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FINAL TECHNICAL REPORT

MASTER PLAN UPDATE
Memphis International Airport

Prepared for

Memphis-Shelby County Airport Authority
Memphis, Tennessee

January 2010

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Master Plan Technical Report

OVERVIEW

This Master Plan Technical Report is comprised of the final versions of six individual working papers that were prepared during the development of the Memphis International Airport Master Plan Update between the beginning of 2008 and the end of 2009. These documents present detailed technical information compiled as part of each major element of the master planning process, as follows:

- **Airport Inventory (Spring 2008) –** provides background data on the Airport and a comprehensive inventory of current and planned near-term Airport facilities and conditions.

- **Aviation Demand Forecasts (Summer 2008) –** summarizes forecasts of aviation demand for enplaned passengers, air cargo tonnage, and aircraft operations over a twenty-year planning horizon.

- **Facility Requirements (Fall 2008) –** presents required facilities, land areas, and policies required to meet aviation demand and maintain existing infrastructure.

- **Airfield Alternatives (Spring 2009) –** describes the identification and evaluation of development alternatives that were considered to accommodate airfield requirements.

- **Terminal Development Alternatives (Spring 2009) –** describes the approach and methodology for identifying and evaluating development alternatives considered to accommodate terminal requirements and resolve facility challenges.

- **Recommended Development Plan (Fall 2009) –** presents the comprehensive recommended development plan, future land use plan, environmental strategy, and capital improvement and financial plans.

Each of the above working papers is presented along with all of its supporting information and appendices. It is important to note that, while the Airport is in a continual state of change, the information presented in each working paper was accurate at the time it was developed as noted above in parentheses. Material changes to Airport conditions were updated and incorporated into the master planning process as necessary over the course of the project to ensure the accuracy of key findings and recommendations.

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FINAL WORKING PAPER

AIRPORT INVENTORY
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Technical Memorandum–A

INTRODUCTION AND AIRPORT OVERVIEW

In accordance with Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5070-6B, *Airport Master Plans*, the information and findings contained in this Working Paper represent the first element of an update to the 2000 Master Plan for Memphis International Airport (the Airport). The purpose of this Master Plan Update is to provide guidance for the continued improvement of the Airport for the 20-year planning horizon and beyond.

This Working Paper provides background data on the Airport and a comprehensive inventory of current and planned near-term Airport facilities and conditions. This information will provide the basis for assessing existing conditions and future facility requirements. The data and information presented herein reflect information compiled in April of 2008 when the Master Plan Update was initiated. As stated in the overview to this Final Technical Report, material changes to Airport conditions were updated and incorporated into the master planning process as necessary over the course of the project to ensure the accuracy of key findings and recommendations.

The Working Paper is organized into nine Technical Memoranda, as follows:

A – Introduction and Airport Overview
B – Airfield and Airspace
C – Passenger Terminal Complex
D – Ground Transportation and Parking
E – Air Cargo
F – General Aviation and Military
G – Airline and Airport Support
H – Infrastructure
I – Environmental Conditions

The feasibility of integrating data compiled through the inventory effort into the Airport's MEMGAIMS interactive airport layout plan or other database management system will be assessed and recommendations provided to the Authority in a memorandum under separate cover.

AIRPORT SETTING

The Airport is owned and operated by the Memphis-Shelby County Airport Authority (the Authority). As shown on Figure A-1, the Airport is located about 7 miles southeast of downtown Memphis and 3.5 miles north of the Tennessee – Mississippi state line. As of 2008, The U.S. Department of Commerce, Bureau of the Census estimated the population of the Memphis Metropolitan Statistical Area (MSA) to be 1.3 million. The MSA's population is highly concentrated in Shelby County where both the Airport and the City of Memphis are located. The Memphis MSA is the fourth largest in the southeast behind Atlanta, Georgia, Nashville,

LEGEND

General aviation airport
Urban areas
State boundary
County boundary

N

2.5 0 2.5 5

Graphic Scale in Miles

Figure A-1

VICINITY MAP

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Tennessee, and Jacksonville, Tennessee. The City of Memphis had an estimated population of 669,700, making it the second largest city proper in the southeast region (only to Jacksonville, Florida).

The Airport is classified in the National Plan of Integrated Airport Systems (NPIAS) as a Commercial Service Primary Airport, serving origin-destination passengers (i.e., passengers beginning or ending their air journeys in Memphis) and connecting passengers transferring from one flight to another. The Airport is an important passenger connecting hub in the route system of Northwest Airlines and its regional/commuter affiliates, and also accommodates FedEx's primary sorting hub. According to 2006 data published by Airports Council International-North America, the Airport is the nation's 40th busiest airport in terms of passenger traffic; 20th busiest in terms of total aircraft operations; and first busiest in terms of air cargo tonnage.

In addition to Northwest and FedEx, the Airport also accommodates numerous other air carriers, including: American Airlines and its affiliates (American Eagle and Trans States Airlines); Northwest Airlines' affiliates (Pinnacle Airlines and Mesaba Airlines); Delta Air Lines and its affiliates (Atlantic Southeast Airlines, Chautauqua Airlines, ComAir, and Skywest Airlines); Air Tran Airways; US Airways and its affiliates (Mesa Airlines, PSA Airlines); Continental Airlines, Continental Express, United Airlines' affiliate (Skywest Airlines); and Frontier Airlines.

AIRPORT SITE

The Airport occupies an approximate 5,100-acre site that is roughly bounded by Nonconnah Creek to the north; Tchulahoma and Swinnea Roads and the Oakhaven residential neighborhood to the east; Shelby Drive to the south; and Airways and Plough boulevards to the west. Primary access is provided from the northwest via Plough Boulevard and Jim McGehee Boulevard. Winchester Road, a primary east-west arterial, bisects the Airport site and tunnels under elements of the airfield infrastructure.

Figures A-2, A-3, and A-4, present the overall Airport site, which consists of the following primary components:

- **Airfield** – The airfield occupies almost half (about 40%) of the total Airport land area, and includes four runways (three north-south parallel runways and one east-west runway), and associated taxiways, aprons, hold pads, and other safety-related protection zones.

- **Passenger Terminal Complex** – Includes three concourses accommodating 79 aircraft gates; passenger processing facility that accommodates ticketing, baggage claim, and security screening functions; ground transportation facilities including access roadways, parking garages, and surface lots; air cargo terminals (belly freight); and a Radisson hotel.

- **FedEx Super-hub** – Located on the north side of the Airport, the FedEx super-hub encompasses numerous facilities to support cargo operations, including aircraft gates/hardstand parking positions, sort facilities, maintenance hangars, corporate offices, employee parking, support vehicle storage, and an independently-operated fuel farm. FedEx facilities are located both north and south of Runway 9-27.

- **Air Cargo** – In addition to FedEx facilities, additional air cargo aprons and hangars facilities serving UPS and other carriers are located on the east side of the airfield.

- **General Aviation** – Two Fixed Base Operators (FBOs)—Signature Flight Support and Wilson Air Center—are located in separate areas of the Airport and provide a wide-range of services to general aviation and corporate users.

- **Rental Car** – Rental car storage, customer processing and ready return facilities are located on the far north side of the Airport, north of Democrat Road. Customers are bussed to and from the terminal via company-operated shuttles.

- **Military** – The Airport is home to the 164th Tactical Airlift Wing of the Tennessee Air National Guard (TnANG), which currently operates C5-A Galaxy aircraft. The TnANG is currently located on an approximately 120-acre site located along Democrat Road adjacent to the FedEx campus, but will move to new facilities on a 118-acre site in the southeast quadrant of the Airport in 2009.

- **Support Facilities** – Primary support facilities include: airline maintenance facilities; fuel farm located south of the terminal complex; Federal Aviation Administration (FAA) air traffic control facilities; employee parking; Aircraft Rescue and Firefighting (ARFF); and airfield maintenance and support facilities located throughout the site.

AIRPORT ACCESS

Access to the Airport is provided predominately via Interstate 240 (I-240), Plough Boulevard, and Tchulahoma Road. Vehicles traveling to the passenger terminal complex from I-240 typically use Plough Boulevard, which provides direct entry to the passenger terminal curbsides and parking facilities. Vehicles leaving the terminal complex use westbound Winchester Road to reach Plough Boulevard, which continues north to I-240. Secondary access to and from the terminal complex is also provided via Winchester Road. The two FBOs are accessed directly from Winchester Road.

