, 7R, 7L
VMC3	29.90%	7R, 7L, 13	7R, 19R, 7L, 13
VMC4	0.27%	19R, 19L	19R, 25L
IMC1	3.07%	25L	25L, 19R, 25R, 31
IMC2	5.05%	1L	1L, 7R, 7L
IMC3	2.44%	7R	7R, 7L, 19R, 13
IMC4	0.74%	19R	19R, 25L

Note: See Exhibit 4.1-1 for a graphic depiction of this table.
Source: FAA Air Traffic Control Tower Management, 2001 data.

4.1.1.1 VMC1/IMC1

Under these runway use configurations, runways 25L, 25R, 19R, and 31 are in operation. For VMC1, 95 percent of jet aircraft arrive on runway 25L and 85 percent of jet departures occur on runway 19R. The remaining jet aircraft arrive and depart on runways 25L and 19R, respectively. Approximately 70 percent of propeller-driven (prop) aircraft arrive on runway 25L with other arrivals distributed on runways 25R, 19R and 31. The majority of prop aircraft depart of from runway 19R (63 percent) and the remaining prop aircraft departures distributed on runways 25L, 25R and 31.

Under IMC1, all aircraft arrive to runway 25L. Departures under IMC1 remain the same as described in VMC1, above.

4.1.1.2 VMC2/IMC2

Runways 1L, 1R, 7R, and 7L are in operation under this runway use configuration. Except for the one percent of prop aircraft arriving to runway 1R under VMC2, all jet and prop aircraft arrive to runway 1L during VMC2 and IMC2 conditions.

Under VMC2, 70 percent of jet aircraft departures occur on runway 7R with the other jet departures using runway 1L. For prop aircraft, 60 percent depart from runway 7R with the others distributed on runways 1L and 7L.

Under IMC2, 60 percent of jet aircraft departures occur on runway 7R while the remaining departures use runway 1L. The majority of prop aircraft (63 percent) depart from runway 7R. Runways 1L and 7L are used for the remaining prop aircraft departures.

4.1.1.3 VMC3/IMC3

Runways 7R, 7L, 19R and 13 are in operation under this runway use configuration. Under VMC3, all jet aircraft arrivals and 80 percent of jet aircraft departures occur on runway 7R. The other 20 percent of jet departures use runway 19R. Runway 7R is used for 60 percent of prop aircraft arrivals and departures with remainder distributed among runways 7L, 19R, and 13.

Under IMC3, all jet aircraft and prop arrivals occur on runway 7R, which also handles 85 percent of jet aircraft departures. The other jet aircraft depart from runway 19R. For prop aircraft, 75 percent depart from runway 7R and the others are distributed on runways 7L, 19R, and 13.

4.1.1.4 VMC4/IMC4

Runways 19R, 19L, and 25L are in operation under this runway use configuration. All jet aircraft arrivals and departures occur on runway 1L under VMC4 and IMC4 conditions.

For prop aircraft, only two percent of arrivals and two percent of departures occur on runways 19L and 25L, respectively. Ninety-eight (98) percent of prop aircraft operations use runway 19R under VMC4 conditions. Under IMC4 conditions, all prop arrivals and departures use runway 19R with the exception of two percent of departures using runway 25L.

4.1.2 Meteorology (Weather Conditions)

Cloud ceiling and visibility determine the air traffic control (ATC) procedures that can be used at the Airport, and are major determinants of runway capacity and aircraft delay. The most common runway operating configurations (illustrated in Exhibit 4.1-1) are grouped into visual flight rules (VFR) and instrument flight rules (IFR) categories. VFR applies when weather conditions are such that aircraft can maintain safe operations by visual means, i.e., visual meteorological conditions (VMC). Instrument meteorological conditions (IMC) prevail when the visibility or cloud ceiling falls below those minimums prescribed for VMC operations (1,000-foot ceiling, three-mile visibility).

Wind conditions are of prime importance in determining runway use and orientation. Where winds are consistently from one direction, a single runway orientation is adequate. In most areas, however, wind direction is not consistent and a multiple runway orientation is required. The FAA has established criteria that state that the most desirable runway orientation is that which has maximum wind coverage and minimum crosswind components. The minimum required wind coverage for a single runway orientation is 95 percent. For GMIA the maximum allowable crosswind component for each runway wind coverage calculations is 20 knots.

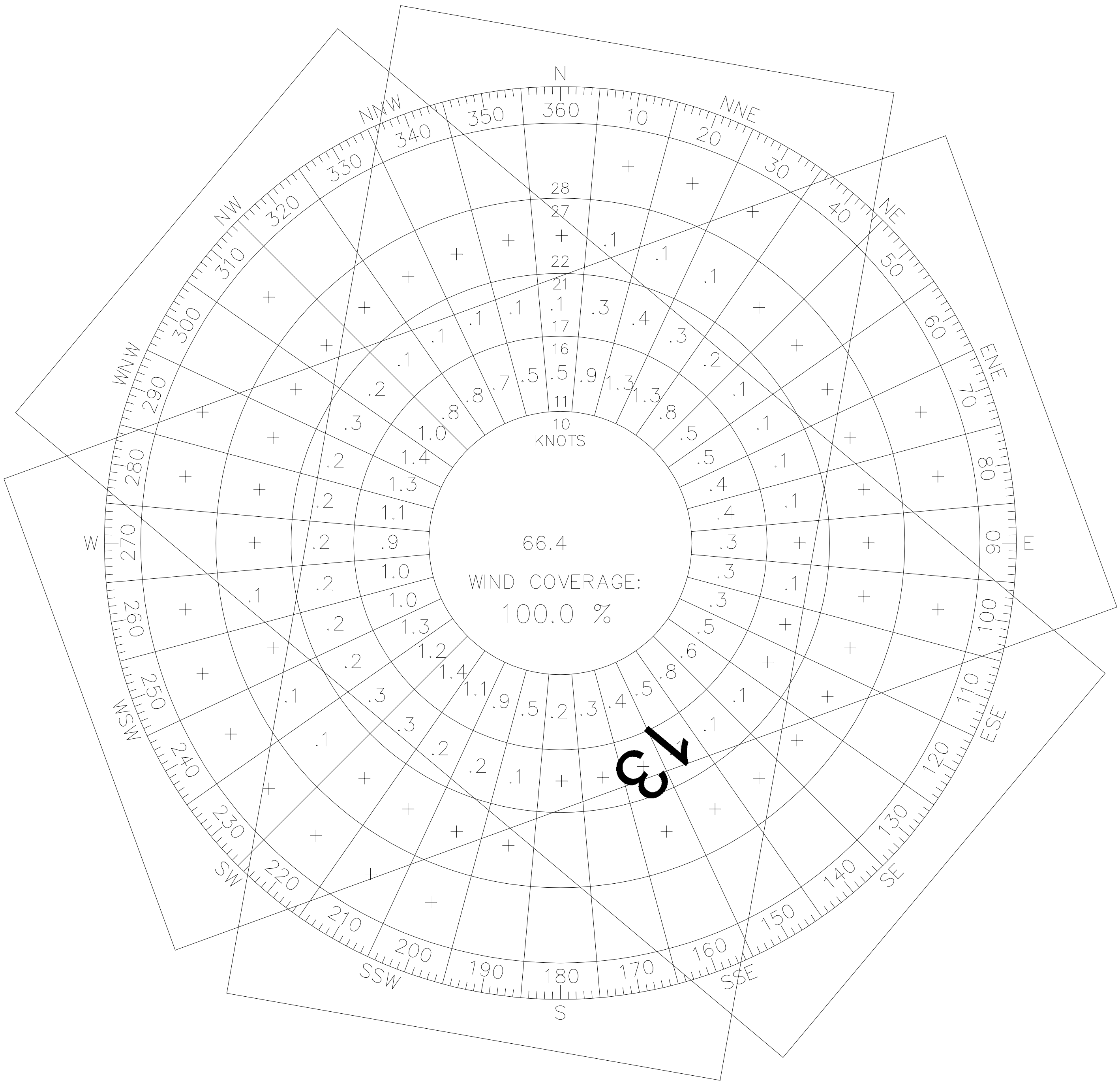
The data required to conduct weather and wind analysis for GMIA were obtained from the National Oceanic and Atmospheric Administration (NOAA) National Climatic Center in Asheville, NC. NOAA maintains a network of weather observation stations that record meteorological conditions at many locations throughout the United States. One such station is located at GMIA. Wind data containing weather observations for the period 1992 to 2001 was used for this analysis.

Wind coverage for the runways was determined through the use of a computerized wind program developed and distributed by the FAA. Wind data for All Weather, VFR, and IFR were analyzed separately. **Exhibits 4.1-2** to **4.1-4** show wind coverage for individual runways and combinations of runways under All Weather, VFR, and IFR conditions, respectively.

The following observations were made from the wind data:

- *VFR weather conditions occur 89.2 percent of the year*
- *IFR weather conditions occur 10.8 percent of the year*
- *Winds in excess of 16 knots occur 6.0 percent of the time during an average year, while winds exceeding 21 knots occur 1.0 percent of the year.*
- *The predominant wind direction is from the west-southwest.*
- *The existing runways provide 100 percent wind coverage under all weather, VFR, and IFR conditions with a 20 knots crosswind component.*
- *The percentages of VFR and IFR conditions provided by the FAA Air Traffic Control Tower management at GMIA are similar to the percentages found in the wind data.*

Weather conditions also determine approach procedures. If, upon arrival at the destination airport, the pilot can see the airport and safely perform an approach to the runway and land, the pilot may use either a visual approach or an



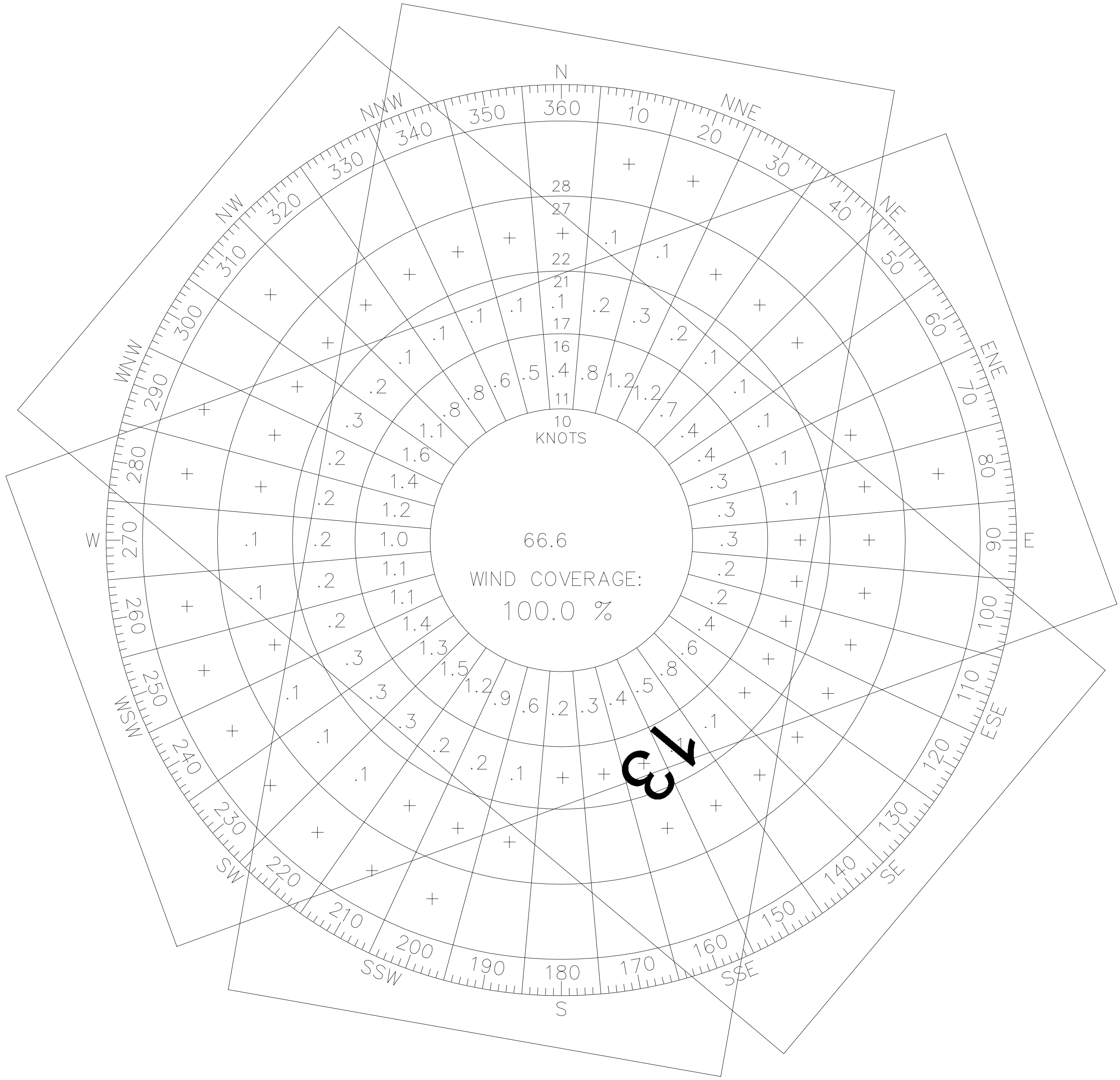
Runway System Wind Coverage (%)

Runway	Maximum Cross Wind Component	
	13 KNOTS	20 KNOTS
13-31	89.16	98.92
1-19	91.94	99.38
7-25	93.25	99.65
1-19 & 7-25	98.65	99.97
1-19 & 7-25 & 13-31	99.97	100.00