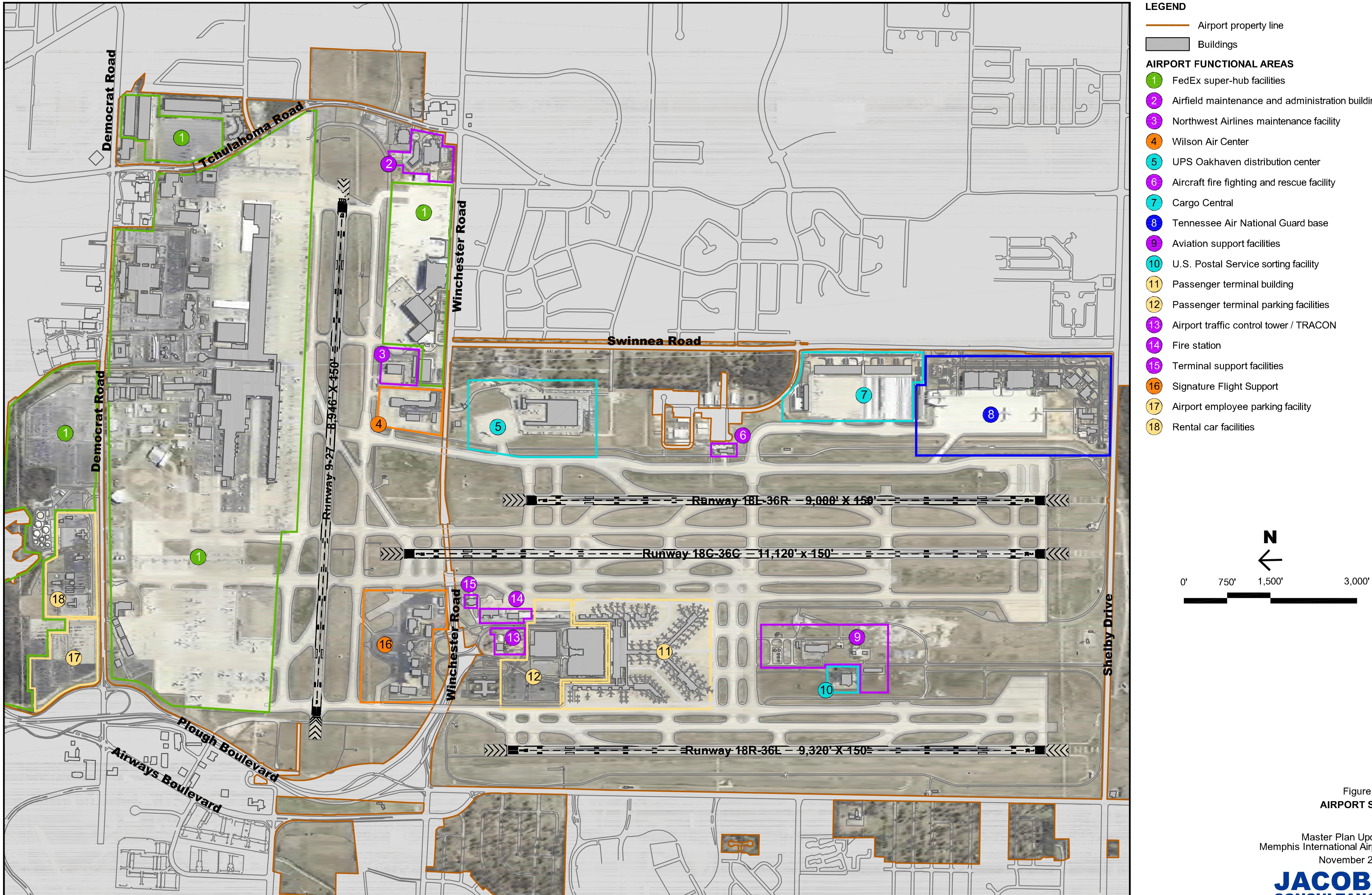

Figure A-2
AIRPORT SITE

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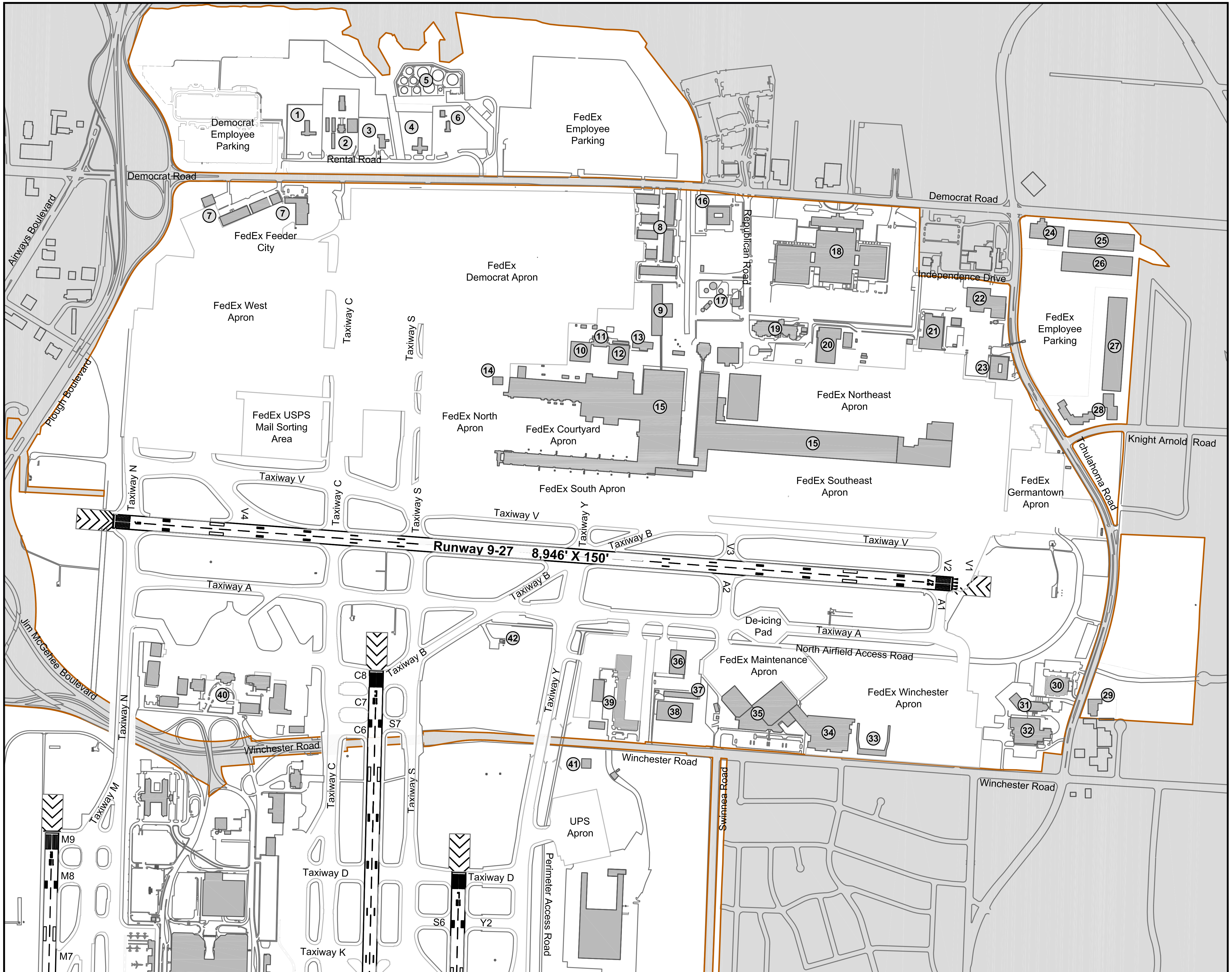

LEGEND

Airport property line

FACILITIES INDEX

1. Avis car rental
2. Hertz car rental
3. Dollar and Thrifty car rental
4. Budget car rental
5. FedEx / WESPAC fuel farm
6. Alamo and National car rental
7. FedEx corporate hangars
8. FedEx warehouses
9. FedEx maintenance facility
10. FedEx hangar
11. FedEx administration building
12. FedEx hangar
13. FedEx generator building
14. FedEx crash, rescue, and fire fighting facility
15. FedEx super-hub
16. FedEx office building
17. Fuel farm
18. FedEx office complex
19. FedEx flight simulator
20. FedEx electrical vehicle storage
21. FedEx bulk area storage building
22. FedEx security screening facility
23. FedEx maintenance building
24. Commercial development
25. FedEx publishing facility
26. FedEx logistics and network services
27. Commercial building
28. BELZ office complex
29. Commercial building
30. Memphis Vocational Technical school
31. Airport administration office building
32. Airport airfield maintenance building
33. FedEx engine testing facility
34. FedEx aircraft maintenance hangar
35. FedEx aircraft maintenance hangars
36. Pinnacle Airlines aircraft maintenance facility
37. FedEx de-icing equipment storage
38. FedEx engine repair shop
39. Wilson Air Center
40. Signature Flight Support
41. Airfield electrical vault
42. Remote Transmitter / Receiver

N

0' 500' 1,000' 2,000'

A-3
NORTH AIRFIELD

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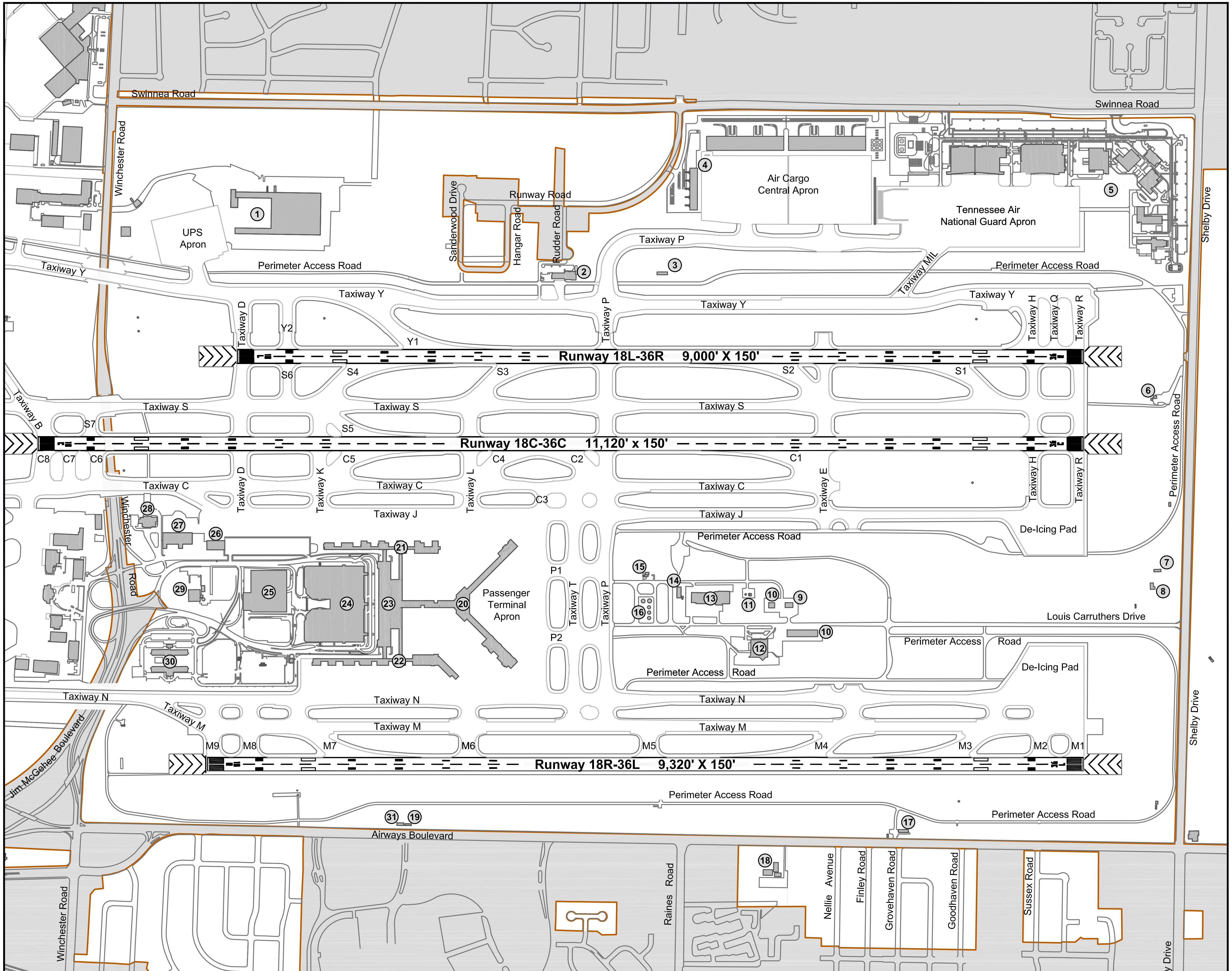