GENERAL MITCHELL INTERNATIONAL AIRPORT MASTER PLAN UPDATE

ALL WEATHER WIND ROSE ANALYSIS

EXHIBIT 4.1-2



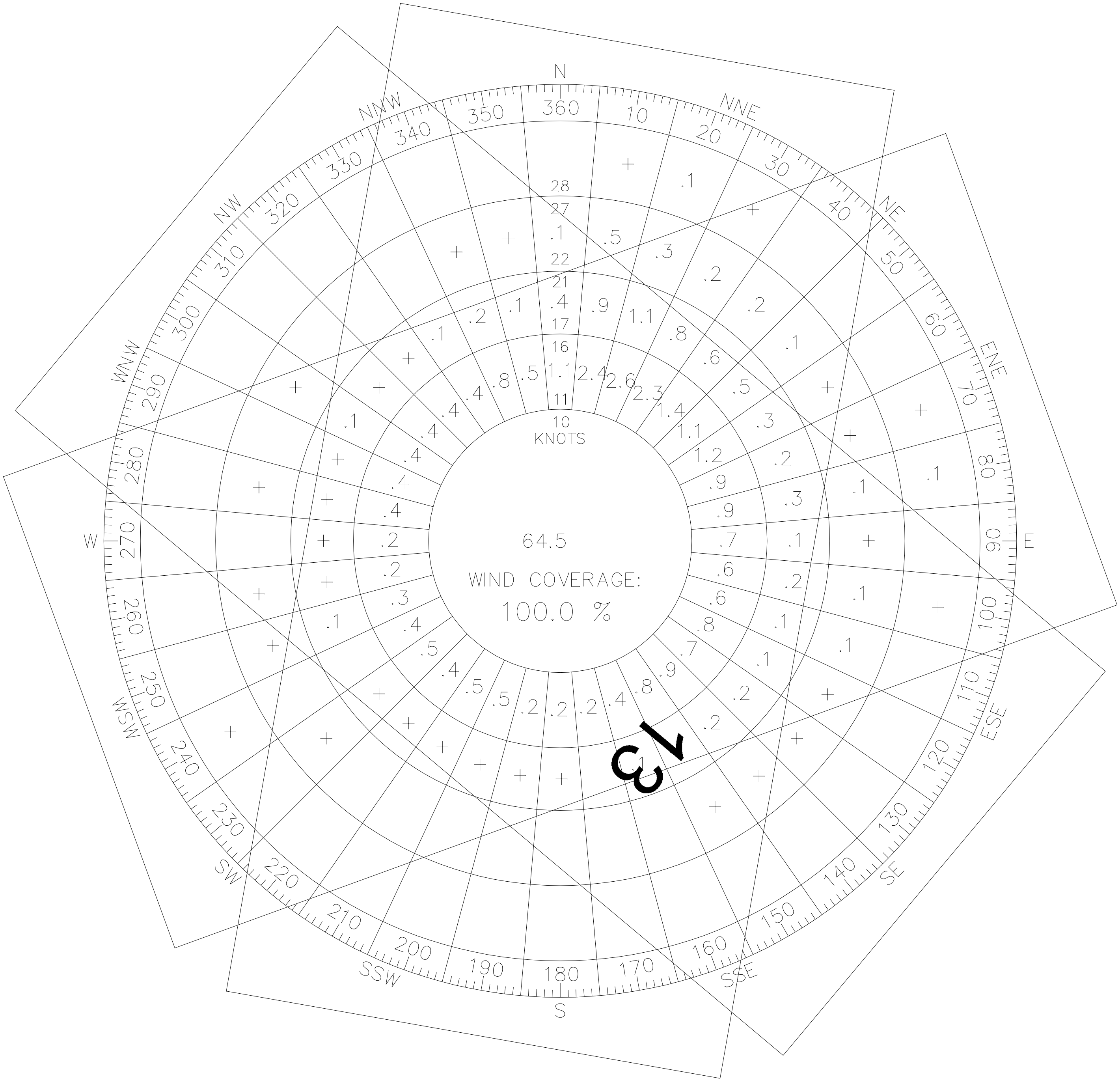
Runway System Wind Coverage (%)

Runway	Maximum Cross Wind Component	
	13 KNOTS	20 KNOTS
13-31	89.59	99.07
1-19	91.73	99.39
7-25	93.61	99.37
1-19 & 7-25	98.62	99.97
1-19 & 7-25 & 13-31	99.98	100.00

GENERAL MITCHELL INTERNATIONAL AIRPORT MASTER PLAN UPDATE

VFR WEATHER WIND ROSE ANALYSIS

EXHIBIT 4.1-3



Runway System Wind Coverage (%)

Runway	Maximum Cross Wind Component	
	13 KNOTS	20 KNOTS
13-31	85.64	97.72
1-19	93.61	99.30
7-25	90.35	99.03
1-19 & 7-25	98.85	99.97
1-19 & 7-25 & 13-31	99.95	100.00

G E N E R A L MITCHELL INTERNATIONAL AIRPORT MASTER PLAN UPDATE

IFR WEATHER WIND ROSE ANALYSIS

EXHIBIT 4.1-4

contact approach. If the weather conditions at the destination airport are such that the pilot is unable to, or chooses not to, conduct a visual approach, he or she must conduct either a nonprecision or precision instrument approach procedure. A precision approach, such as the Instrument Landing System (ILS), provides both vertical guidance and lateral guidance to the runway. The nonpreceison instrument approaches, such as the terminal VOR, non-directional beacon (NDB), or localizer directional aid (LDA), only provide lateral guidance thus requiring higher weather minima (i.e. better cloud ceiling and visibility) than required when conducting a precision instrument approach.

ILS systems are classified into three categories, each category being defined in term of minimum visibility and decision height altitudes. The categories are listed in **Table 4.1-2**. Minimum visibility is measured in fractions of a mile when measured by human observers or in hundreds of feet when measured by runway visual range (RVR) equipment located on the Airport.

TABLE 4.1-2

General Mitchell International Airport

ILS WEATHER MINIMA

ILS Category	Decision Height	Visibility or RVR
CAT I	200 feet	½ mile or 1,800 feet
CAT II	100 feet	1,200 feet**
CAT IIIa	*	700 feet**
CAT IIIb	*	150 feet**
CAT IIIc	*	***

* No decision height specified. Visibility is the only limiting factor

** No fraction of miles authorized when determining visibility. The runway served by the ILS must have operable RVR equipment

*** No ceiling or visibility specified. Aircraft must be equipped with automatic landing equipment

A Category I ILS provides accurate guidance information in visibilities as low as one-half mile and ceiling as low as 200 feet. These minima are representative of a standard ILS installation.

A Category II ILS permits a properly rated pilot to utilize make an approach to the runway in visibilities as low as 1,200 feet or ceilings as low as 100 feet. The additional equipment required for a Category II installation includes more precise localizer and glide slope monitoring equipment, an inner marker beacon, and additional approach lighting.

A Category III ILS installation is much more expensive since it requires completely redesigned localizer and glide slope equipment. Category III ILS approaches is of three types: IIIa, IIIb, or IIIc. Category IIIc approaches may be conducted when the ceiling or visibility is zero.

At GMIA, runways 19R and 7R have Category I ILS equipment while runway 1L is equipped and certified for Category III ILS approaches. Runway 25L has an LDA which provides nonprecision approach guidance.

4.1.3 Aircraft Operational Fleet Mix

For theoretical capacity calculations, the aircraft mix is the relative percentage of operations conducted by each of the four classes of aircraft (A, B, C, and D) based on takeoff weight (**Table 4.1-3**). The Airport's mix index is obtained by calculating the percentage of Class C aircraft plus three times the percentage of Class D aircraft. For GMIA, the existing and projected aircraft fleet mix by aircraft class is shown in **Table 4.1-4.**

4.1.4 Percentage of Arrivals

The percentage of all aircraft operations that are arrivals has an influence on the capacity of runways. For example, a runway used exclusively for departures will have a capacity different from that of one used solely for arrivals. Based on observations of the runway use and discussions with FAA ATC personnel, 60 percent of total peak hour operations are departures and 40 percent are arrivals.

TABLE 4.1-3 *General Mitchell International Airport* *AIRCRAFT CLASSIFICATIONS*				
Aircraft Class	Typical Aircraft	Maximum Certified Takeoff Weight (pounds)	Number of Engines	Estimated Approach Speed (knots)
A	C172, C206	12,500 or less	Single	95
B	C44, BE58	12,500 or less	Multi	120
C	C750, CRJ, BRJ, BRJ, B717, B737, DC9	12,500 – 300,000	Multi	130
D	KC-B5, A330	Over 300,000	Multi	140

Source: FAA Advisory Circular 150/5060-5

TABLE 4.1-4 *General Mitchell International Airport* *EXISTING AND PROJECTED PEAK HOUR VMC AND IMC FLEET MIX AND MIX INDEX*								
Aircraft Class	2002		2006		2011		2021	
	VMC	IMC	VMC	IMC	VMC	IMC	VMC	IMC
A & B	12.2%	9.9%	12.2%	9.9%	12.2%	10.1%	11.0%	9.3%
C	84.7%	87.0%	84.5%	86.8%	84.3%	86.3%	85.0%	86.7%
D	3.1%	3.2%	3.3%	3.4%	3.5%	3.6%	4.0%	4.0%
Total	100%	100%	100%	100%	100%	100%	100%	100%
Mix Index	94.0	96.6	94.4	97.0	94.8	97.1	97.0	98.7

Source: PB Aviation, Inc. Analysis

4.1.5 Touch-and-Go Operations

Touch-and-go operations are landings during which the aircraft continue to roll down the runway and take off again. Pilots conducting touch-and-go operations normally stay in the airport traffic pattern. This procedure is usually a training activity. Airport operational capacity can increase with the ratio of touch-and-go operations to total operations; the reason for this increase is that the aircraft in the pattern are continually available for approaches. Touch-and-go operations, however, reduce the availability of the runway for other operations. In instances where commercial operations constitute a substantive portion of the airport's total operations, training by light aircraft in repetitive field operations can actually reduce airport capacity.

There are no touch-and-go operations in peak hour (7:00 AM – 7:59 AM) and the touch-and-go operations outside of the peak hour are less than two percent of total operations. Therefore, the touch-and-go operations are not a factor in the theoretical demand/capacity analysis.

4.1.6 Peak Hour Airfield Capacity

The activity projections presented in Chapter 3.0*, Activity Projections,* were used as part of the demand/capacity analysis. Peak hour capacity was calculated for each of the Airport's runway operating configurations by utilizing the hourly capacity methodology presented in FAA Advisory Circular 150/5060-5. The input assumptions used for these calculations are summarized as follows:

- *Peak hour operations are 40 percent arrivals and 60 percent departures*
- *VMC and IMC fleet mixes as shown in Table 4.1-4*
- *Runway conditions are dry*
- *Percentage of touch-and-go operations is less than 10 percent during the peak hour*

The results of the hourly capacity analysis are listed in **Table 4.1-5**. The numbers in bold indicate that the peak hour demand is at or more than peak hour capacity. This table also compares projected peak hour VMC and IMC activity for GMIA to hourly operational capacities.

As shown, GMIA does not have adequate hourly capacity throughout the 20-year planning period to accommodate projected peak hour VMC and IMC demand, especially in VMC2 and VMC4 runway use configurations. In IMC2 and IMC 4 configurations, the peak hour is at or more than the capacity in 2011. In all IMC conditions, the peak hour demand is at or more than the capacity in 2021.

TABLE 4.1-5 *General Mitchell International Airport* *AIRFIELD DEMAND/CAPACITY ANALYSIS RESULTS*				
Runway Use Configuration	**Aircraft Operations**			
	2002	2006	2011	2021
VMC 1				
Peak Hour Demand	56	60	67	80
Peak Hour Capacity	110	110	109	109
VMC 2				
Peak Hour Demand	56	60	67	**80**
Peak Hour Capacity	81	81	80	**80**
VMC 3				
Peak Hour Demand	56	60	67	80
Peak Hour Capacity	108	108	107	107
VMC 4				
Peak Hour Demand	56	60	67	**80**
Peak Hour Capacity	76	76	75	**75**
IMC 1				
Peak Hour Demand	56	60	67	**80**
Peak Hour Capacity	68	68	68	**67**
IMC 2				
Peak Hour Demand	56	60	**67**	**80**
Peak Hour Capacity	67	67	**67**	**67**
IMC 3				
Peak Hour Demand	56	60	67	**80**
Peak Hour Capacity	69	69	69	**68**
IMC 4				
Peak Hour Demand	56	60	**67**	**80**
Peak Hour Capacity	65	65	**65**	**65**

Source: PB Aviation, Inc. Analysis
Bold indicates where Peak Hour Demand is equal to or greater than Peak Hour Capacity

4.1.7 Annual Service Volume

Annual service volume (ASV) is an important indicator of an airport's ability to meet demands placed on its airfield. ASV combines the physical capacity of the airfield, as measured by its hourly capacity, with the characteristics of an airport's users, as measured by peak period operations.

To calculate an airfield's ASV, the percentage of occurrence of different runway operating configurations and their associated hourly capacities must be specified. These percentages, along with ASV weighing factors (derived from the capacity estimate), are used to compute a weighted hourly capacity. Two additional factors—the ratio of annual demand to average daily demand in the peak month of the year (referred to as the D factor) and the ratio of average daily demand to average peak hour demand, for the peak month of the year (referred to as the H factor)—are then used to calculate the ASV (see **Table 4.1-6**).

Typically, when an airfield demand reaches 60 percent of its capacity, enhancements should be planned. When airport activity reaches 80 percent of the capacity, new airfield facilities should be constructed or demand management strategies should be in place. The 60 percent planning ratio and the 80 percent action ratio were applied to the estimated ASV for GMIA to determine a general time frame in which these milestones could be expected to be reached (see **Exhibit 4.1-5**). As shown, GMIA's baseline annual demand is projected to increase from 200,708 operations (57 percent of ASV) in 2001 to 324,460 operations (93 percent of ASV) in 2021. This level of demand, when compared to GMIA's ASV, indicates that implementation of capacity enhancement improvements should begin between 2015 and 2021.

TABLE 4.1-6 *General Mitchell International Airport* ***AIRFIELD CAPACITY***					
Operation Configuration	Runway Use Percentage (P)	Hourly Capacity (C)	Weighing Factor (W)[1]	Weighted Hourly Capacity (CPW)	Weighted Runway Use Percentage (PW)
VMC 1	57.38%	110	1	63.12	0.57
VMC 2	1.15%	81	15	13.97	0.17
VMC 3	29.90%	108	1	32.29	0.30
VMC 4	0.27%	76	15	3.08	0.04
IMC 1	3.07%	68	20	41.75	0.61
IMC 2	5.05%	67	20	67.67	1.01
IMC 3	2.44%	69	20	33.67	0.49
IMC 4	0.74%	65	20	9.62	0.15
Total	100%			265.17	3.34

The ASV was calculated as follows: [1]

* Runway use percentages (P) were obtained from FAA ATC personnel. Hourly Capacity (C) comes from Table 4.1.5
* ASV weighing factors (W) were assigned to each runway use configuration in accordance with Table 3-1 contained in FAA Advisory Circular 150/5060-5.
* The weighted hourly capacity (C_w) is calculated by dividing CPW by PW, where:

  CPW = the sum total of $CPW_1 + CPW_2 + \ldots + CPW_n$, and

  PW = the sum total of $PW_1 + PW_2 + \ldots + PW_n$

  Thus: CPW = 265.17

  PW = 3.34

  $C_w = 79.39$
* Daily and Hourly demand ratios, (D) and (H) respectively, were calculated based on guidelines contained in the FAA Advisory Circular 150/5060-5.