LEGEND

Airport property line

FACILITIES INDEX

1. United Parcel Service Oakhaven hub
2. Aircraft rescue and fire fighting station
3. Airfield electrical vault
4. Cargo central warehouse
5. Tennessee Air National Guard base
6. NAVAID electrical vault
7. Airport surveillance radar
8. National Weather Service equipment shed
9. Aircraft Services International building
10. Northwest Airlines ground equipment maintenance
11. Aircraft surface detection antenna
12. United States Postal Service building
13. Aircraft catering kitchen
14. Airport chiller unit
15. Airfield electrical vault
16. Passenger terminal fuel farm
17. Airfield electrical vault
18. Airport project center and noise office
19. Passenger terminal emergency generators
20. Passenger terminal--Concourse B
21. Passenger terminal--Concourse C
22. Passenger terminal--Concourse A
23. Passenger terminal building
24. Passenger terminal parking garage
25. Passenger terminal parking garage
26. Terminal concessions storage building
27. Terminal support and air cargo
28. Fire station
29. FAA airport traffic control tower and TRACON
30. Radisson hotel
31. Memphis Light, Gas, and Water switch gear

N

0' 500' 1,000' 2,000'

Figure A-4
SOUTH AIRFIELD

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Vehicles traveling to and from the aviation-related facilities located along Democrat Road, which include the rental car and many FedEx facilities, use Plough Boulevard or Tchulahoma Road to connect between I-240 and Democrat Road. Access to facilities on the south and west sides of the airfield is provided by Airways Boulevard to the west, Shelby Drive on the south, and Swinnea Road to the east. Shelby Drive provides direct access to I-55, which runs on a north-south alignment approximately one mile west of the Airport. Airport facilities located in the south midfield portion of the site are reached via Louis Carruthers Drive, which connects directly to Shelby Drive.

BASELINE CONDITIONS

At the time this Master Plan Update was initiated, several Airport projects were either in progress or approved for funding. Because it is expected with certainty that these projects will be completed in the near-term, these projects are considered part of the existing or "baseline" conditions at the Airport. Categorizing projects that are in progress or approved allows for an effective evaluation of the Airport's long-term facility requirements. Locations, descriptions, and start dates of baseline conditions projects are presented on Figure A-5.

EXISTING LAND USES

Existing Airport land use is depicted on Figure A-6. The use and acreage of Airport land by functional designation is presented in Table A-1, and summarized below.

- **Airfield** – Runways, taxiways, aprons and safety areas directly related to the movement of aircraft
- **Reserved** – Areas owned and controlled by the Authority for future aviation- and/or non-aviation related development
- **FedEx** – Airport land areas leased by FedEx for activities associated with their super-hub cargo operations
- **Air Cargo** – Areas utilized and dedicated to the movement, distribution, and delivery of cargo, excluding FedEx
- **Passenger Terminal** – Passenger terminal/concourse buildings, and other landside facilities including curbside and vehicle parking
- **Aviation Support** – Facilities associated with, but not part of, the passenger terminal facilities, include car rental, airline catering, ground support equipment, employee parking, etc.
- **Military** – Areas utilized by the Tennessee Air National Guard (TnANG)

Table A-1

EXISTING AIRPORT LAND USES
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Land use	Area (acres)	% of total
Airfield	2,155	40%
Reserved	1,546	28%
FedEx	964	18%
Commercial Aviation *(a)*	214	4%
Air Cargo *(b)*	179	3%
Aviation Support	139	3%
Military	122	2%
General Aviation	78	1%
Commercial Development	52	1%
Total	5,449	100%

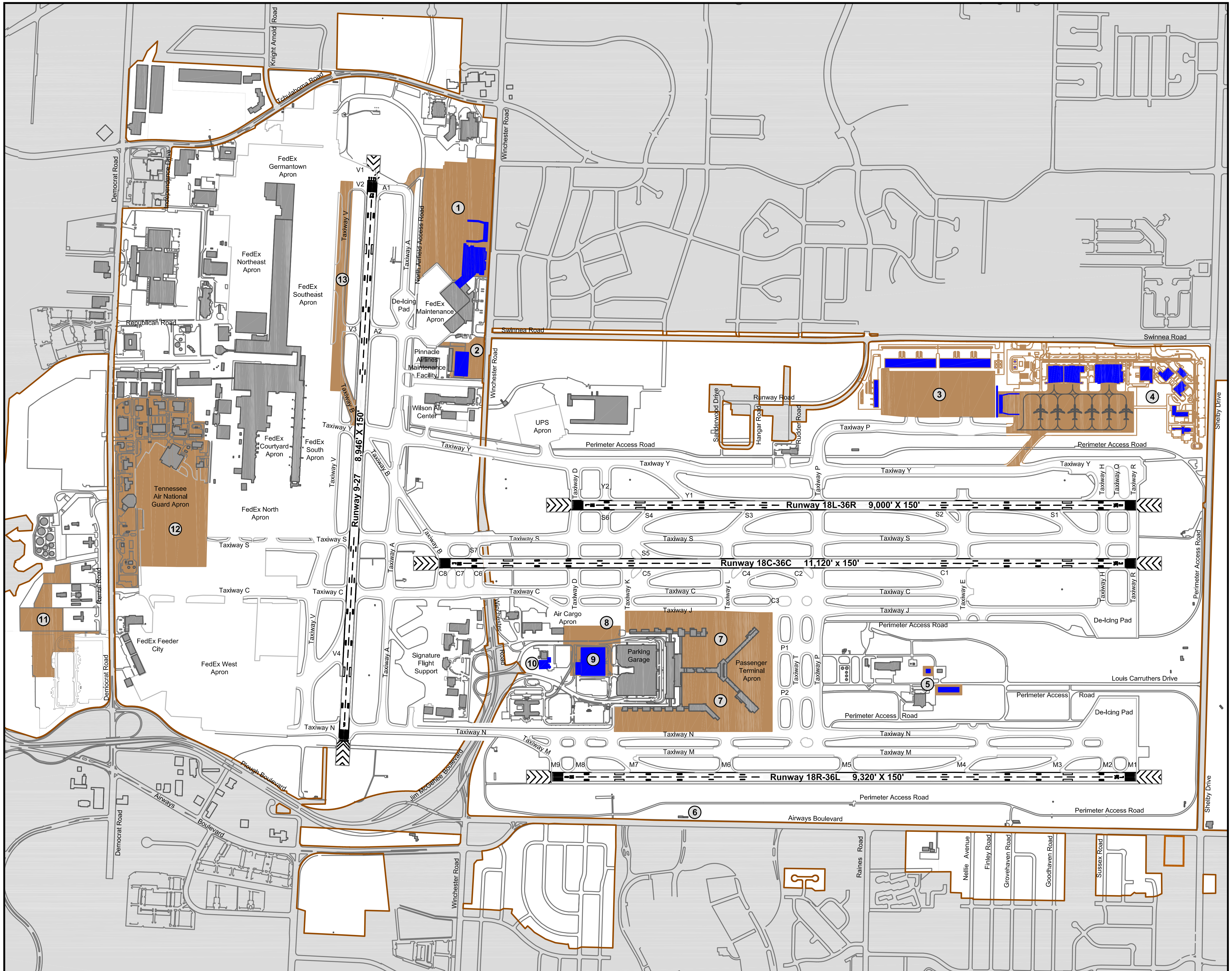
(a) Includes passenger terminal, public and Authority-controlled parking, and rental car functions.
(b) Excludes FedEx land areas.

Source: Jacobs Consultancy, November 2009.

- **General Aviation** – FBO and aircraft service areas where aviation services are provided to general aviation users; includes hangars, parking aprons, offices, fuel storage, etc.

- **Commercial Development** – Properties leased to private entities for office, warehouse, and other revenue-generating development

Large areas of Airport property located west and south of the Airport were acquired by the Authority for noise mitigation purposes. Although this land is currently undeveloped, the area is available for future aviation-related noise-compatible development.



LEGEND

- Airport property line
- Building construction
- Infrastructure improvement
- Facility to be removed

Baseline projects

1. FedEx Winchester Apron and hangar
2. FedEx engine maintenance facility
3. Cargo Central
4. Tennessee Air National Guard relocation
5. Ground support equipment storage
6. Emergency generator installation
7. Apron replacement
8. Parking lot construction (East Lot)
9. Parking garage (Phase I)
10. ATCT and TRACON replacement
11. FedEx employee parking expansion
12. FedEx apron expansion
13. Taxiways B and V rehabilitation

Source: Discussions with Memphis Shelby County Airport Authority program management staff, March 2008.