  D = 335

  H=13
* The annual Service Volume (ASV) is calculated as follows:

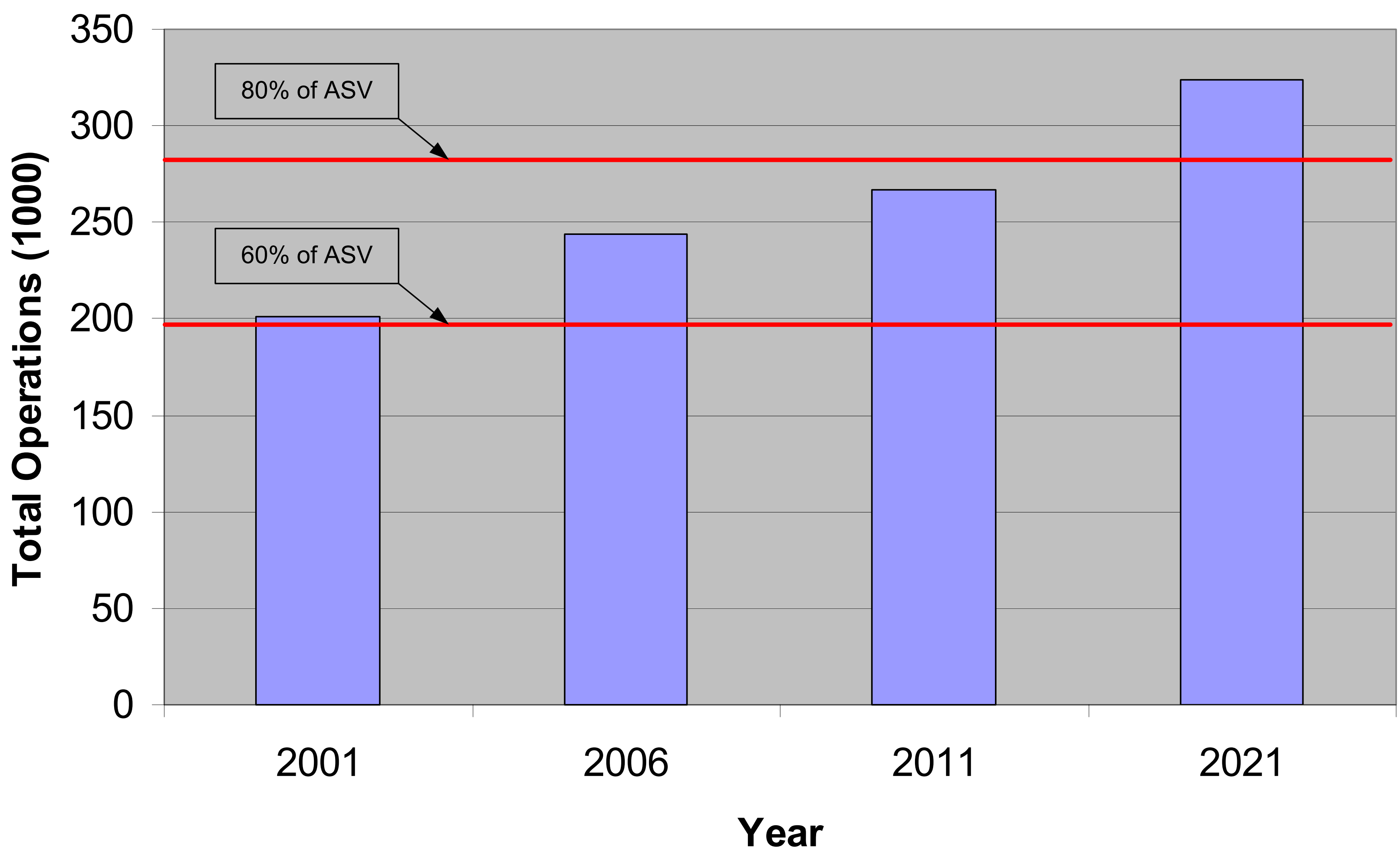
  $ASV = (C_w)(H)(D)$

  Thus: ASV = 350,000

[1]FAA Advisory Circular 150-5060-5
Source: PB Aviation, Inc. Analysis

The following equation was used to calculate the ASV for the Airport:

$$\begin{aligned} ASV &= \text{Weighted Hourly Capacity} \times D \times H \\ &= 81.21 \times 330 \times 13 \\ &= 350{,}000 \text{ Annual Operations} \end{aligned}$$



GENERAL MITCHELL INTERNATIONAL AIRPORT MASTER PLAN UPDATE

AIRFIELD DEMAND AND CAPACITY

EXHIBIT 4.1-5

4.2 AIRFIELD SIMULATION ANALYSIS

Computer simulations were used to evaluate the capacity of the existing airfield to accommodate projected operations for the existing (2001), 2006, 2011, and 2021 demand levels. The analysis was conducted using the FAA's Airport and Airspace Simulation Model, *SIMMOD PLUS!,* a comprehensive package of airport/airspace simulation development tools to aid in the development of airfield and airspace simulations.

Simulations were conducted for the eight operating configurations in Exhibit 4.1-1. A full day of operations was modeled. Peak hour operations were also analyzed. The airfield simulations measured the amount of aircraft delay that occurs in each of these situations with existing and forecast levels of traffic.

4.2.1 SIMMOD Input

4.2.1.1 Activity Levels and Aircraft

The four schedules that were simulated contained the number of flights depicted by hour in **Exhibits 4.2-1** through **4.2-4**. The total number of daily operations increases from 708 in year 2001 to 960 in year 2021. **Table 4.2-1** presents the maximum number of operations simulated for the peak hour period.

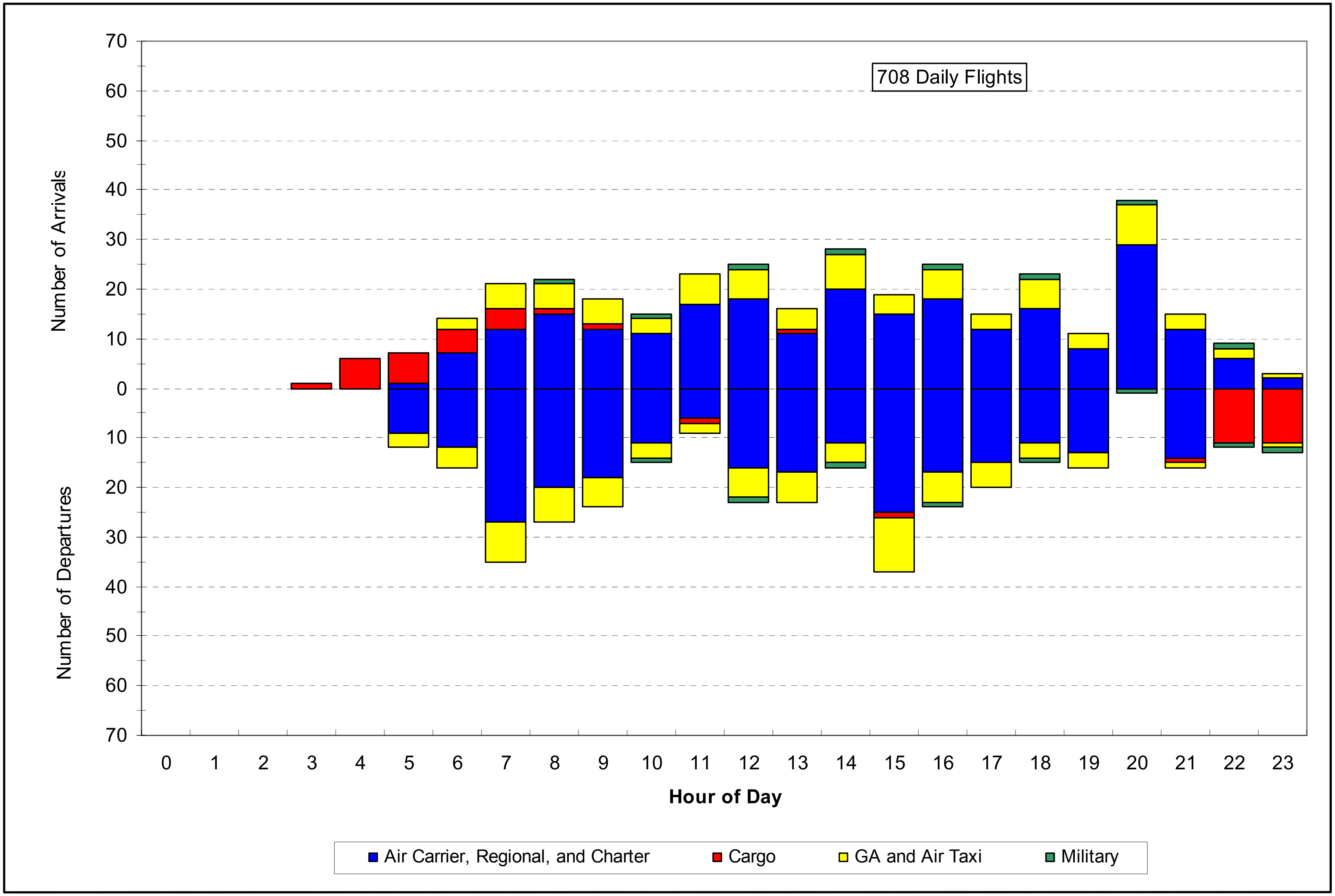
TABLE 4.2-1

General Mitchell International Airport

SIMULATED ACTIVITY LEVELS

Year	Daily Operations	Peak Arrival and Departure Operations (Hour)
2002	708	56 (07:00-7:59 AM)
2006	724	60 (07:00-7:59 AM)
2011	790	67 (07:00-7:59 AM)
2021	960	80 (07:00-7:59 AM)

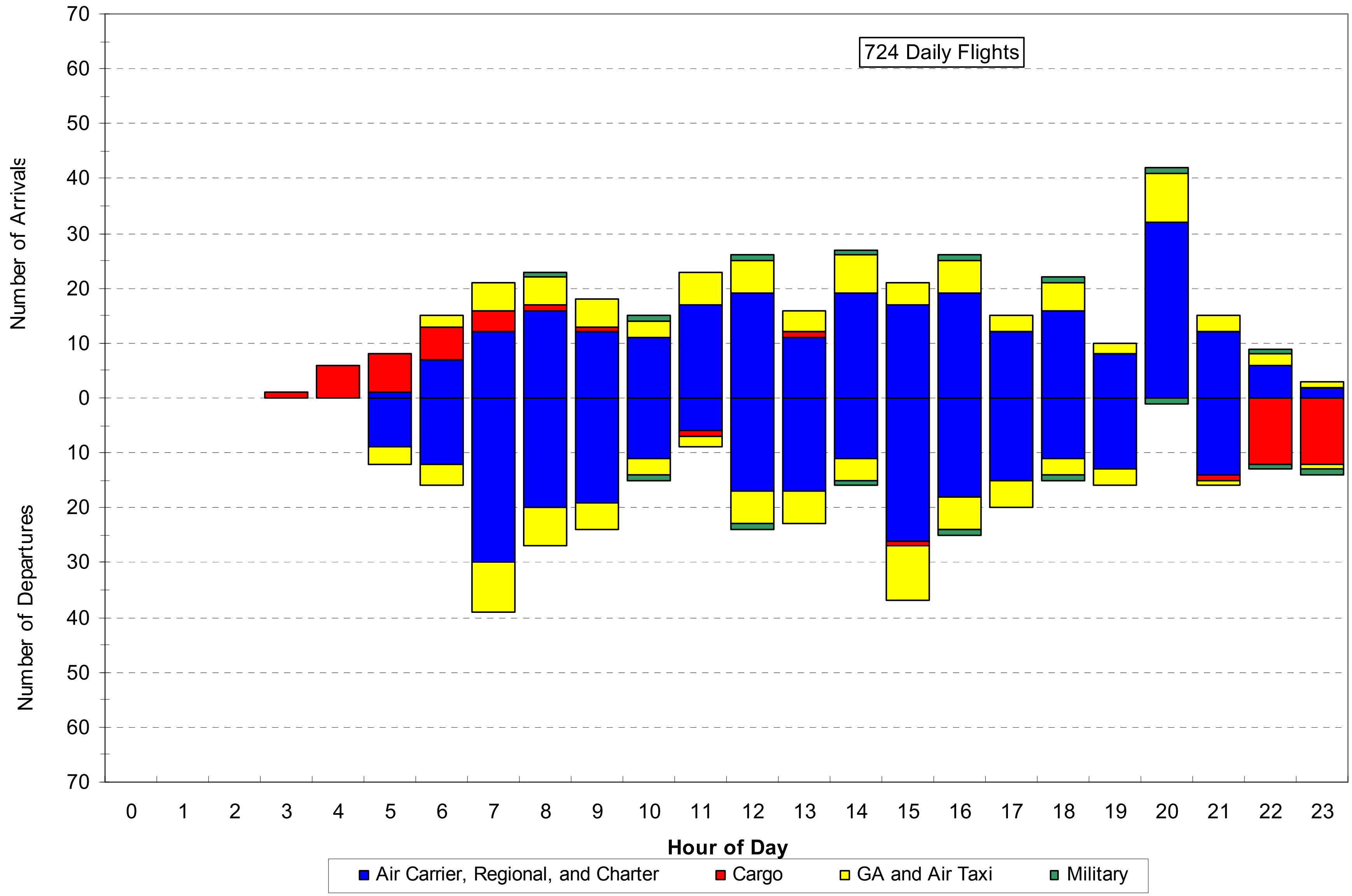
Source: PB Aviation, Inc. Analysis
Note: Helicopter operations in each traffic demand projection were removed from the simulation because they do not use a runway.



GENERAL MITCHELL INTERNATIONAL AIRPORT MASTER PLAN UPDATE

EXISTING DAILY OPERATIONS

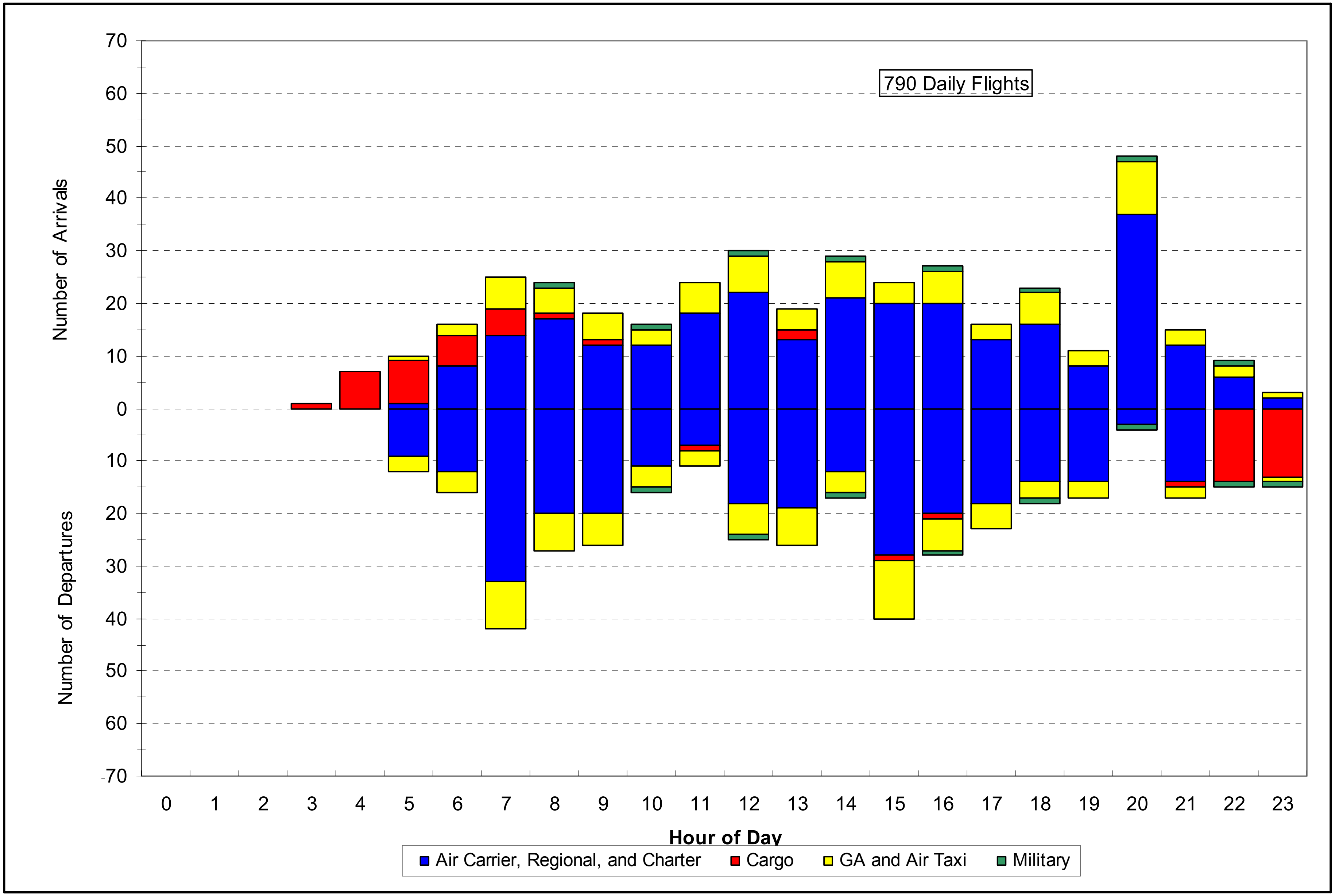
EXHIBIT 4.2-1



GENERAL MITCHELL INTERNATIONAL AIRPORT MASTER PLAN UPDATE

DAILY OPERATIONS IN 2006

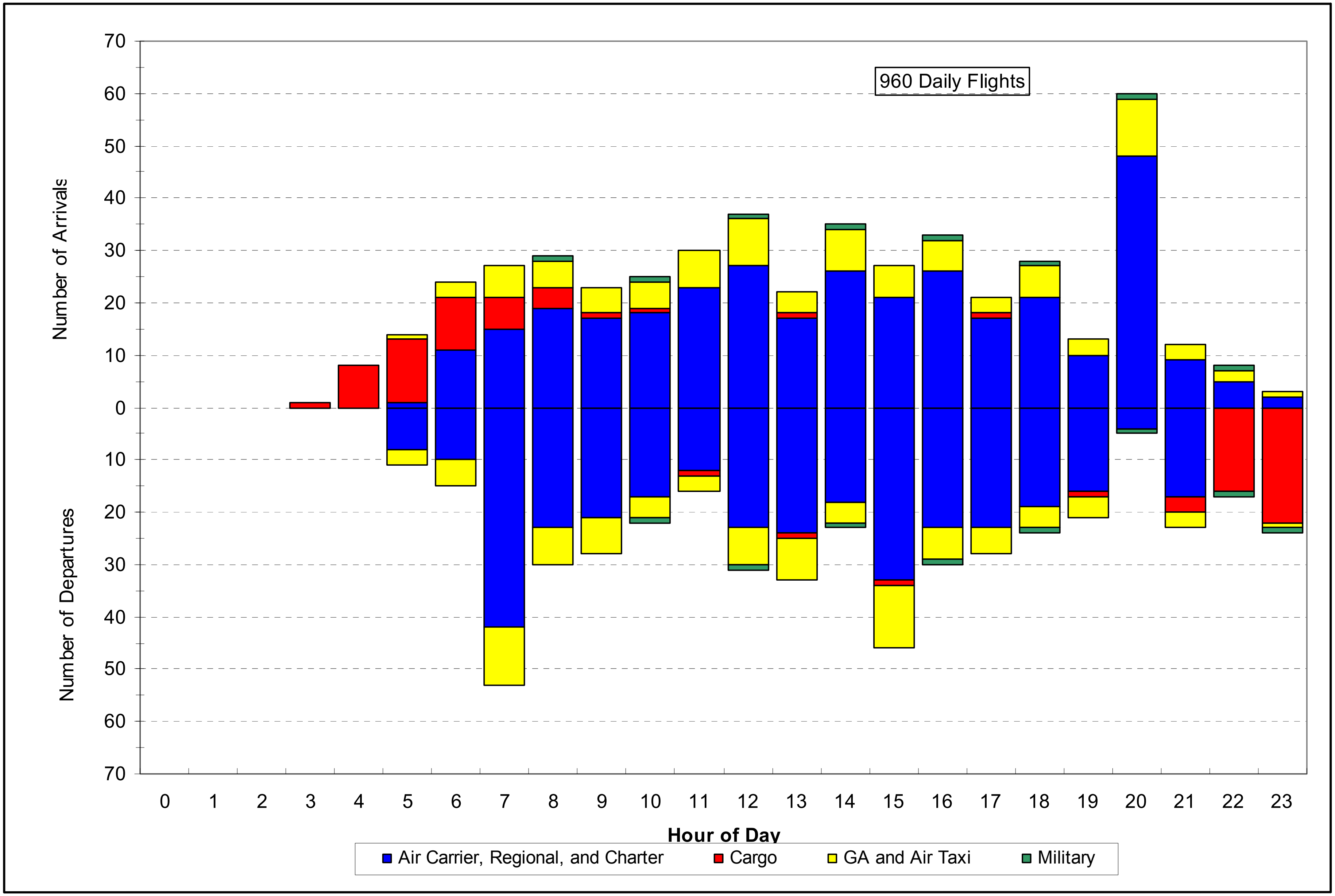
EXHIBIT 4.2-2



GENERAL MITCHELL INTERNATIONAL AIRPORT MASTER PLAN UPDATE

DAILY OPERATIONS IN 2011

EXHIBIT 4.2-3



GENERAL MITCHELL INTERNATIONAL AIRPORT MASTER PLAN UPDATE

DAILY OPERATIONS IN 2021

EXHIBIT 4.2-4

SIMMOD is capable of handling a wide variety of aircraft types. However, aircraft are grouped into aircraft classes defined by the user. Within each class, aircraft generally have the same size, weight, and performance characteristics. For the simulation experiments, the following classes were used:

- *Group 1 –* *General Aviation*: All single-engine piston aircraft.
- *Group 2 –* *Small Aircraft*: Twin turboprop aircraft and single-engine Cessna Caravan turboprops.
- *Group 3 –* *Corporate Jets and Regional Jets*: 328J, CRJ, ARJ, and ERJ
- *Group 4 –* *Large Jets*: B727, various 737 and DC9 models, and MD80
- *Group 5 –* *Boeing 757*
- *Group 6 –* *Heavy Jets*: Includes all wide-bodied aircraft, plus KC-135 military aircraft.

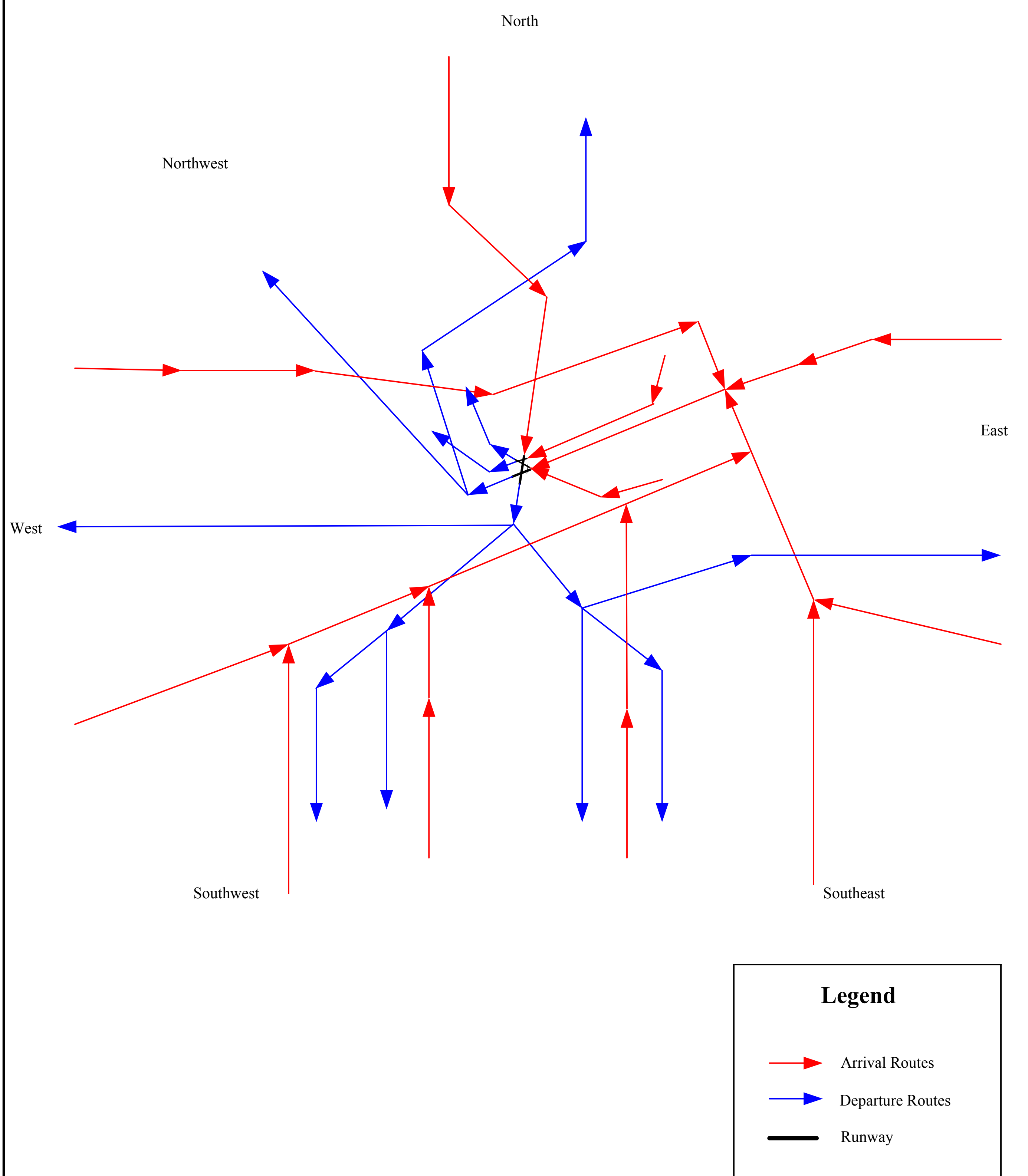
For the simulation analysis, the 757 was classified in a separate category and modeled separately, due to its unique airspace separation characteristics. It should be noted that the aircraft groups used in SIMMOD differ from the FAA's airplane design groups.

4.2.1.2 Airspace

The SIMMOD airspace is composed of an interrelated network of aircraft routes characterized by a series of nodes and links. As each aircraft traverses a link, it is required to maintain minimum separation from preceding and succeeding aircraft, unless the link is defined to allow passing.

Exhibits 4.2-5 through **4.2-8** depict the arrival and departure routes simulated for the analysis. Five approach paths to GMIA were used for all wind and weather situations. These approach paths were:

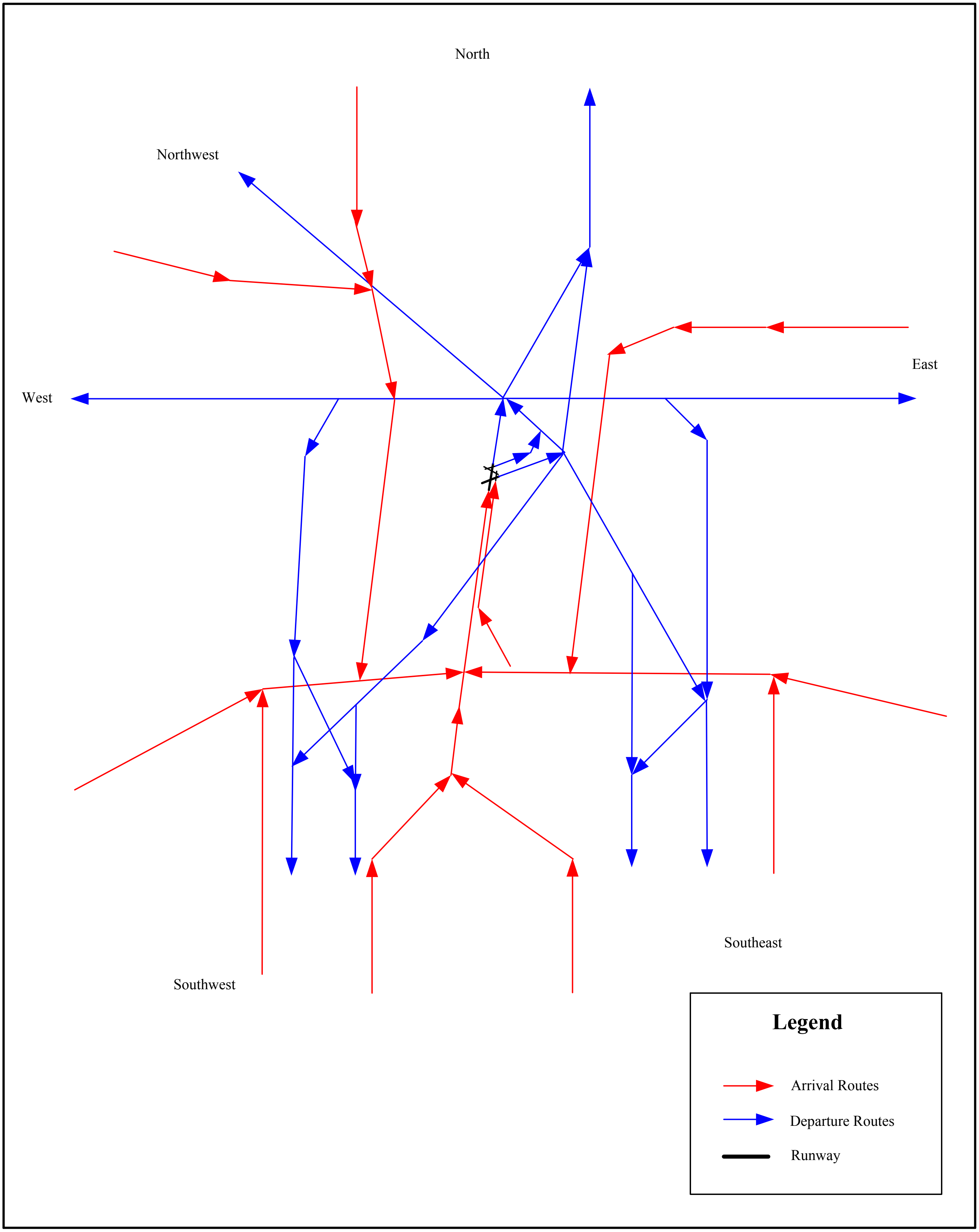
- *East Route* – Handles all traffic from New York, Boston, Philadelphia, Buffalo, Cleveland, Detroit, etc.
- *Southeast Route* – Handles all traffic from Cincinnati, Columbus, Indianapolis, Charleston, Richmond, etc.
- *Southwest Route* – Handles all traffic from St. Louis, Kansas City, etc.
- *West Route* – Handles all traffic from Denver, Omaha, etc.
- *Northwest Route* – Handles all traffic from Minneapolis, Winnipeg, Duluth, etc.