N

0' 750' 1,500' 3,000'

Figure A-5
BASELINE CONDITIONS

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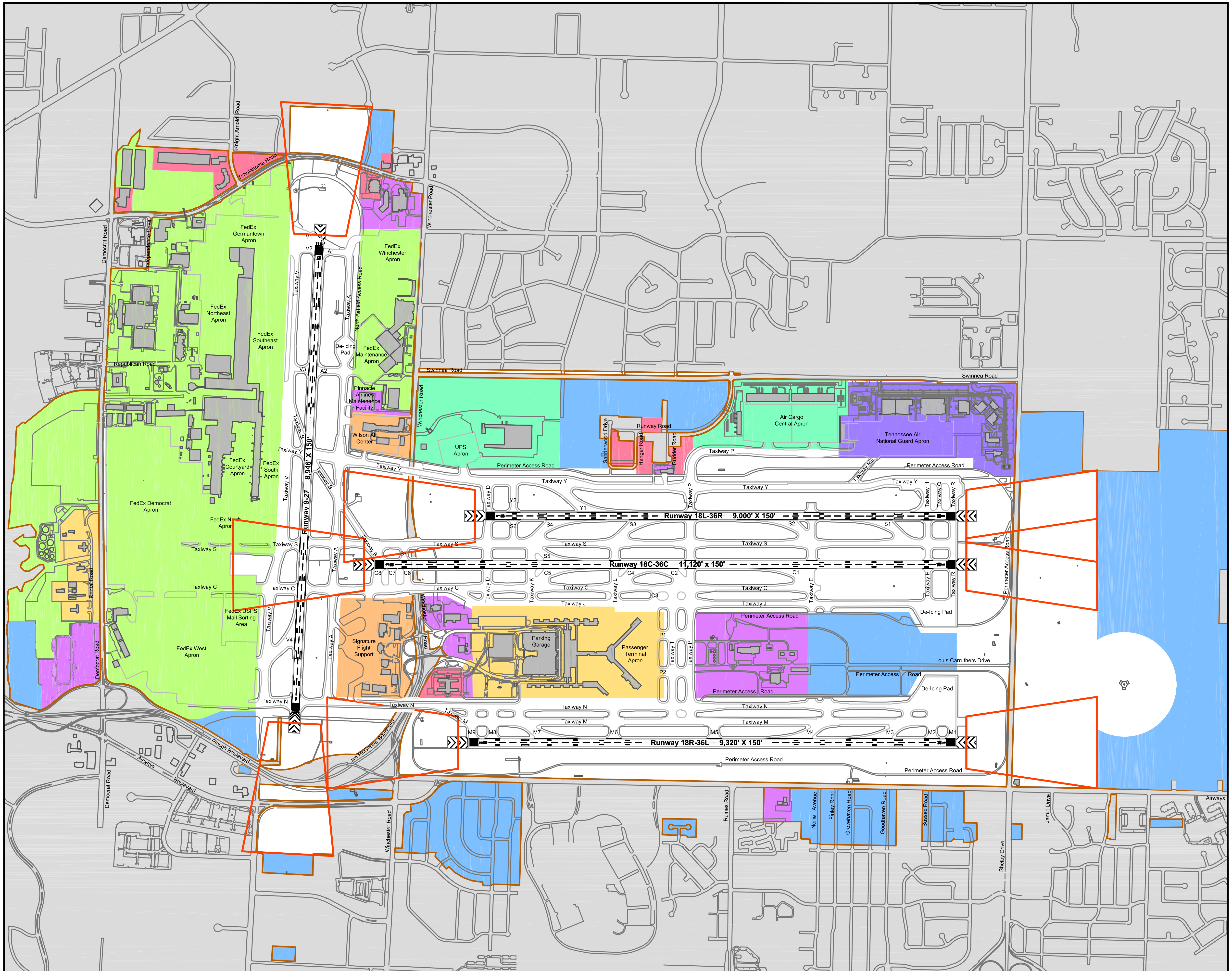

LEGEND

- Airport property line
- Runway Protection Zone
- Air cargo
- Airfield
- Aviation support
- Commercial aviation
- Commercial development
- FedEx
- General aviation
- Reserved for future development
- Military

Source: Jacobs Consultancy, based on field verification, March 2008.

N

0' 900' 1,800' 3,600'

Figure A-6

GENERALIZED ON-AIRPORT LAND USE

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ON-GOING STUDIES

The Authority has several studies that are concurrent with the Master Plan Update, among them:

- **Apron Reconstruction –** analyzing the scope, cost, and schedule of a project that would replace concrete apron areas surrounding the passenger terminal building
- **Glycol Management –** evaluating airport-wide stormwater and de-icing fluid collection facilities and recommending future needs to ensure compliance with Tennessee Department of Environmental Quality regulations
- **Parking Garage and Rental Car Facility –** designing new structured public parking and rental car ready/return facilities on a site within the passenger terminal complex
- **Runway 9-27 Reconstruction –** designing the complete reconstruction of existing Runway 9-27 to address deteriorating subgrade and pavement conditions
- **Seismic Risk Assessment –** evaluating the vulnerabilities of Airport facilities and airfield structures during a potential seismic event in parallel with the Master Plan Update

A seismic risk assessment is being conducted in parallel with the Master Plan Update to evaluate the vulnerabilities of Airport facilities and airfield structures during a potential seismic event. The Authority also has several financially-oriented project feasibility studies underway for various capital improvement projects.

The results and conclusions of these studies will be incorporated into relevant portions of the Master Plan Update throughout the planning process.

Technical Memorandum–B

AIRFIELD AND AIRSPACE

An overview of existing airfield facilities at Memphis International Airport (the Airport) as well as aids to navigation and airspace provisions is provided in the following sections.

AIRFIELD

The airfield is depicted on Figure B-1, and consists of runways, taxiways, apron areas, service roads, and other facilities, as discussed below. Airfield facilities meet Airport Reference Code (ARC) D-V criteria—meaning the runways and taxiways can accommodate air carrier aircraft with approach speeds up to 165 knots and wingspans of up to 214 feet. Aircraft Design Group (ADG) V aircraft include the Boeing 777 and Boeing 747.

Currently, airfield facilities do not meet design requirements for ADG VI, which includes the Airbus A380. In 2006, the Authority prepared an assessment of the airfield to determine what improvements would be required to accommodate ADG VI aircraft (*Project Studies for Aircraft Group VI Airfield Improvements*, Kimley-Horn and Associates, May 2006). The assessment identified approximately $16.5 million in improvements necessary to accommodate ADG VI aircraft operations, including: taxiway and runway asphalt shoulder expansions; improvements to de-icing pads; and other miscellaneous improvements. However, the need to accommodate the Airbus A380 diminished when FedEx cancelled their Airbus A380 order and instead ordered the Boeing 777 freighter.

Runways

As illustrated on Figure B-1, the Airport has four active runways: 9-27, 18C-36C, 18L-36R, and 18R-36L, all of which are used to accommodate air carrier aircraft. Runways 18C-36C, 18L-36R, and 18R-36C are parallel to one another and are located in the southern portion of the airfield. Runway 9-27 is perpendicular to and located north of the other runways. None of the four runways intersect. Detailed characteristics of the Airport's runways, including dimensions, lighting and navigational aids, and pavement strength are summarized on Table B-1.

Table B-1

RUNWAY DATA
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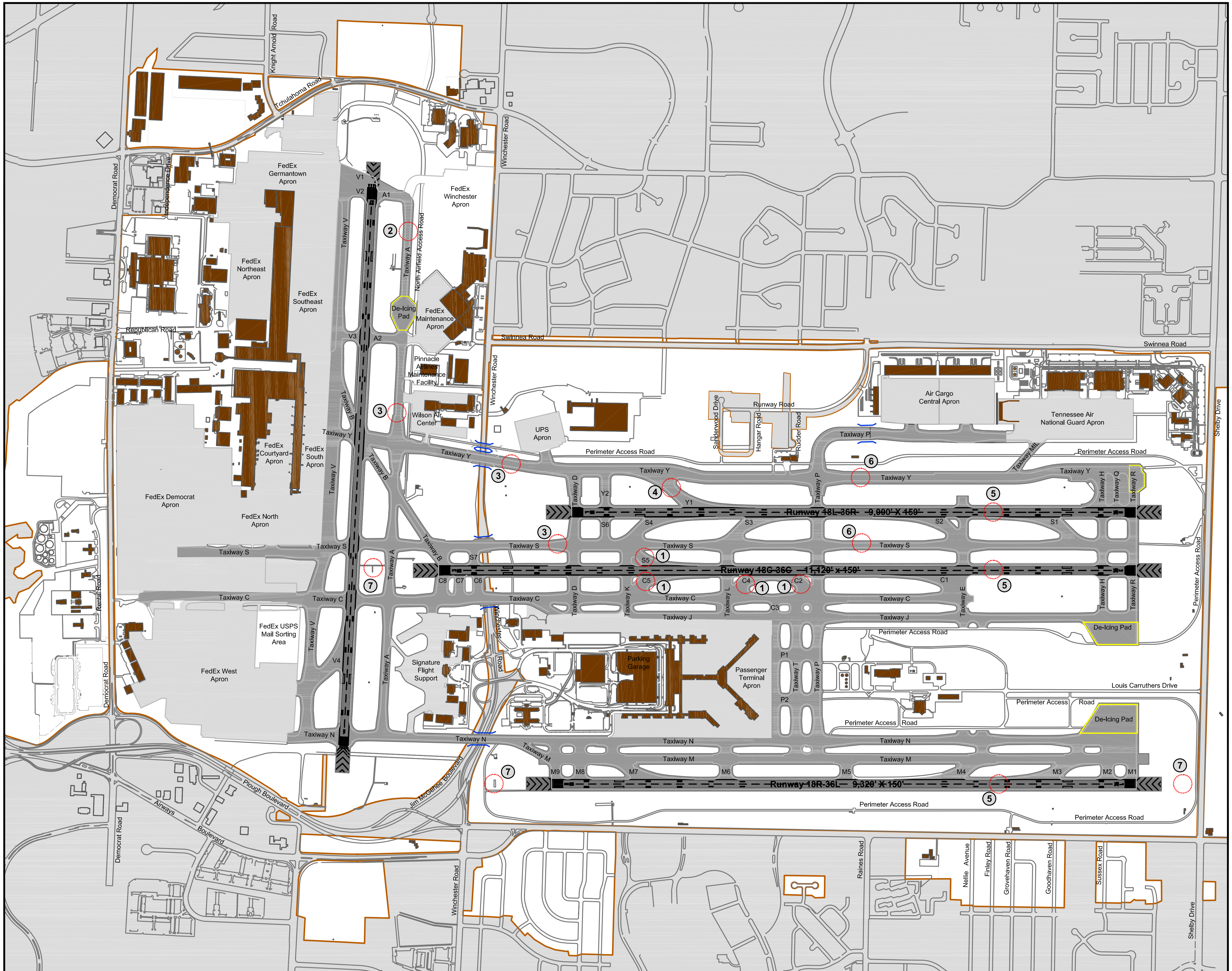
Memphis International Airport