GENERAL MITCHELL INTERNATIONAL AIRPORT MASTER PLAN UPDATE

ARRIVAL AND DEPARTURE ROUTES WESTERLY AND SOUTHERLY FLOW (25L)

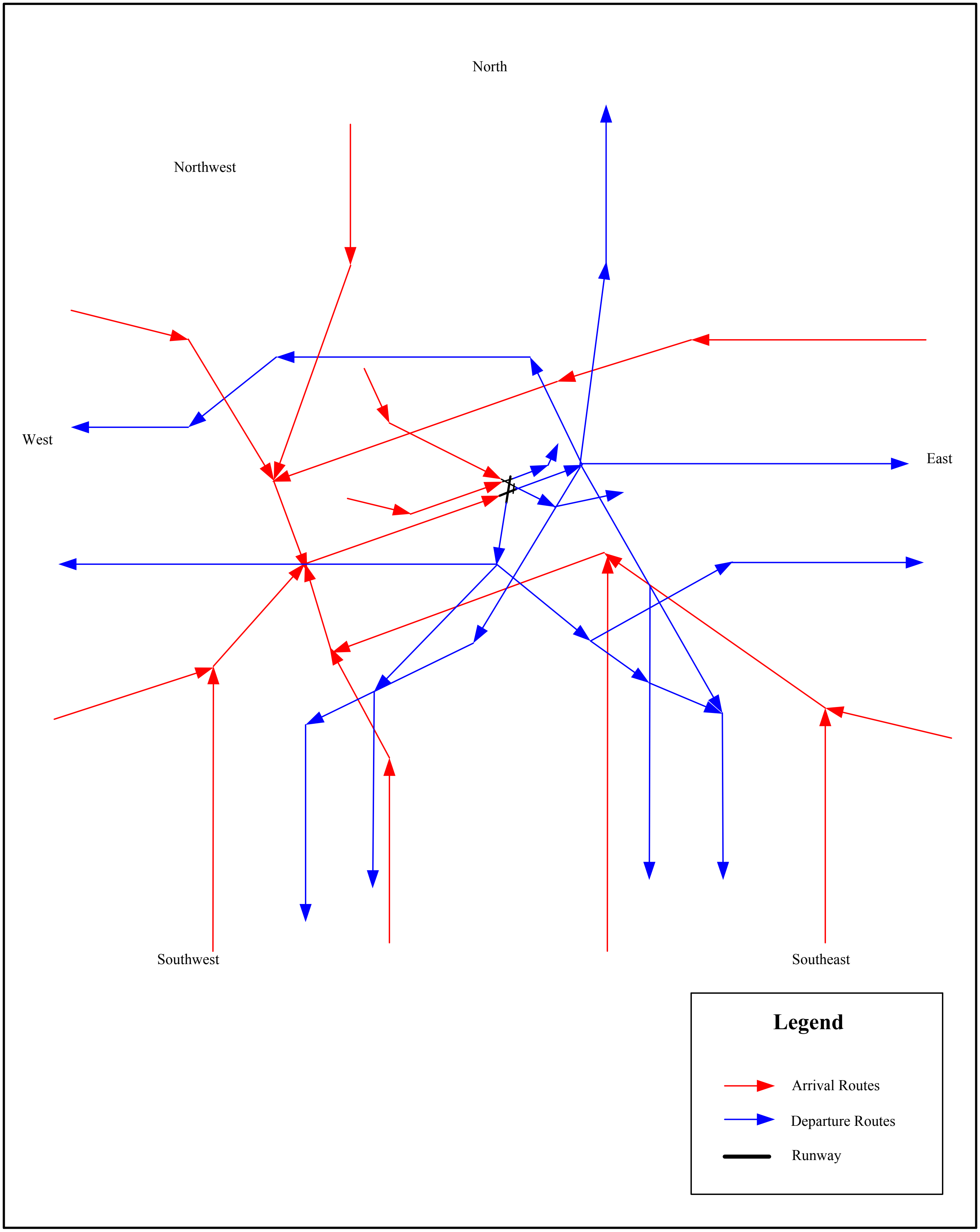
EXHIBIT 4.2-5



GENERAL MITCHELL INTERNATIONAL AIRPORT MASTER PLAN UPDATE

ARRIVAL AND DEPARTURE ROUTES NORTHERLY AND EASTERLY FLOW (01L)

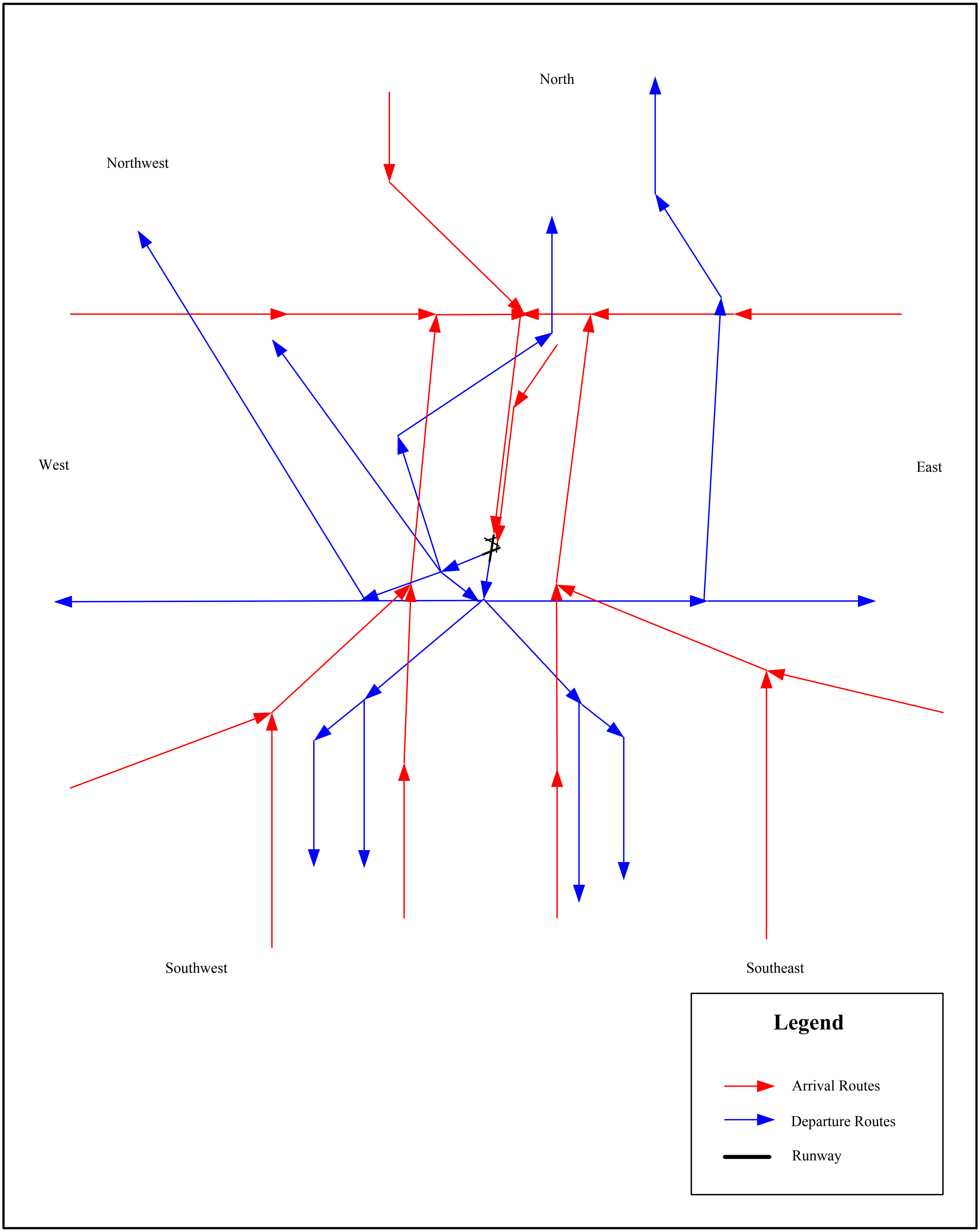
EXHIBIT 4.2-6



GENERAL MITCHELL INTERNATIONAL AIRPORT MASTER PLAN UPDATE

ARRIVAL AND DEPARTURE ROUTES EASTERLY AND SOUTHERLY FLOW (07L)

EXHIBIT 4.2-7



GENERAL MITCHELL INTERNATIONAL AIRPORT MASTER PLAN UPDATE

ARRIVAL AND DEPARTURE ROUTES SOUTHERLY (19R)

EXHIBIT 4.2-8

In VFR conditions, arrival routes to runways 25R, 7L, 31, 13, 19L, and 1R are designated for all Group 1 and Group 2 aircraft arrivals. These routes are discontinued in IFR conditions.

Six departure routes from GMIA were included in the simulation. These were the east, southeast, southwest, west, northwest, and north departure routes, with only turboprops using the North departure route.

4.2.1.3 Procedures and Aircraft Separation and Speed

The SIMMOD model gives priority to arrivals, consistent with standard air traffic control procedures. However, if gaps between successive arrivals on the same runway are great enough, departures are interspersed between the arrivals, increasing the overall capacity of the airfield and helping to reduce departure delays.

En-route procedures are designed on a straightforward first-in/first-out regime for aircraft crossing each departure node. The exception is where two paths merge. At that node, the aircraft that proceeds first is always the faster aircraft.

Under VFR conditions, arrivals within three nautical miles of the runway block departure procedures until clear of the runway. Group 1 arrivals clear the runway in 45 seconds, Groups 2 and 3 clear in 50 seconds, Groups 4, 5, and 6 clear in 60 seconds. Departures block subsequent arrivals for a minimum of 45 seconds, and block subsequent departures until the aircraft is three nautical miles beyond the departure runway end.

Under IFR conditions, arrivals within three nautical miles of runways block departure procedures until clear of the runway. Group 1, 2, and 3 arrivals clear the runway in 65 seconds, Groups 4, 5, and 6 clear the runway in 75 seconds. Departures block subsequent arrivals for a minimum of 45 seconds, and block subsequent departures until the aircraft is three nautical miles beyond the departure runway end.

Based on discussions with Air Traffic Control Tower management at GMIA, the separations maintained between aircraft are the same during IFR and VFR conditions. Minimum aircraft separations between aircraft groups (in nautical miles) are shown in **Table 4.2-2**.

TABLE 4.2-2 *General Mitchell International Airport* *MINIMUM AIRCRAFT SEPARATIONS (NM)*						
	Lead Aircraft					
Trailing Aircraft	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Group 1	3	3	4	4	6	6
Group 2	3	3	4	4	6	6
Group 3	3	3	3	3	5	5
Group 4	3	3	3	3	5	5
Group 5	3	3	3	3	5	5
Group 6	3	3	3	3	4	4

Source: PB Aviation, Inc. Analysis

Average aircraft speeds for all conditions are presented in **Table 4.2-3**.

TABLE 4.2-3 *General Mitchell International Airport* *AVERAGE AIRCRAFT SPEEDS (KNOTS) – ALL CONDITIONS*							
	SIMMOD Link Type						
Aircraft Class	1	2	3	4	5	6	7
Group 1	110	100	90	80	90	100	110
Group 2	230	170	120	115	120	170	200
Group 3	250	210	170	135	170	210	250
Group 4	250	210	170	135	170	210	250
Group 5	250	210	170	135	180	210	250
Group 6	250	210	170	140	180	210	250

Source: PB Aviation, Inc. Analysis

4.2.1.4 Runway Utilization

Based on the data provided by FAA Air Traffic Control Tower management at GMIA, the runway end utilization percentages that occur in the simulations under VMC and IMC are listed in **Tables 4.2-4** and **4.2-5**.

TABLE 4.2-4

General Mitchell International Airport

RUNWAY END UTILIZATION – VMC

		VMC1		**VMC2**		**VMC3**		**VMC4**	
	Runways	Arrive	Departure	Arrive	Departure	Arrive	Departure	Arrive	Departure
Jet Aircraft	25L	95%	15%						
	25R								
	7L								
	7R				70%	100%	80%		
	13								
	31								
	1L			100%	30%				
	1R								
	19R	5%	75%				15%	100%	90%
	19R@V*		10%				5%		10%
	19L								
Prop Aircraft	25L	70%	15%						
	25L@T*		5%		2%				2%
	25R	25%	15%						
	7L				8%	20%	20%		
	7R				60%	60%	60%		
	13					20%	5%		
	31	2%	2%						
	1L			99%	30%				
	1R			1%					
	19R	3%	60%				15%	98%	88%
	19R@V		3%						10%
	19L							2%	

* 19R@V and 25L@T indicate departures from taxiway intersections
Source: FAA Air Traffic Control Management

		IMC1		IMC2		IMC3		IMC4	
	Runways	Arrive	Departure	Arrive	Departure	Arrive	Departure	Arrive	Departure
Jet Aircraft	25L	100%	15%						
	25R								
	7L								
	7R				60%	100%	85%		
	13								
	31								
	1L			100%	40%				
	1R								
	19R		82%				10%	100%	50%
	19R@V		3%				5%		50%
	19L								
Prop Aircraft	25L	100%	15%						
	25L@T		5%		2%				2%
	25R	25%	15%						
	7L				5%		10%		
	7R				63%	100%	75%		
	13						5%		
	31		2%						
	1L			100%	30%				
	1R								
	19R		60%				10%	100%	88%
	19R@V		3%						10%
	19L								

TABLE 4.2-5

General Mitchell International Airport

RUNWAY END UTILIZATION – IMC

* 19R@V and 25L@T indicate departures from taxiway intersections
Source: FAA Air Traffic Control Management.

The FAA Controllers are able to separate aircraft landings by concourse because there is ample airfield capacity. As air traffic grows, however, this flexibility will diminish. SIMMOD has the capability to perform dynamic reassignment of aircraft to an available runway; as demand levels increased, this capability was used to model operations in the forecast years. **Exhibit 4.2-9** depicts the airfield network that was used in the simulations.

GENERAL MITCHELL INTERNATIONAL AIRPORT MASTER PLAN UPDATE

AIRFIELD NETWORK IN SIMMOD

EXHIBIT 4.2-9

Assumptions concerning arrival runway occupancy time were based on field observations of runway exit utilization and were adjusted based on input from FAA Air Traffic Control management at the Airport. **Tables 4.2-6** through **4.2-9** depict the assumptions that were used to model arrival runway length use for each aircraft class during VMC (dry pavements).

TABLE 4.2-6

General Mitchell International Airport

PERCENTAGE OF ARRIVALS EXITING WITHIN STATED DISTANCE ON RUNWAY 19R–VMC

Aircraft Group	2,900 ft.	3,700 ft.	4,800 ft.	6,400 ft.	8,200 ft.	9,600 ft.
Group 1	5%	15%	60%	20%	0%	0%
Group 2	0%	10%	65%	25%	0%	0%
Group 3	0%	5%	50%	45%	0%	0%
Group 4	0%	5%	20%	50%	20%	5%
Group 5	0%	5%	20%	50%	20%	5%
Group 6	0%	0%	0%	25%	65%	10%

Source: PB Aviation, Inc. Analysis

TABLE 4.2-7

General Mitchell International Airport

PERCENTAGE OF ARRIVALS EXITING WITHIN STATED DISTANCE ON RUNWAY 1L–VMC

Aircraft Group	3,300 ft.	4,900 ft.	6,000 ft.	6,800 ft.	7,700 ft.	8,600 ft.	9,600 ft.
Group 1	10%	50%	40%	0%	0%	0%	0%
Group 2	5%	40%	50%	5%	0%	0%	0%
Group 3	0%	15%	50%	30%	5%	0%	0%
Group 4	0%	10%	45%	30%	10%	5%	0%
Group 5	0%	10%	45%	30%	10%	5%	0%
Group 6	0%	0%	15%	20%	50%	10%	5%

Source: PB Aviation, Inc. Analysis

TABLE 4.2-8

General Mitchell International Airport

PERCENTAGE OF ARRIVALS EXITING WITHIN STATED DISTANCE ON RUNWAY 7R–VMC

Aircraft Group	3,050 ft.	4,000 ft.	4,600 ft.	5,150 ft.	6,900 ft.	8,000 ft.
Group 1	10%	20%	60%	10%	0%	0%
Group 2	5%	15%	50%	20%	10%	0%
Group 3	0%	10%	40%	30%	15%	5%
Group 4	0%	0%	10%	30%	50%	10%
Group 5	0%	0%	10%	30%	50%	10%
Group 6	0%	0%	0%	0%	25%	75%

Source: PB Aviation, Inc. Analysis

TABLE 4.2-9 *General Mitchell International Airport* ***PERCENTAGE OF ARRIVALS EXITING WITHIN STATED DISTANCE ON RUNWAY 25L–VMC***							
Aircraft Group	2,800 ft.	3,400 ft.	4,000 ft.	4,900 ft.	5,500 ft.	6,650 ft.	8,000 ft.
Group 1	5%	10%	30%	50%	5%	0%	0%
Group 2	0%	10%	15%	40%	25%	10%	0%
Group 3	0%	0%	10%	45%	30%	10%	5%
Group 4	0%	0%	0%	15%	30%	45%	10%
Group 5	0%	0%	0%	15%	30%	45%	10%
Group 6	0%	0%	0%	0%	0%	25%	75%

Source: PB Aviation, Inc. Analysis

Departure runway length usage was observed and confirmed through coordination with FAA Air Traffic Control management. **Table 4.2-10** contains departure runway length usage assumptions for VMC and IMC. Departure runway length usage is expected to be unaffected by wet weather.

TABLE 4.2-10 *General Mitchell International Airport* ***TAKE-OFF DISTANCE***					
Aircraft Group	2,500 ft.	4,500 ft.	6,500 ft.	8,500 ft.	9,600 ft.
Group 1	65%	35%	0%	0%	0%
Group 2	25%	75%	0%	0%	0%
Group 3	0%	35%	40%	25%	0%
Group 4	0%	25%	50%	25%	0%
Group 5	0%	25%	50%	25%	0%
Group 6	0%	0%	65%	25%	10%

Source: PB Aviation, Inc. Analysis

The following sets of data are used for each aircraft class in IFR weather conditions (wet pavements). During IMC, aircraft generally use more runway length to slow and exit, as reflected in **Tables 4.2-11** through **4.2-14**.

TABLE 4.2-11 *General Mitchell International Airport* ***PERCENTAGE OF ARRIVALS EXITING BY DISTANCE ON RUNWAY 19R–IMC***						
Aircraft Group	2,900 ft.	3,700 ft.	4,800 ft.	6,400 ft.	8,200 ft.	9,600 ft.
Group 1	0%	5%	50%	45%	0%	0%
Group 2	0%	0%	35%	60%	5%	0%
Group 3	0%	0%	15%	50%	35%	0%
Group 4	0%	0%	10%	30%	50%	10%
Group 5	0%	0%	10%	30%	50%	10%
Group 6	0%	0%	0%	5%	75%	20%

Source: PB Aviation, Inc. Analysis

TABLE 4.2-12

General Mitchell International Airport

PERCENTAGE OF ARRIVALS EXITING BY DISTANCE ON RUNWAY 1L–IMC

Aircraft Group	3,300 ft.	4,900 ft.	6,000 ft.	6,800 ft.	7,700 ft.	8,600 ft.	9,600 ft.
Group 1	0%	30%	50%	20%	0%	0%	0%
Group 2	0%	10%	30%	50%	10%	0%	0%
Group 3	0%	0%	20%	30%	30%	20%	0%
Group 4	0%	0%	10%	20%	30%	35%	5%
Group 5	0%	0%	10%	20%	30%	35%	5%
Group 6	0%	0%	0%	0%	20%	60%	20%

Source: PB Aviation, Inc. Analysis

TABLE 4.2-13

General Mitchell International Airport

PERCENTAGE OF ARRIVALS EXITING BY DISTANCE ON RUNWAY 7R–IMC

Aircraft Group	3,050 ft.	4,000 ft.	4,600 ft.	5,150 ft.	6,900 ft.	8,000 ft.
Group 1	0%	10%	30%	50%	10%	0%
Group 2	0%	5%	20%	35%	40%	0%
Group 3	0%	0%	0%	30%	30%	40%
Group 4	0%	0%	0%	25%	25%	50%
Group 5	0%	0%	0%	25%	25%	50%
Group 6	0%	0%	0%	0%	0%	100%

Source: PB Aviation, Inc. Analysis

TABLE 4.2-14

General Mitchell International Airport

PERCENTAGE OF ARRIVALS EXITING BY DISTANCE ON RUNWAY 25L–IMC

Aircraft Group	2,800 ft.	3,400 ft.	4,000 ft.	4,900 ft.	5,500 ft.	6,650 ft.	8,000 ft.
Group 1	0%	5%	15%	60%	20%	0%	0%
Group 2	0%	0%	10%	40%	35%	15%	0%
Group 3	0%	0%	0%	10%	20%	30%	40%
Group 4	0%	0%	0%	5%	20%	25%	50%
Group 5	0%	0%	0%	5%	20%	25%	50%
Group 6	0%	0%	0%	0%	0%	0%	100%

Source: PB Aviation, Inc. Analysis

4.2.1.5 Taxiway Travel Times and Routes

Aircraft travel times on various airfield segments were measured in order to assign taxi speeds to aircraft on those segments. While some carriers had faster taxi speeds than others, it was generally observed that aircraft in all classes had similar taxi speeds on the same taxiway segments, and that taxi speeds tend to be slower in the terminal area than on the taxiways paralleling the runways. Therefore, aircraft speeds on the taxiway system were estimated to average 25 nautical miles/hour (knots per hour) while taxi speeds in the gate areas were estimated to be 15 nautical miles/hour.

Aircraft routings on the taxiway system are assigned by the model on the basis of the shortest path (based on travel time) from exit taxiway to gate, and from gate to departure runway queue. Head-to-head conflicts were avoided by placing controls in the model.

4.2.1.6 Departure Queues

In SIMMOD, departure queue is used to define an airfield node where aircraft queue to depart on a runway. The following departure queues were included in the simulation for each runway use configuration:

VMC1: Runway 19R (at Taxiways F and V)
Runway 25L (at Taxiways M and T)
Runway 25R (at Taxiway F)
Runway 31 (at Taxiway M)

IMC1: Same as the queues under VMC1

VMC2: Runway 1L (at Taxiways R4)
Runway 7L (at Taxiway B)
Runway 7R (at Taxiway A5)

IMC2: Same as the queues under VMC2

VMC3: Runway 19 (at Taxiway F and V)
Runway 7L (at Taxiway B)
Runway 7R (at Taxiway A5)
Runway 13 (at Taxiway F)

IMC3: Same as the queues under VMC3

VMC4: Runway 19R (at Taxiways F and V)
Runway 25L (at Taxiway T)

IMC4: Same as the queues under VMC4

When a departure has been in queue for more than 180 seconds, arrival spacing will be increased to allow the aircraft sufficient separation to depart.

4.2.1.7 Terminal Gate Utilization

To allow the simulation to model the aircraft interactions occurring in the terminal areas, the gate area in the vicinity of Concourses C, D, and E was included in the simulation model. Each individual gate has a capacity of one aircraft, except for Gate 52 used by Skyway, which uses multiple parking positions from a single gate. Gate area characteristics are listed in **Table 4.2-15**.

TABLE 4.2.15

General Mitchell International Airport

TERMINAL GATE CHARACTERISTICS

Concourse	Gate Name	Aircraft Capacity per Gate	Aircraft Accommodated	Aircraft Group	Carrier	Pushback/ Powerback
C	C20-C23	1	Regional Jet	3,4,5	American Eagle	Push
	C24, C26	1	Large	3,4,5	Continental Express America West	Push
	C25	1	Regional Jet	3	Comair	Push
	C27	1	Large	3,4,5	Delta	Push
D	D30, D34, D36-49	1	Large	3,4,5	Midwest Express	Push
	D31, D33, D35	1	Large	3,4,5	United Express	Push
	D33	1	Regional Jet	3,4,5	Air Canada	Push
	D52	16	Small	2,3	Skyway ATA Connection	Power
	D51, D53	1	Large	3,4,5	US Airways US Airways Express	Push
E	E60, E61	1	Large	3,4,5	Funjet	Push
	E62-69	1	Large	3,4,5	Northwest KLM	Push

Source: Airport Records.

Gate assignments for each flight are made at random among the gates available to that airline. Arrivals and departures were paired, which allowed the impacts of delayed arrival times on the scheduled departure time of the outbound flight to be measured. All gates are pushback (i.e., aircraft are pushed backwards by tugs) except Gate D52 where power-in and power-out operations occur. In SIMMOD, aircraft pushbacks block the taxi path adjacent to the gate.

4.2.2 Simulation Results – Aircraft Delays

4.2.2.1 24-Hour Average Aircraft Delay

When using a simulation model, the primary measures of airfield/airspace capacity are arrival airspace delay and departure taxi-out delay (including departure queue delay). Delay is measured as the difference in the amount of time and aircraft actually uses the runway and the time it would have used if it were able to move unimpeded throughout the airfield/airspace system. For example, if there is only one aircraft taxiing out to depart and it obtains immediate departure clearance, the aircraft would have no delay (0.0 minutes delay).

Delay statistics were evaluated for the entire 24-hour traffic demand. **Tables 4.2-16** through **4.2-19** present average daily delays per operation for VMC1, 2, 3, and 4 runway use configurations.

TABLE 4.2-16

General Mitchell International Airport

DAILY AVERAGE DELAYS–VMC1

Year	Number of Flights	Average Arrival Airspace Delay (minutes)	Departure Taxi-Out Delay (minutes)
2001	708	1.29	0.15
2006	724	1.26	0.55
2011	790	1.87	0.80
2021	960	4.17	6.01

Source: PB Aviation, Inc. Analysis

TABLE 4.2-17

General Mitchell International Airport

DAILY AVERAGE DELAYS–VMC2

Year	Number of Flights	Average Arrival Airspace Delay (minutes)	Departure Taxi-Out Delay (minutes)
2001	708	1.45	1.05
2006	724	1.76	2.05
2011	790	3.08	3.72
2021	960	6.22	13.49

Source: PB Aviation, Inc. Analysis

TABLE 4.2-18 *General Mitchell International Airport* *DAILY AVERAGE DELAYS–VMC3*			
Year	Number of Flights	Average Arrival Airspace Delay (minutes)	Departure Taxi-Out Delay (minutes)
2001	708	1.88	0.42
2006	724	2.00	0.60
2011	790	2.89	1.00
2021	960	4.02	6.53

Source: PB Aviation, Inc. Analysis

TABLE 4.2-19 *General Mitchell International Airport* *DAILY AVERAGE DELAYS–VMC4*			
Year	Number of Flights	Average Arrival Airspace Delay (minutes)	Departure Taxi-Out Delay (minutes)
2001	708	1.15	3.07
2006	724	1.36	3.50
2011	790	3.27	5.87
2021	960	6.10	17.83

Source: PB Aviation, Inc. Analysis

Tables 4.2-20 through **4.2-23** present average daily delays per operation for runway use configurations under IMC. The delays shown for IMC2 and IMC4 runway use configurations during IMC are considerably higher than VMC because some runways are not available for arrivals and departures. Only a small percentage of the annual operations occur in IMC at GMIA; however, estimates of delay during IMC are very important in the airfield capacity evaluation for the Airport.

TABLE 4.2-20 *General Mitchell International Airport* *DAILY AVERAGE DELAYS–IMC1*			
Year	Number of Flights	Average Arrival Airspace Delay (minutes)	Departure Taxi-Out Delay (minutes)
2001	708	1.20	0.56
2006	724	1.95	1.07
2011	790	2.21	3.03
2021	960	5.33	6.82

Source: PB Aviation, Inc. Analysis

TABLE 4.2-21 *General Mitchell International Airport* *DAILY AVERAGE DELAYS–IMC2*			
Year	Number of Flights	Average Arrival Airspace Delay (minutes)	Departure Taxi-Out Delay (minutes)
2001	708	2.08	1.77
2006	724	2.73	2.55
2011	790	4.02	4.71
2021	960	7.71	16.09

Source: PB Aviation, Inc. Analysis

TABLE 4.2-22 *General Mitchell International Airport* *DAILY AVERAGE DELAYS–IMC3*			
Year	Number of Flights	Average Arrival Airspace Delay (minutes)	Departure Taxi-Out Delay (minutes)
2001	708	2.33	1.52
2006	724	2.91	2.11
2011	790	3.03	5.63
2021	960	9.86	6.96

Source: PB Aviation, Inc. Analysis

TABLE 4.2-23 *General Mitchell International Airport* *DAILY AVERAGE DELAYS–IMC4*			
Year	Number of Flights	Average Arrival Airspace Delay (minutes)	Departure Taxi-Out Delay (minutes)
2001	708	1.56	3.15
2006	724	1.89	4.42
2011	790	3.77	6.16
2021	960	8.85	18.02

Source: PB Aviation, Inc. Analysis

4.2.2.2 Peak Hour Average Delay

Another measure of delay is the average delay for peak hour operations. **Tables 4.2-24** through **4.2-27** present average delays per operation during peak hour operations for runway use configurations VMC1 through 4.

TABLE 4.2-24

General Mitchell International Airport

PEAK HOUR AVERAGE DELAYS–VMC1

Year	Number of Flights	Average Arrival Airspace Delay (minutes)	Departure Taxi-Out Delay (minutes)
2001	56	1.31	0.52
2006	60	1.88	0.62
2011	67	2.72	2.45
2021	80	5.46	7.23

Source: PB Aviation, Inc. Analysis

TABLE 4.2-25

General Mitchell International Airport

PEAK HOUR AVERAGE DELAYS–VMC2

Year	Number of Flights	Average Arrival Airspace Delay (minutes)	Departure Taxi-Out Delay (minutes)
2001	56	2.27	1.86
2006	60	2.67	2.16
2011	67	4.33	4.88
2021	80	6.74	21.00

Source: PB Aviation, Inc. Analysis

TABLE 4.2-26

General Mitchell International Airport

PEAK HOUR AVERAGE DELAYS–VMC3

Year	Number of Flights	Average Arrival Airspace Delay (minutes)	Departure Taxi-Out Delay (minutes)
2001	56	1.97	0.46
2006	60	2.13	1.18
2011	67	2.93	2.52
2021	80	4.14	8.43

Source: PB Aviation, Inc. Analysis

TABLE 4.2-27

General Mitchell International Airport

PEAK HOUR AVERAGE DELAYS–VMC4

Year	Number of Flights	Average Arrival Airspace Delay (minutes)	Departure Taxi-Out Delay (minutes)
2001	56	1.88	3.63
2006	60	1.85	4.50
2011	67	3.76	8.79
2021	80	7.95	19.89

Source: PB Aviation, Inc. Analysis

Tables 4.2-28 through **4.2-31** present average peak hour delays per operation for runway use configurations during IMC. The delays observed during IMC are slightly higher than those simulated for VMC, especially during the IMC configuration 1MC2 and 1MC4 runway use configurations. Arrival and departure delays become unacceptable as peak hour activity levels grow, and particularly during the IMC2 and IMC4 runway use configurations.