	Runway							
	9	27	18L	36R	18C	36C	18R	36L
Runway length (feet)	8,946	8,946	9,000	9,000	11,120	11,120	9,320	9,320
Runway width (feet)	150	150	150	150	150	150	150	150
Runway end elevation (ft. above MSL)	253.2	292.0	277.5	334.7	270.6	340.9	288.4	320.8
Pavement type/friction	Asphalt/grooved	Asphalt/grooved	Concrete/grooved	Concrete/grooved	Concrete/grooved	Concrete/grooved	Concrete/grooved	Concrete/grooved
Pavement strength (pounds)								
Single gear	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000
Dual gear	178,000	178,000	210,000	210,000	210,000	210,000	210,000	210,000
Dual tandem gear	602,000	602,000	458,000	458,000	458,000	458,000	458,000	458,000
Double dual tandem gear	870,000	870,000	873,000	873,000	873,000	873,000	873,000	873,000
Runway markings	Precision	Precision	Precision	Precision	Precision	Precision	Precision	Precision
Runway lighting	HIRL	HIRL	HIRL	HIRL	HIRL	HIRL	HIRL	HIRL
Centerline lights	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Approach lighting	MALSR	MALSR	MALSR	ALSF-2	MALSR	ALSF-2	MALSR	ALSF-2
Approach aids	LOC GS	PAPI (P4L) LOC GS	PAPI (P4L) TDZ LOC GS	PAPI (P4L) TDZ LOC GS	TDZ LOC GS	TDZ LOC GS	TDZ LOC GS	PAPI (P4L) TDZ LOC GS
Instrument approach procedures	ILS (CAT I) RNAV (GPS)	ILS (CAT I) RNAV (GPS)	ILS (CAT I) RNAV (GPS)	ILS (CAT I, II, III) RNAV (GPS)	ILS (CAT I) RNAV (GPS)	ILS (CAT I, II, III) RNAV (GPS)	ILS (CAT I) RNAV (GPS)	ILS (CAT I, II, III) RNAV (GPS)
Minimum approach decision height (feet above MSL)	459	492	501	NA	490	NA	493	NA
Minimum approach visibility	2,400 RVR	2,400 RVR	1,800 RVR	300 RVR	2,400 RVR	300 RVR	2,400 RVR	300 RVR

ALSF-2 = High-intensity approach light system with centerline sequenced flashers
CAT = Category
GPS = Global positioning system
GS = Glide slope
HIRL = High-intensity runway lights
ILS = Instrument landing system
LOC = Localizer
MALSR = Medium-intensity approach light system with runway alignment indicator lights
NA = Not applicable
PAPI (P4L) = Precision approach path indicator (four identical light units placed on left side of runway)
RNAV = Area navigation
RVR = Runway visual range
TDZ = Touchdown zone lights

Sources: Airport Master Record, January 2008.
Federal Aviation Administration, *Digital Terminal Procedures Publication* (Version 0801), January 2008.



LEGEND

- Airfield bridges
- Airport property line
- De-icing pad
- Modification of design standard
- Apron pavement
- Runway pavement
- Taxiway pavement
- Buildings

MODIFICATION OF DESIGN STANDARDS

1. Runway exit geometry
2. ADG VI taxiway object free area
3. ADG VI taxiway width
4. ADG VI pavement edge margin
5. ADG VI runway width
6. ADG VI runway to parallel taxiway separation
7. Runway safety area

Source: Modification of design standards -- Memphis Shelby County Airport Authority records, March 2008.

N

0' 750' 1,500' 3,000'

Figure B-1
AIRFIELD FACILITIES

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Taxiways

Figure B-1 shows the location of the taxiways that connect the runway system to aircraft parking areas. All taxiways are at least 75 feet wide, satisfying the dimensional requirement for accommodating Airplane Design Group (ADG) V aircraft. Taxiways Y, S, C, J, N, and M (listed from east to west) run in a north-south direction parallel to the Runway 18-36 system. Taxiways T and P provide connections between the east and west portions of the southern airfield. Taxiways V and A run parallel to Runway 9-27.

The Airport has taxiway use restrictions in place due to both Modification to Standards (MOS) and Operational Agreements with air traffic control. These are listed and described in detail in the Memorandum B – Appendix 2 of the *Facility Requirements Working Paper.*

Apron Areas

As presented on Figure B-1, there are several aircraft apron and parking areas located throughout the airfield.

- **Passenger Terminal –** The Passenger Terminal Apron is approximately 3,105,000 square feet and located mid-field between Runways 18R-36L and 18C-36C. Aircraft ranging in size from small commuter to large widebody aircraft park here to load and unload passengers and belly cargo. Airfield access is provided via Taxiways J, N, and T. A 390,000 square foot air cargo apron is located immediately north of the Passenger Terminal Apron alongside Taxiway C. This apron accommodates DHL and other air cargo carriers, excluding FedEx and UPS. The majority of air cargo activity accommodated on this apron will move to the Cargo Central Apron in 2008.

- **Cargo Central –** The Airport's new 1.3 million square foot general-use cargo apron, named Cargo Central, is located on the east side of the airfield. The apron is planned to accommodate traffic currently using the Air Cargo Apron. Airfield access is provided via an extension of Taxiway P.

- **United Parcel Service –** A 390,000 square foot UPS Apron is located north of the UPS Oakhaven Distribution Center on the east side of the airfield, immediately south of Winchester Road. The UPS Apron is used for parking aircraft and active loading and unloading of cargo. Airfield access is provided via Taxiway Y.

- **FedEx (various) –** FedEx parks aircraft for active loading and unloading on several aprons surrounding their major sorting facilities. These aprons encompass 14.3 million square feet, and include the following:

  – West Apron, between Taxiways C, N, and V
  – North Apron, between Taxiway C, V, and the super-hub

– Courtyard Apron, between Taxiway S and two wings of the super-hub;
– South Apron, between Taxiways S, V, and Y
– Southeast Apron, between Taxiways Y, V, and V1
– East Apron, between the super-hub and the Germantown Apron
– Germantown Apron, between Taxiway V1 and Tchulahoma Road
– Northeast Apron, located to the northeast of the super-hub

An additional 4 million square feet will be gained once construction is complete on the Winchester Apron south of Taxiway A and space currently occupied by the TnANG (to be named the Democrat Apron) is transferred to FedEx.

- **General Aviation –** The Signature Flight Support fixed base operator (FBO) aircraft parking apron is 560,000 square feet and located on the northern portion of their property. The Wilson Air Center FBO aircraft parking apron is 610,000 square feet and located to the north of Winchester Road. Both aprons are used for FBO operations and itinerant and based aircraft parking.

- **Tennessee Air National Guard –** The TnANG will be relocated from their facility adjacent to FedEx on the northern edge of the airfield to a site in the southeast corner of the airfield at the end of 2008. The new site will be accessible to aircraft via Taxiway P, which will connect to new Taxiway MIL and existing Taxiway Y.

De-icing Pads

Treatment of aircraft during winter weather and icing conditions with de-icing fluids (i.e., glycol) take place at four de-icing pads located throughout the airfield. As shown on Figure B-1, three pads are located at the southern end of the airfield adjacent to Taxiways J, N, and Y; the fourth is located on Taxiway A adjacent to the FedEx aircraft maintenance facility. In total, approximately 800,000 square feet of space is provided for de-icing operations. While Memphis rarely experiences heavy snowfalls, there were 53 days in both 2006 and 2007 that necessitated some type of de-icing fluid application. Approximately 100,000 to 150,000 gallons of glycol is applied each year.

Service Roads

As depicted on Figure B-1, the Airport's main service road is Perimeter Access Road that surrounds much of the south airfield and provides Authority and other airport personnel with a continuous secure access route clear of aircraft operations to over 80 percent of the airfield. Perimeter Access Road provides access from the Airport's maintenance and operations center at the corner of Tchulahoma and Winchester Roads to the FedEx apron and maintenance facility, Pinnacle Airlines hangar, Wilson Air Center, UPS Oakhaven facility, ARFF station, Cargo Central Apron, new

TnANG base, and major aviation support facilities located in the south airfield between Runway 18C-36C and 18R-36L.

Airfield Structures

As depicted on Figure B-1, the Airport is bisected by Winchester Road, effectively creating two separate airfields linked by four structures (or bridges). These four structures include: (1) a narrow bridge supporting Perimeter Road; (2) a reinforced concrete bridge that supports Taxiway Y; (3) a 1,125-foot-long reinforced concrete bridge supporting Runway 18C-36C and Taxiways C and S; and (4) a bridge that supports Taxiway N. Most structures span between 150 and 200 feet, varying with the width of Winchester Road below. Furthermore, both Taxiway P and Taxiway MIL are located on structures where they cross Hurricane Creek.