TABLE 4.2-28

General Mitchell International Airport

PEAK HOUR AVERAGE DELAYS–IMC1

Year	Number of Flights	Average Arrival Airspace Delay (minutes)	Departure Taxi-Out Delay (minutes)
2001	56	1.38	0.63
2006	60	2.82	2.03
2011	67	4.01	5.16
2021	80	7.73	8.67

Source: PB Aviation, Inc. Analysis

TABLE 4.2-29

General Mitchell International Airport

PEAK HOUR AVERAGE DELAYS–IMC2

Year	Number of Flights	Average Arrival Airspace Delay (minutes)	Departure Taxi-Out Delay (minutes)
2001	56	2.52	1.86
2006	60	3.97	2.75
2011	67	4.72	5.02
2021	80	9.68	22.08

Source: PB Aviation, Inc. Analysis

TABLE 4.2-30

General Mitchell International Airport

PEAK HOUR AVERAGE DELAYS–IMC3

Year	Number of Flights	Average Arrival Airspace Delay (minutes)	Departure Taxi-Out Delay (minutes)
2001	56	2.33	1.80
2006	60	2.91	2.23
2011	67	3.03	6.78
2021	80	7.19	11.65

Source: PB Aviation, Inc. Analysis

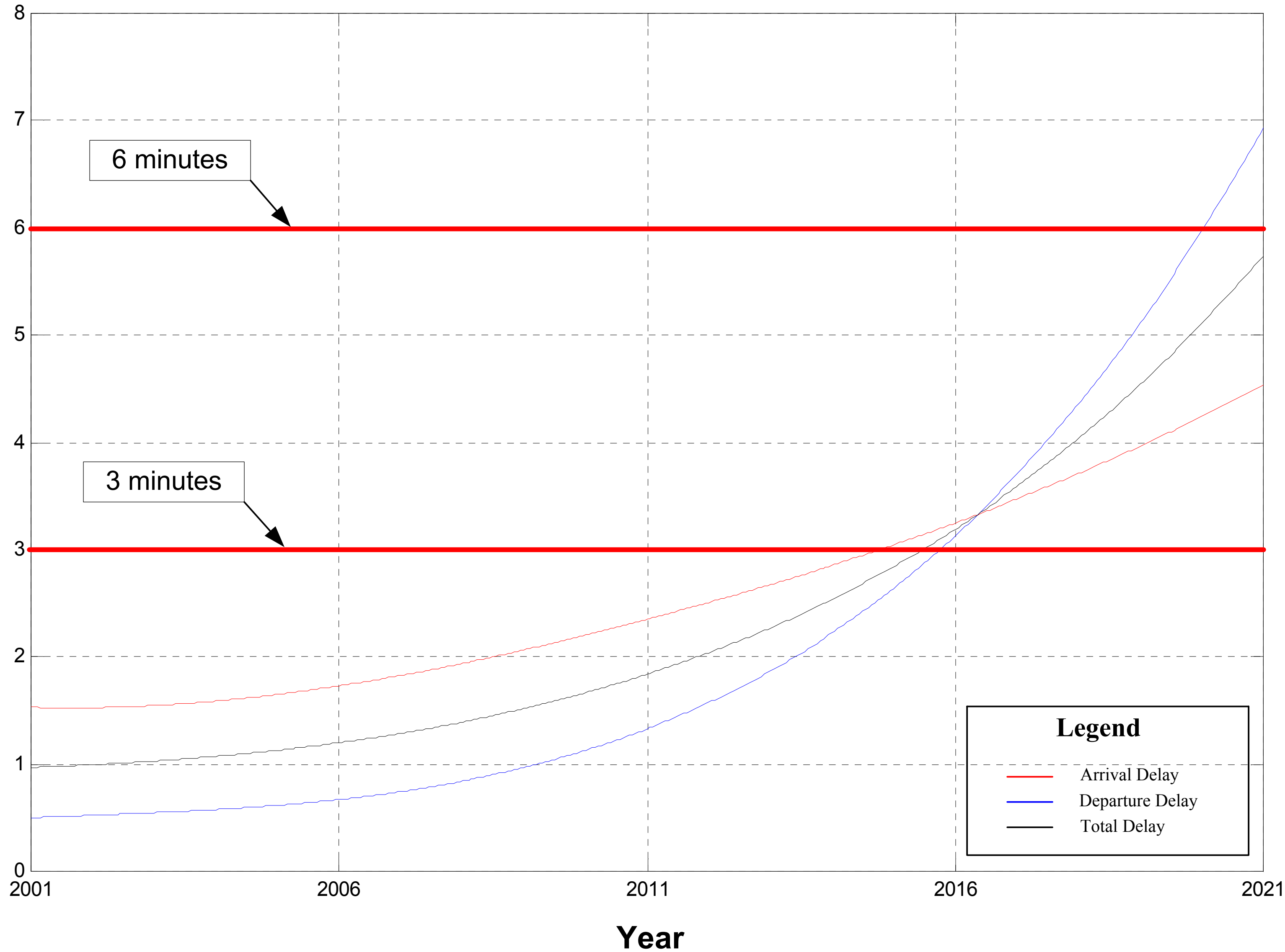
TABLE 4.2-31 ***General Mitchell International Airport*** ***PEAK HOUR AVERAGE DELAYS–IMC4***			
Year	Number of Flights	Average Arrival Airspace Delay (minutes)	Departure Taxi-Out Delay (minutes)
2001	56	1.90	5.08
2006	60	2.41	7.53
2011	67	4.28	10.21
2021	80	9.36	22.16

Source: PB Aviation, Inc. Analysis

4.2.3 Summary of Simulation Results

Much like the analysis of the theoretical capacity, the simulations indicate that the airfield at GMIA generally is not capable of accommodating projected demands through the end of the 20-year planning period. However, the simulations indicate some very specific issues that should be addressed in planning for GMIA's future. First, the need for improved runway exits on runway 19R and 7R is clearly evident in the simulations. Second, the simulations demonstrate a need to balance runway use in the future, because the flexibility of FAA ATC personnel to assign a runway based on an aircraft's origin or destination point at the Airport will diminish as traffic levels grow. Third, the simulations show a potential need for capacity enhancements for the VMC2/IMC2 and VMC4/IMC4 runway use configurations. These runway use configurations constitute only 7.21 percent of annual total operations; therefore, capacity improvement for these two configurations should only be considered with facility improvements that provide other benefits as well. Fourth, the simulations project rising levels of arrival and departure delays after the year of 2011. Consequently, the "C-1 runway" will be necessary for decreasing arrival and departure delays.

Exhibit 4.2-10 depicts annual average arrival, departure, and total delays. Generally, annual average arrival airspace delays less than three minutes per operation are considered to be acceptable, while departure taxi-out delays often



GENERAL MITCHELL INTERNATIONAL AIRPORT MASTER PLAN UPDATE

ANNUAL AVERAGE DELAY

EXHIBIT 4.2-10

reach an annual average of six minutes before delays are considered unacceptable. Annual average arrival delay will be over three minutes around the year of 2015, indicating that capacity enhancement measures should be started before 2015. This time frame is a slightly earlier than the time given in theoretical capacity analysis. Annual average departure delay will reach six minutes and be unacceptable by 2019. This is because departure delay is longer than arrival delay before it is considered unacceptable and because departure flights can operate with less limiting ceiling and visibility conditions.

Also, it is important to note that the delays that were simulated occur as a result of the airfield configuration, airspace procedures, and air traffic demand specific to GMIA and the airspace immediately surrounding it. No attempt has been made to account for delays to aircraft generated by traffic at destination airports. While a number of aircraft departing from GMIA were delayed because of flow controls at the Chicago airports, those delays are not included as part of this study.

4.2.4 Airspace Capacity Issues

The airspace surrounding GMIA is under the operational jurisdiction of the FAA. The efficiency of the use of that airspace is determined by air traffic control procedures implemented for the safety of operations through the airspace.

Air traffic control flow management and traffic separation standards ensure that actual operations do not exceed the airspace capacity. The trade-off of such safety assurance measures is that some aircraft are delayed. For example, an increase in arrival delay is expected at GMIA as traffic levels increase, and arrival delays are likely to become problematic after 2011. Arrival delay is a measurement of aircraft delays in the air and is related to the configuration of the airfield as well as airspace management and air traffic control procedures. Consequently, it may be necessary to look at opportunities for improving airspace procedures during the later part of the planning period. Improvements to airspace management are the responsibility of the FAA, however, and are not addressed within the context of a Master Plan Update.

The FAA through its National Airspace Redesign (NAR) will restructure existing domestic and oceanic airspace to increase its efficiency, while maintaining a high level of safety. The NAR will consist of incremental changes to the national airspace structure, consistent with evolving air traffic and avionics technologies. The particular elements described have the potential to improve airspace capacity for the Airport.

One key element of the NAR is the redesign of traffic routes. Aircraft generally follow airways defined by ground navigational aids. Because these are not direct routes from origin to destination, the time and distance required is increased. Modern avionics such as the global positioning system (GPS) and flight management systems (FMS) can provide more direct and user-preferred routes.

The other key element that is nearing implementation is the consolidation of terminal radar approach facilities. Rather than using separate TRACON facilities at each airport in a particular region, a consolidated facility allows airspace restructuring by improving communications among controllers handling operations over a wide geographic range and increasing their flexibility in merging, maneuvering, and sequencing aircraft to and from the area airports.

4.3 GEOMETRIC DESIGN REQUIREMENTS

The planning and design of an airport is typically based on the airport's role and the critical aircraft that are planned to use it. Guidance for the planning and design of the airfield are based on FAA Advisory Circulars that aim to maximize airport safety, economy, efficiency, and longevity.

For geometric design purposes, it is necessary to establish applicable design standards for future runway and taxiway development. Information from FAA Advisory Circular 150/5300-13, *Airport Design*, was used to determine the Airport Reference Code (ARC) for the Airport. The ARC is a coding system used to relate airport design criteria to the operational and physical characteristics of the aircraft intended to operate at an airport (see **Table 4.3-1**). The ARC has two components that reflect an airport's critical aircraft. The first component, designated by a letter, is the approach category of the aircraft as defined by aircraft approach speed. The second component, designated by a Roman numeral, is the airplane design group as determined by aircraft wingspan. Generally, aircraft approach speed applies to runways and runway-related facilities, whereas, aircraft wingspan relates primarily to separation criteria involving taxiways and taxilanes.

TABLE 4.3-1

General Mitchell International Airport

FAA AIRCRAFT CLASSIFICATIONS

FAA Aircraft Approach Category Classification		
Approach Category	Approach Speed (knots)	
A	Less than 91	
B	91 – 120	
C	121 – 140	
D	141 – 165	
E	166 or greater	
FAA Airplane Design Group Classification		
Airplane Design Group	Wingspan (feet)	Typical Aircraft
I	Less than 49	Learjet 24, Rockwell Sabre 75A
II	49 but less than 79	Falcon 50, Rockwell Sabre 80
III	79 but less than 118	727, 737, MD80, DC9
IV	118 but less than 171	757, 767
V	171 but less than 214	747, A330, A340
VI	214 but less than 262	Antonov AN-124, A380 (under design)

Source: FAA Advisory Circular 150/5300-13

Standards at the Airport are based on the current and projected aircraft fleet. It should be noted that the airfield is designed to meet a variety of needs of many different aircraft. As reflected in Table 4.3-1, all series of Boeing's 747 aircraft fall within an ARC of D-V, while the 767 and 757 are classified as ARC C-IV aircraft.

Forecasts prepared for the Master Plan Update indicate that the **A330-200** will be the critical aircraft, in terms of the airfield geometric requirements, with an ARC of D-V. **Table 4.3-2** shows the applicable FAA design criteria for aircraft in Groups IV, V, and VI.

TABLE 4.3-2

General Mitchell International Airport

AIRFIELD DESIGN REQUIREMENTS

Design Criteria	Group IV (ft.)	Group V (ft.)	Group VI (ft.)
Runway Width	150	150	200
Runway Shoulder Width	25	35	40
Runway Centerline to:			
- Taxiway Centerline	400	400	600
- Aircraft Parking Area	500	500	500
Runway Object Free Area (Width)	800	800	800
- Length Beyond Runway End	1,000	1,000	1,000
Runway Obstacle Free Zone (Width)	400	400	400
- Length Beyond Runway End	200	200	200
Runway Safety Area (Width)	500	500	500
- Length Beyond Runway End	1,000	1,000	1,000
Taxiway Width	75	75	100
Taxiway Centerline to:			
- Parallel Taxiway Centerline	215	267	324
- Fixed or Movable Object	130	160	193
Taxiway Object Free Area (Width)	259	320	386
Taxiway Safety Area (Width)	171	214	262
Runway Blast Pad			
- Length	200	400	400
- Width	200	220	280

Source: FAA Advisory Circular 150/1500-13

4.4 RUNWAY LENGTH

The future fleet mix at GMIA is projected to contain a mix of aircraft types that shift over the planning period. As outlined in Table 3.4-10 of Chapter 3.0*, Activity*

Projections, the future aircraft fleet also includes larger aircraft traveling longer distances. This section evaluates the need for longer runways based on the future fleet mix projections.

The most demanding aircraft in the projected fleet, in terms of runway length, is the A330-200, assuming this aircraft is used for longer travel distances. However, this aircraft is projected to be used by cargo carriers at GMIA for flights to their midwest cargo-sorting hubs such as Memphis and Louisville. With a flight distance of approximately about 300 miles, the A330-200 aircraft does not need to carry a full fuel load. Consequently, the existing runway length is sufficient to accommodate the A330-200 at GMIA unless its future uses changes. The narrow-body generation aircraft, such as the B737 and MD80 series, can provide non-stop service from GMIA to the west coast and are expected to be used for the longer stage length flights as anticipated in the forecast.

The Wisconsin Air National Guard's 128th Air Refueling Wing operates KC-135 aircraft from GMIA that carry fuel for in-flight refueling of other aircraft. The previous Master Plan investigated the need for a runway extension to meet the operational requirements of the Air National Guard. The need for such an extension was driven by wind and temperature conditions that occurred on a very limited basis. This, combined with the KC-135 modernization program that upgraded the aircraft engines with quieter and more efficient models, led to a decision to not include a runway extension for this purpose as part of the recommended plan. Consultation with the Air National Guard as part of this Master Plan Update indicated that the additional 1,000-foot extension considered in the previous Master Plan would provide operational flexibility for air-refueling and overseas deployments. Specifically, additional fuel could be carried for the domestic air-refueling missions and overseas destinations could be reached without a refueling stop en-route. The Air National Guard estimates that the 10,600-foot runway length would be used approximately 180 departures per year. This level of operations would not justify a runway extension under normal airport planning criteria (500 operations per year for the critical aircraft). However, national defense may dictate that this issue be reconsidered.

Runway length requirements were determined by the performance characteristics of the wide-body aircraft (KC-135), narrow-body aircraft (B737-800, MD81 and B717), and regional jets (CRJ-200ER and ERJ145) at maximum gross take-off weight for standard day and hot day temperatures. **Table 4.4-1** depicts runway length requirements at maximum gross takeoff weight. As shown, a runway length of 10,600 feet is needed to meet this requirement of the most demanding aircraft, i.e., the KC-135. The 737-800 and MD81 can be accommodated by the runway length currently available at GMIA. Runway 1-19, which is 9,690 feet long, is part of the entire runway use configurations at GMIA (refer to Exhibit 4.1-1).