Additionally, there are several drainage culverts located beneath portions of the airfield. The largest is a concrete culvert that channels Hurricane Creek in a north-south orientation beneath Runway 9-27 and FedEx Super-hub facilities. A separate concrete culvert for Hurricane Creek is located beneath Taxiway MIL at the southern end of the airfield. Lastly, wastewater collected in the vicinity of the Passenger Terminal Apron transports water through a culvert in an east-west orientation to a drainage area near Airways Boulevard.

NAVIGATIONAL AIDS

A summary of navigational aids and lighting systems that support aircraft operations is provided on Table B-1, and summarized below.

Instrument Approaches

Airport runways include multiple precision instrument approach procedures to allow continuous aircraft operations during periods of low visibility. A precision approach utilizes ground- or satellite-based navigational aids to provide pilots with definitive guidance on the horizontal and vertical position of the aircraft. Approaches in place at the Airport include:

- **Area Navigation (RNAV) –** All runway ends have RNAV approaches that utilize pre-determined waypoints and global positioning system (GPS) guidance to enable aircraft to fly point-to-point until reaching the runway. RNAV approaches at the Airport allow pilots to descend to a minimum of 400 feet above threshold elevation and 0.75 miles of visibility before visual contact with the runway must be established (varies by runway end).

- **Category I ILS –** All runways are equipped with a Category I instrument landing systems (ILS), which allows aircraft approaches to a decision height of 200 feet above ground level (AGL) in visibility minimums of 0.5 mile, varying slightly on each runway taking into account approach-specific parameters.

- **Category III ILS –** Runways 36C, 36L, and 36R are equipped with Category II, IIIa, and IIIb ILS approaches to allow aircraft to land in even the most challenging of visibility conditions. Execution of these approaches requires aircraft to be equipped with specific avionics and pilots to receive additional training.

Approach and Runway Lighting

All eight runway ends are equipped with approach lighting systems and touchdown zone lights that assist pilots in visually recognizing the orientation and touchdown point of the runway during descent. As presented in Table B-1, Runways 9, 27, 18C, 18L, and 18R are equipped with medium-intensity approach light systems with runway alignment indicator lights (MALSR) to support Category I ILS approaches. Runways 36C, 36L, and 36R are equipped with more-sophisticated high-intensity approach light systems with centerline sequenced flashers (ALSF-2) to allow Category II and III ILS approaches during extremely poor weather and visibility conditions.

In addition, all runways are equipped with high-intensity runway lights (HIRL) along their edges to depict the edge of runway pavement during nighttime and low visibility conditions. Runways 18C-36C, 18L-36R, and 18R-36L also have centerline lights.

Approach Aids

Additional visual and instrument approach aids include the following:

- **Precision Approach Path Indicator (PAPI) –** Runways 18L, 27, 36L, and 36R are equipped with a PAPI located beside the runway end that provides visual guidance during descent using red and white lights.

- **Very-high Frequency Omnidirectional Range/Tactical Air Navigation Facility (VORTAC) –** The VORTAC is located south of Shelby Drive approximately 3,400 feet to the southeast of the Runway 36L threshold and is used for both en route navigation and non-precision instrument approaches.

- **Airport Surveillance Radar (ASR) –** The ASR-9 system, which is used to detect and display an aircraft's position within the surrounding airspace, displays range and azimuth information and can provide coverage within a 60-mile radius of the Airport. The Airport's ASR-9 antenna is located north of Shelby Drive on a platform that is approximately 2,030 and 1,670 feet from the Runway 36L and 36C thresholds, respectively.

- **Rotating Beacon –** The Airport's rotating beacon is located adjacent to Taxiways J and P. The beacon flashes an alternating green and white light to help pilots locate the airfield at nighttime.

Surface Detection

The Airport utilizes an airport surface detection equipment (ASDE-3) system, which uses surface radar and multi-lateration sensors to detect the presence and position of aircraft and surface vehicles on the airfield to air traffic control to assist with ground movements. The ASDE radar antenna is located between Runways 18C-36C and 18R-36L, approximately 5,900 feet from the ATCT. In its current location, the radar signal is unable to reach all areas along Runway 9-27 and adjacent taxiways. There are plans to upgrade to an ASDE-X when the new ATCT is completed, which will provide both position and identification information to air traffic control.

The Airport also operates a Surface Movement Guidance Control Systems (SMGCS) that provides for the safe and efficient movement of aircraft on the ground during low visibility operations. The SMGCS is activated at the discretion of air traffic control when visibility falls below 1,200 feet runway visual range. When active, specific airfield lighting on runways and taxiways as well as specific taxi routes are utilized to ensure that aircraft are able to taxi around the airfield.

AIRFIELD OPERATIONS

The operational configuration of the Airport's runway and taxiway system is primarily dictated by the prevailing wind and weather conditions. The following paragraphs describe typical wind and weather patterns in the region and the general operating procedures put in place by FAA air traffic control and Authority personnel.

Runway Wind Coverage

Runway wind coverage refers to the percent of time that the crosswinds associated with a particular runway orientation are within an acceptable level. Airport wind coverage is determined by considering all runways simultaneously. Crosswinds, which are the components of wind that flow in a direction perpendicular to a runway's orientation, can effectively close a runway for use. The maximum allowable crosswind components for a particular aircraft are determined largely by aircraft size, aircraft weight, and pilot capabilities. In general, larger, heavier air carrier aircraft can land and take off in higher crosswinds than smaller, lighter general aviation aircraft.

The FAA provides guidance regarding wind coverage in AC 150/5300-13, *Airport Design*, which states the desirable wind coverage for an airport is 95 percent, taking into account various factors influencing operations and the economics of providing the coverage. The 95 percent wind coverage is computed on the basis of the crosswind not exceeding a specific magnitude, which varies by Airport Reference Code (ARC). The allowable crosswind for ARC A-IV through D-IV is 20 knots.

Based on this guidance, wind coverage for the Runway 18-36 direction, and Runway 9-27, and each of the runways combined was estimated using the following maximum allowable crosswind component conditions:

- 10.5-knot crosswind component represents the crosswind component at which pilots of light general aviation aircraft are unable to use the runways
- 13-knot crosswind component represents the crosswind component at which pilots of twin-engine propeller aircraft are unable to use the runways
- 16-knot crosswind component represents the crosswind component at which pilots of larger, commuter, propeller aircraft and smaller business jets are unable to use the runway
- 20-knot crosswind component represents the crosswind component at which pilots of air carrier jets are be unable to use the runway

Table B-2 summarizes the wind coverage of the Airport's runways at these crosswind speeds. In this analysis, 24-hour observational wind data were used given much of FedEx's operation occurs at night. These results indicate that the Airport's airfield provides wind coverage in excess of the FAA's 95 percent coverage criteria for all four crosswind components evaluated. In addition, the results of the combined wind analysis indicate the airfield provides beyond 99 percent wind coverage given any of the four crosswind components.

Weather Coverage

In addition to wind coverage, weather data were analyzed to determine the percent occurrence of the various weather conditions for the 10-year period ending December 31, 2007. All aircraft flights are governed by either visual flight rules (VFR) or instrument flight rules (IFR).* The basic difference between VFR and IFR is that under VFR a pilot uses visual references to navigate an aircraft, whereas under IFR a pilot uses aircraft instruments to navigate. When weather conditions are poor (e.g., when the cloud ceiling is less than 1,000 feet or the visibility is less than 3 miles), pilots are required to fly according to IFR in controlled airspace. As presented on Table B-3, poor weather conditions in the Memphis area occur less than 7 percent annually and the Airport operates under VFR approximately 93.8 percent of the time. However, regardless of weather conditions, all air carrier aircraft and many military and high-performance general aviation aircraft generally operate under IFR flight plans.

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*Definitions are contained in FAR Part 91, *General Operating and Flight Rules*.

Table B-2

WIND DATA SUMMARY
Master Plan Update
Memphis International Airport

Crosswind component	Runway 18-36 System	Runway 9-27	Combined
	All weather coverage (21.6% calm)		
10.5 knots	92.4%	87.9%	99.2%
13 knots	95.9	94.0	99.8
16 knots	98.2	98.1	100.0
20 knots	99.9	99.6	100.0
	VMC weather coverage (21.5% calm) *(a)*		
10.5 knots	92.4	87.8	99.2
13 knots	95.9	94.0	99.8
16 knots	98.2	98.1	100.0
20 knots	99.9	99.6	100.0
	IMC weather coverage (23.3% calm) *(b)*		
10.5 knots	92.5	89.8	99.4
13 knots	96.2	95.2	99.8
16 knots	98.6	98.6	100.0
20 knots	99.9	99.6	100.0

Notes: Calm includes all winds below 5 knots; tailwind component is assumed as 5 knots.

(a) VMC (Visual Meteorological Conditions) defined as a cloud ceiling of at least 1,000 feet and visibility of at least 3 miles.
(b) IMC (Instrument Meteorological Conditions) defined as a cloud ceiling less than 1,000 feet or visibility less than 3 miles.

Source: Jacobs Consultancy, based on Surface Airways Hourly Data (TD-3280), January 1, 1998, through December 31, 2007, from the National Climatic Data Center.

Runway Use Configurations

Direction of air traffic flow is largely dictated by prevailing wind and weather conditions. Because three of the Airport's four runways are in a parallel north-south orientation, the two primary runway operational configurations are north flow and south flow. North flow is the preferred direction during periods of calm winds; and a tailwind of 7 knots or a crosswind of 10 knots necessitates a shift in flow direction. Strong crosswinds force all traffic to use Runway 9-27 approximately two days per year.

Table B-3

WEATHER CONDITIONS
Master Plan Update
Memphis International Airport

Weather condition	Minima: Cloud ceiling (feet)	Minima: Visibility (miles)	Occurrence
VFR	1,000	3	93.8%
IFR Category I	200	½	5.5
IFR Category II	100	¼	0.2
IFR Category III	0	0	0.5
Total occurrence			100.0%

VFR = Visual flight rules
IFR Category I = IFR weather conditions in which a Category I ILS must be used.
IFR Category II = IFR weather conditions in which a Category II ILS must be used.
IFR Category III = IFR weather conditions in which a Category III ILS must be used.

Source: Jacobs Consultancy, based on Surface Airways Hourly Data (TD-3280), January 1, 1998, through December 31, 2007, from the National Climatic Data Center.

In north flow, Runways 36C, 36L, and 36R are active and typically supplemented with the use of Runway 27. In south flow, Runways 18C, 18L, and 18R are active and also supplemented with the use of Runway 27. In south flow, the proximity of Runway 9-27 to the approach ends of Runways 18C and 18L creates a full dependency between the two. As a result, the runways are operated by FAA air traffic personnel as if they physically intersect.

Typical north and south flow runway configurations during daytime hours are shown on Figure B-2. Peak-time runway operating configurations, during which the Airport accommodates a significant number of either departures or arrivals, are shown on Figure B-3.

FAA introduced Converging Runway Display Aid (CRDA) procedure at the Airport in July 2007 to facilitate dependent instrument approaches to Runway 27 and either Runway 18C or 18L. The CRDA ensures positive separation between aircraft at the intersection of Runways 27 and 18L. Under the CRDA, a minimum of 4 nautical mile spacing must be maintained on each approach which results in a minimum 2 nautical mile separation between an aircraft at the runway intersection and an aircraft on approach. During CDRA operations, Runway 9-27 is limited to non-heavy aircraft (i.e., aircraft weighing 255,000 pounds or less).

Figure B-2

DAYTIME RUNWAY OPERATING CONFIGURATIONS
Master Plan Update
Memphis International Airport

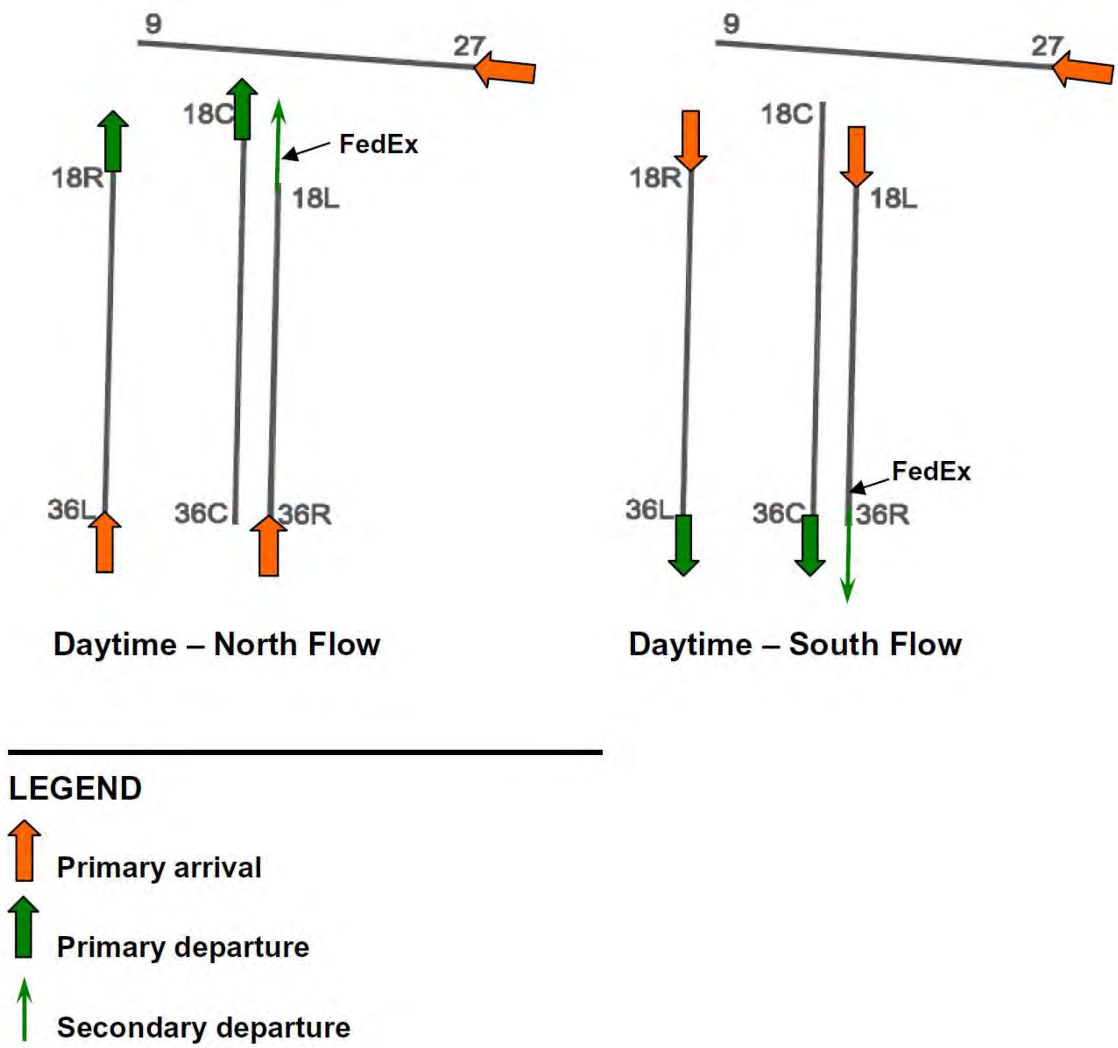
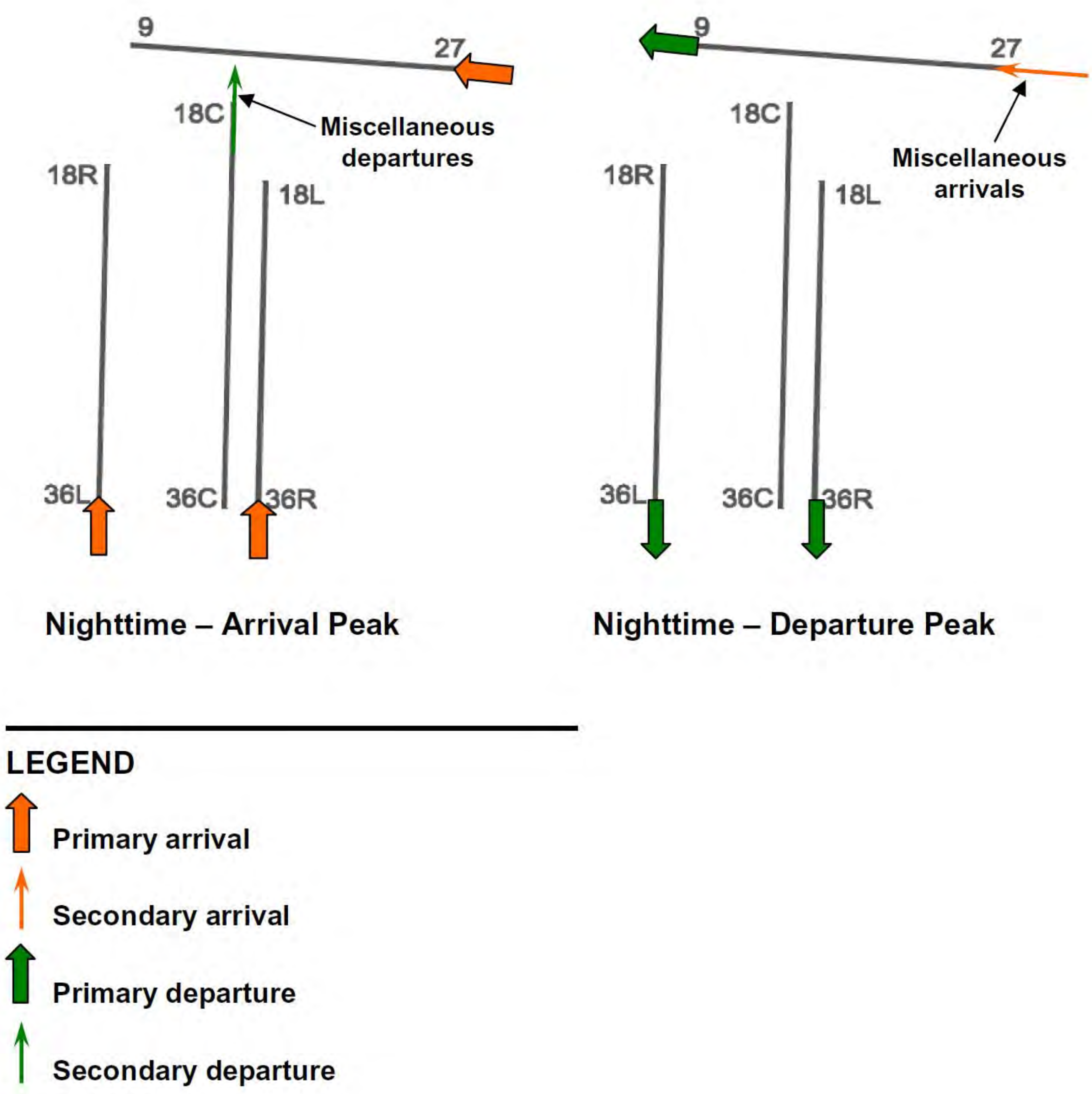


Figure B-3

PEAK PERIOD RUNWAY OPERATING CONFIGURATIONS
Master Plan Update
Memphis International Airport



FAA air traffic and FedEx representatives expressed several areas of concern regarding current airfield operations, including:

- **Runway 9-27 Crossings –** Departures and arrivals on Runway 27 must be sequenced and coordinated with FedEx aircraft needing to cross the runway to get to or from the FedEx apron.

- **Departure Queuing –** The de-icing pads located adjacent to the ends of Runways 36L, 36C, and 36R are used for queue management during departure-heavy periods. However, when south flow is in use during the FedEx nighttime departure bank, taxiways to accommodate queued aircraft is limited because of the proximity to Runway 9-27 and the limited taxi routes across Winchester Road. This problem is particularly acute for aircraft queued for departure at Runway 18C.