TABLE 4.4-1

General Mitchell International Airport

CRITICAL AIRCRAFT RUNWAY LENGTH REQUIREMENTS

Aircraft Model	Max. TOW (pounds)	Standard Day[1] (feet)	Hot Day[2] (feet)
KC-135	322,500	10,000	10,600
B737-800	172,500	8,800	9,500
MD81	140,000	7,700	8,500
B717	116,000	7,200	7,800
CRJ-200LR	53,000	6,600	7,500
ERJ	42,328	6,000	6,900

Sources: PB Aviation, Inc. Analysis
Aircraft Operating Manuals
Notes: [1] 59° Fahrenheit at sea level
[2] Hot day is defined as standard day + 27 degrees Fahrenheit

4.5 RUNWAY WIDTH

Runway width requirements are based on the ARC standards described earlier. GMIA's longest runway, runway 1L/19R, is currently 200 feet wide and exceeds Group V design requirements. Runways 1R/19L, 7R/25L, and 13/31 are 150 feet wide, which meets Group IV and V standards. Runway 7L/25R is 100 feet wide, the required width for Group II and limited Group III aircraft.

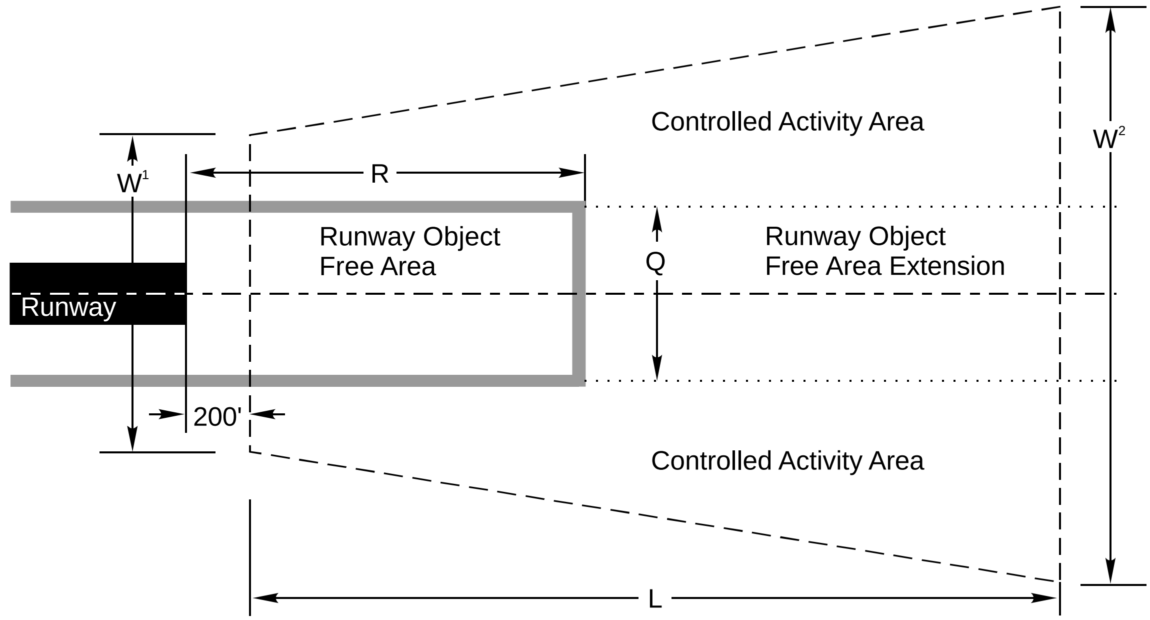
4.6 AIRFIELD SAFETY AREAS

This section presents the FAA's standards as they apply to safety at the Airport. The following airfield safety standards apply and are reviewed in this section:

- *Runway Protection Zone (RPZ)*
  - Runway Object Free Area (OFA)
  - Controlled Activity Area
- *Runway Safety Area (RSA)*
- *Obstacle Free Zone (OFZ)*
  - Runway OFZ
  - Inner Approach OFZ
- *Inner-Transitional OFZ*

4.6.1 Runway Protection Zone (RPZ)

As depicted in **Exhibit 4.6-1**, the RPZ is an area on the ground that is trapezoidal in shape and is centered on the extended runway centerline. The purpose of the area is to enhance the protection of people and property on the ground. This is achieved through airport owner control of property located in RPZs. The RPZ begins 200 feet beyond the end of the runway pavement that is useable for takeoff and landing. It is important to note that the threshold location does not affect the beginning point of the RPZ. The dimensions of the RPZ are contingent on the size of aircraft operating on the runway as well as the type of



Runway	W^1	W^2	L	R	Q
01L	1,000 FT	1,750 FT	2,500 FT	1,000 FT	800 FT
19R	1,000 FT	1,750 FT	2,500 FT	1,000 FT	800 FT
01R	500 FT	700 FT	1,000 FT	1,000 FT	800 FT
19L	500 FT	700 FT	1,000 FT	1,000 FT	800 FT
07R	1,000 FT	1,750 FT	2,500 FT	1,000 FT	800 FT
25L	1,000 FT	1,750 FT	2,500 FT	1,000 FT	800 FT
07L	500 FT	700 FT	1,000 FT	300 FT	500 FT
25R	500 FT	700 FT	1,000 FT	300 FT	500 FT
13	500 FT	700 FT	1,000 FT	1,000 FT	800 FT
31	500 FT	700 FT	1,000 FT	1,000 FT	800 FT

W^1 = Runway Protection Zone - Inner Width
W^2 = Runway Protection Zone - Outer Width
L = Runway Protection Zone - Length
R = Object Free Area - Length
Q = Object Free Area - Width

Source: Advisory Circular 150/5300-13, "Airport Design," Change 6.

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RUNWAY PROTECTION ZONE AND OBJECT FREE AREA STANDARDS

EXHIBIT 4.6-1

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approach capability. Generally, as aircraft size increases and approach minimums decrease, dimensions of the RPZ increase.

The RPZ contains two sub-areas: the runway OFA and the controlled activity area. The runway OFA is a two-dimensional ground area surrounding the runway. FAA standards do not allow any objects, including parked aircraft, except NAVAIDs and frangible objects with locations fixed by function (e.g., runway visual range – RVR – posts), within the OFA. The runway system was reviewed and the following topographical impacts to runway OFAs were noted:

- *Runway 25L*
  - Railroad

- *Runway 7R*
  - 6th Street

- *Runway 19R*
  - Perimeter road and fencing
  - Layton Avenue

- *Runway 1L*
  - Natural terrain
  - College Avenue

- *Runway 13*
  - Layton Avenue
  - Perimeter road
  - Access/maintenance roads from the runway end

- *Runway 31*
  - Railroad

- Transformer
- Drainage ditch
- Perimeter road and fencing
- Access/maintenance roads from the runway end

- *Runways 7L, 25R, 1R, and 19L meet the FAA standards for runway OFAs.*

The controlled activity area is the portion of the RPZ that lies outside the runway OFA. It is recommended that the airport have positive control of this area. It should be free of land uses that create glare, smoke, and activities that attract large amounts of people. While it is desirable to clear all objects from this area, some uses are permitted if they are below the approach surface and do not interfere with NAVAIDs. Other than the objects listed above in the runway OFAs, the RPZ areas meets the FAA recommendations.

4.6.2 Runway Safety Area (RSA)

The RSA is a critical two-dimensional safety area surrounding the runway. Based on FAA design criteria, the RSAs for the runways 1L/19R, 1R/19L, 7R/25L, and 13/31 are 500 feet in width and extend 1,000 feet beyond each runway end, while the RSA for runway 7L/25R is 150 feet in width and extends 300 feet beyond the runway ends. The RSA is the most stringently regulated surface associated with a runway. The RSA must be:

- *Cleared, graded, and free of potentially hazardous surface variations*

- *Properly drained*

- *Capable of supporting aircraft rescue and firefighting (ARFF) equipment or an aircraft without causing damage to the aircraft*

- *Free of objects, except for objects mounted on low-impact resistant supports whose location is fixed by function*

The FAA Airports District Office conducted "RSA Determinations" for GMIA as part of its Runway Safety Area Program and found that the following six runway ends, with their respective topographical features, do not meet the current RSA standards:

- *Runway 25L*
  - Localizer
  - Railroad

- *Runway 7R*
  - 6th Street

- *Runway 19R*
  - Perimeter road and fencing
  - Layton Avenue

- *Runway 1L*
  - Natural terrain
  - College Avenue

- *Runway 13*
  - Layton Avenue
  - Perimeter road
  - Access/maintenance roads from the runway end

- *Runway 31*
  - Railroad
  - Transformer
  - Drainage ditch
  - Perimeter road and fencing
  - Access/maintenance roads from the runway end

Planning related to airfield improvements must address alternatives for meeting the RSA requirements. Therefore, alternatives will be examined for meeting these requirements. These solutions could include both relocation of object from the existing RSAs or moving the RSA limits through adjustments to the runway length.

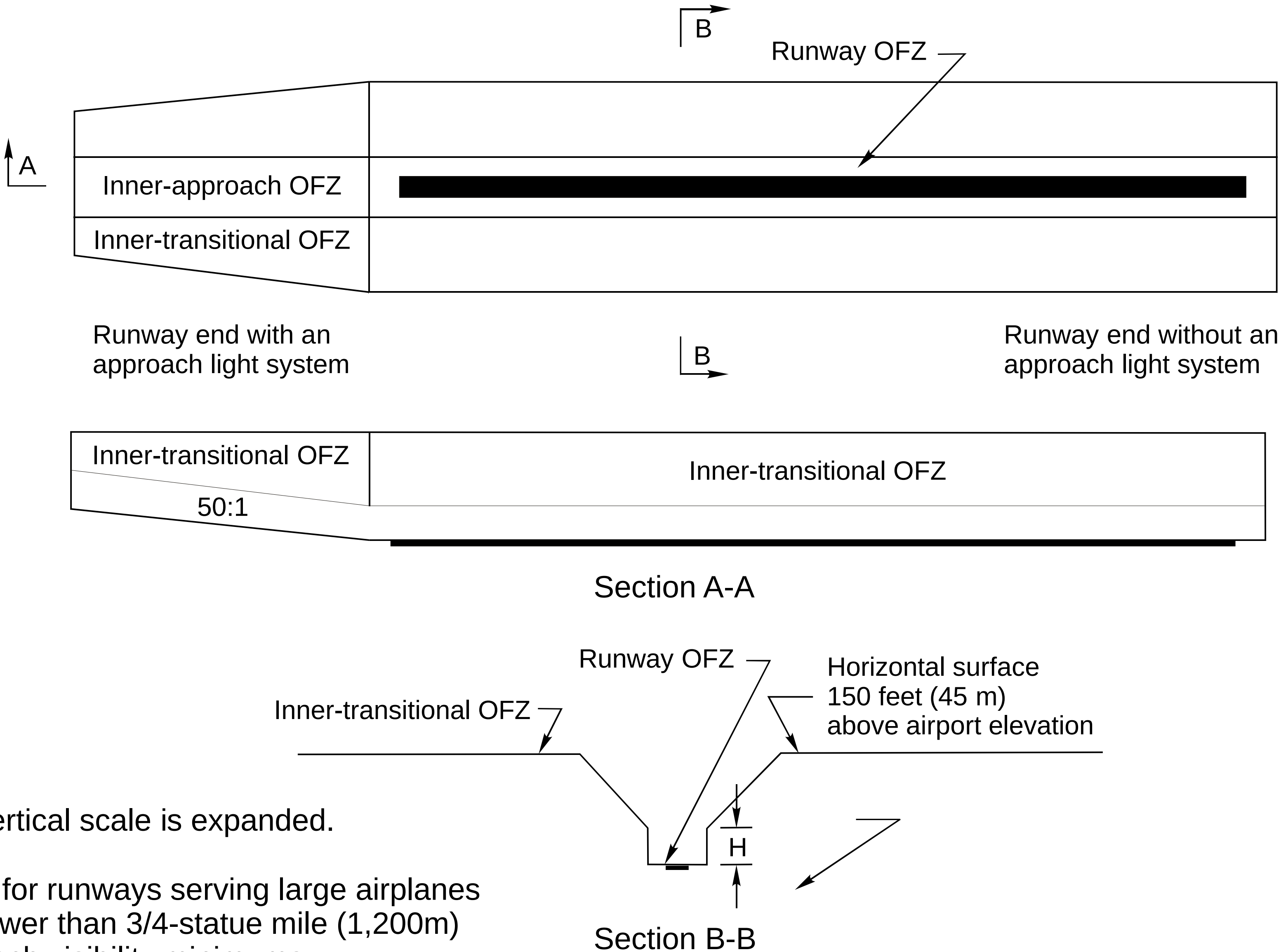
4.6.3 Obstacle Free Zone (OFZ)

The OFZ, depicted in **Exhibit 4.6-2**, is a three-dimensional volume of airspace (as opposed to the RPZ, OFA, and RSA, which are two-dimensional and at ground level) that supports the transition of ground to airborne operations (or vice versa). The standards prohibit taxiing and parked aircraft and other objects, except frangible NAVAIDs or fixed-function objects, from penetrating the OFZ. The OFZ encompasses the runway OFZ, inner-approach OFZ, and inner-transitional OFZ.

The runway OFZ extends 200 feet beyond each end of the runway and measures 400 feet in width.

The inner-approach OFZ is a defined volume of airspace, centered on the approach area that applies only to runways with approach lighting. The inner-approach OFZ begins 200 feet from the runway threshold and extends 200 feet beyond the last unit in the approach lighting system. It is the same width as the runway OFZ and rises at a slope of 50:1 away from the runway. At GMIA, the approach ends of runways 7R, 1L, and 19R are equipped with approach lighting systems.

The inner-transitional OFZ is a defined volume of airspace along the sides of the runway OFZ and inner-approach OFZ. It applies to runways with lower than the 3/4-statute mile approach visibility minimums, which at GMIA are runways 7R, 1L, and 19R.



The vertical scale is expanded.

(OFZ) for runways serving large airplanes with lower than 3/4-statue mile (1,200m) approach visibility minimums.

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OBSTACLE FREE ZONE

EXHIBIT 4.6-2

Currently, no objects violate the runway OFZ, the inner-approach OFZ, or the inner-transitional OFZ for the runways at GMIA.

* * * * * *

The findings of the airfield demand/capacity analysis indicate that capacity enhancements, will be required during the 20-year planning period. Some key airfield improvements from the previous Master Plan remain valid based on these analyses. The theoretical capacity analysis and the airfield simulations indicate that the "C-1 runway," identified as the major airfield capacity project in the previous Master Plan, will need to be in place within the planning period. The runway extensions to runway 1R/19L would provide additional capacity during the times that the Airport was limited to a north or south operation based on wind and weather. During the alternatives phase of the Master Plan Update, this improvement will be modeled to determine the point at which benefits derived exceed the costs. Other airfield improvements, such as future taxiway locations, will need to be determined in the context of the overall airport development plan. Also, runway safety area improvements are needed in conjunction with airfield enhancements to meet FAA requirements.

In summary, the key conclusions from these analyses are: 1.) Airfield capacity enhancements, including the C-1 runway, will be required in the 20-year planning period; 2.) Improvements to the runway safety areas are necessary.

The next chapter examines facility requirements for landside facilities (i.e., terminal, parking, and general aviation). Those requirements, combined with the results presented in this Chapter, will be used to develop alternatives for meeting the projected facility needs of the GMIA in the future.