- **Exit taxiway optimization –** Several exit taxiways are not located at optimal locations, increasing runway occupancy time and decreasing arrival capacity. Additionally, taxi patterns that utilize many high-speed exits from runways are immediately flowed by an acute-angled turn, hindering the theoretical benefits of the high-speed exits.

AIRSPACE AND AIR TRAFFIC CONTROL

This section describes airspace and air traffic control provisions that affect aircraft operations and includes descriptions of airspace procedures, air traffic control jurisdictions, and obstructions affecting the navigable airspace.

Terminal Routes

Standard terminal arrival routes (STARs) and standard instrument departure procedures (SIDs) are established by the FAA as an aid to air traffic controllers and pilots. STARs and SIDs help reduce “verbiage” on ATC radio frequencies by providing the pilot with a coded description of the assigned terminal routing. Memphis has one SID, named Memphis Seven Departure; and four STARs – Gilmore Three, Holly One, Marvell Three, and Wlder Four.

In the vicinity of the Airport, pilots operating under IFR conditions are typically given radar vectors to their assigned routes as necessary by the Memphis terminal radar approach control (TRACON), or follow published instrument approach and departure procedures. A radar vector is a heading issued to a pilot to provide navigational guidance by radar.

Air Traffic Control Jurisdictions

Airspace in the Memphis area falls under the jurisdiction of the following entities: Memphis Air Route Traffic Control Center (ARTCC), Memphis TRACON, and Memphis ATCT.

- **Memphis Center –** The airspace over the continental United States is divided into 20 geographically defined ATC jurisdictions based on ARTCCs. The primary purpose of an ARTCC is to provide radar service and other ATC services to en route aircraft (i.e., those aircraft that are not landing or taking off). The Memphis ARTCC, which has jurisdiction of en-route traffic over western Tennessee, most of Arkansas and Mississippi, and small portions of Alabama, Kentucky, and Missouri, is located adjacent to Airport property near the intersection of Democrat and Tchulahoma Roads.

- **Memphis TRACON –** The TRACON provides radar approach and departure control as well as other ATC services to aircraft flying in terminal area airspace. The Memphis Center has delegated control over certain airspace in the Memphis area to the Memphis TRACON, located at the Airport. In radio communications, pilots refer to the Memphis TRACON as either Memphis approach control or Memphis departure control, depending on the phase of flight. The TRACON has control of airspace within a 40 nautical mile radius of the Airport up to altitudes of 16,000 feet.

- **FAA ATCT –** The ATCT provides air traffic control services to aircraft at and in the immediate vicinity of an airport, ensuring the safe, orderly, and expeditious flow of traffic. Controllers are responsible for separating aircraft on the ground and in the traffic pattern, giving arrival and departure clearance to aircraft, and providing weather information to pilots. The ATCT at Memphis is located along the Airport's primary entrance road to the north of the passenger terminal.

IMAGINARY SURFACES AND OBSTRUCTIONS

The airspace in the vicinity of airports consists of imaginary or obstacle clearance surfaces, as described in FAR Part 77, *Objects Affecting Navigable Airspace*. The slopes of these imaginary surfaces are generally the same at all airports, with the exception of approach surfaces, which vary depending on the type of instrument approach procedure. Because all runways at the Airport are equipped with at least a Category I ILS, all runway ends have common Part 77 approach slopes of 50:1.

Any existing or proposed manmade object, object of natural growth, or terrain is considered an obstruction to air navigation if it penetrates an imaginary surface or is of greater height than allowed under other specific conditions described in FAR Part 77. According to a photo-slope survey (GCR and Associates, June, 2007), there are several man-made and natural obstructions that penetrate the approach surface. The type, height, and location of these objects is summarized in Table B-4.

Natural objects such as trees will be topped or felled in order to remove the penetration.

The controlling obstruction is the object with the greatest penetration of the approach surface, which in turn requires the steepest slope to remain clear. The controlling obstruction for each runway end is summarized below. There are no objects penetrating the approach surface for Runways 18L and 18R.

- **Runway 9 –** A pole located 1,237 feet from the runway threshold and 607 feet to the left (when looking toward the runway) of the extended runway centerline penetrates by 8 feet.
- **Runway 27 –** A tree located 2,788 feet from the runway threshold and 806 feet to the right of the extended runway centerline penetrates by 21 feet.
- **Runway 18C –** A pole located 2,595 feet from the runway threshold and 803 feet to the right of the extended runway centerline penetrates by 17 feet.
- **Runway 36C –** A tree located 1,596 feet from the runway threshold and 693 feet to the left of the extended runway centerline penetrates by 12 feet.
- **Runway 36R –** A tree located 1,763 feet from the runway threshold and 728 feet to the right of the extended runway centerline penetrates by 41 feet.
- **Runway 36L –** A pole located 1,025 feet from the runway threshold and 622 feet to the right of the extended runway centerline penetrates by 5 feet.

Table B-4

APPROACH SURFACE OBSTRUCTIONS
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Memphis International Airport

Number	Description	Elevation MSL (feet)	Object clearance slope	Height of penetration (feet)	Centerline offset *(a)*	Distance from runway threshold (feet)
Runway 9						
1	Pole	281	37:1	8	607	1,237
2	Tree	303	42:1	8	-817	2,318
3	Tree	326	42:1	11	879	3,311
4	Tree	323	42:1	11	920	3,182
5	Tree	320	46:1	5	722	3,330
Runway 27						
6	Tree	364	35:1	21	-806	2,788
7	Pole	325	37:1	9	-206	1,439
8	Pole	324	38:1	8	-579	1,439
9	Tower	450	44:1	19	1,232	7,166
10	Tower	456	44:1	20	1,452	7,445
11	Tree	345	46:1	4	-172	2,648
12	Tree	345	46:1	4	282	2,647
13	Tree	344	46:1	4	668	2,636
14	Pole	344	46:1	4	780	2,623
Runway 18C						
15	Pole	335	37:1	17	-803	2,595
16	Pole	316	40:1	9	487	2,030
17	Pole	315	40:1	9	703	1,960
18	Pole	333	43:1	8	-755	2,914
19	Pole	334	44:1	8	531	2,981
20	Pole	333	44:1	7	659	2,973
21	Pole	333	44:1	7	789	2,969
Runway 36C						
22	Tree	381	34:1	12	693	1,596
23	Tree	380	36:1	11	652	1,611
24	Tree	415	50:1	--	-136	3,921
25	Light pole	358	51:1	--	406	1,076
26	Tree	421	53:1	--	695	4,487
Runway 18L						
27	Pole	337	65:1	--	205	4,082
Runway 36R						
28	Tree	407	21:1	41	-728	1,763
29	Tree	384	25:1	25	-603	1,430
30	Tree	383	26:1	23	-570	1,460
31	Tree	397	28:1	27	-540	1,992
32	Tree	397	31:1	24	-498	2,143
33	Tree	412	46:1	5	607	3,804
34	Tree	416	46:1	6	796	3,947
35	Tree	388	50:1	--	-16	2,897
36	Pole	352.5	51:1	--	462	1,096
37	Airport antenna	353	31:1	7	499	769
Runway 18R						
38	Light Pole	319	58:1	--	-533	2,015
Runway 36L						
39	15-ft road clearance	342	39:1	5	-622	1,025
40	Pole	390	42:1	11	-863	3,122
41	Tree	397	43:1	10	860	3,524
42	Tree	419	46:1	7	683	4,752
43	Tree	419	46:1	8	804	4,730
44	Tree	397	47:1	4	103	3,819
45	Tree	397	47:1	4	410	3,828

Note: Height of natural objects changes with time – exact penetration may differ from data presented above.

(a) A positive number indicates obstruction is to the left of the runway centerline when facing the runway end.

Source: Photoslope survey, GCR and Associates, June 2007.

Technical Memorandum–C
PASSENGER TERMINAL COMPLEX

The Memphis International Airport (the Airport) passenger terminal complex occupies approximately 160 acres between Runways 18C-36C and 18R-36L to the north of cross-field Taxiways P and T. The terminal complex, depicted on Figure C-1, serves as a passenger hub for Northwest Airlines and its affiliates (Pinnacle Airlines and Mesaba Airlines), as well as provides aircraft gates and processing facilities for eight other airlines: American Airlines and its affiliates (American Eagle and Trans States Airlines); Delta Air Lines and its affiliates (Atlantic Southeast Airlines, Chautauqua Airlines, ComAir, and Skywest Airlines); Air Tran Airways; US Airways and its affiliates (Mesa Airlines, PSA); Continental Airlines and its affiliate (ExpressJet Airlines), United Airlines' affiliate (Skywest Airlines); and Frontier Airlines.

This memorandum provides a description of the terminal complex, focusing on the terminal buildings and concourses and the various passenger processing functions contained therein. Mechanical, electrical, and plumbing systems within the passenger terminal are documented and assessed under a separate memorandum. Additionally, a life safety and egress assessment, based on current state and local building codes, is also provided under separate cover.

PASSENGER TERMINAL

The passenger terminal consists of a terminal building and three separate concourses that provide a total of approximately 1.3 million square feet of space on four levels. When originally constructed in 1963, what is now the central portion of the terminal—Terminal B and Concourse B—provided 22 aircraft gates. By 1974, Terminals and Concourses A and C, had been constructed to each side of the original in a matching architectural style. The central portions of each terminal building are architecturally significant for their soaring reinforced-concrete pedestal columns and multi-story glass curtain walls that create an atrium-like space. While the central portions of each terminal are able to be delineated, they are connected to one another on several levels in many locations, combining to form one large terminal processor building.

The following sections describe the primary elements of the passenger terminal. The gross area provided in the terminal building and concourse, calculated by level, is presented in Table C-1. The allocation of space among the various functional uses of the terminal building and concourses is presented in Table C-2.

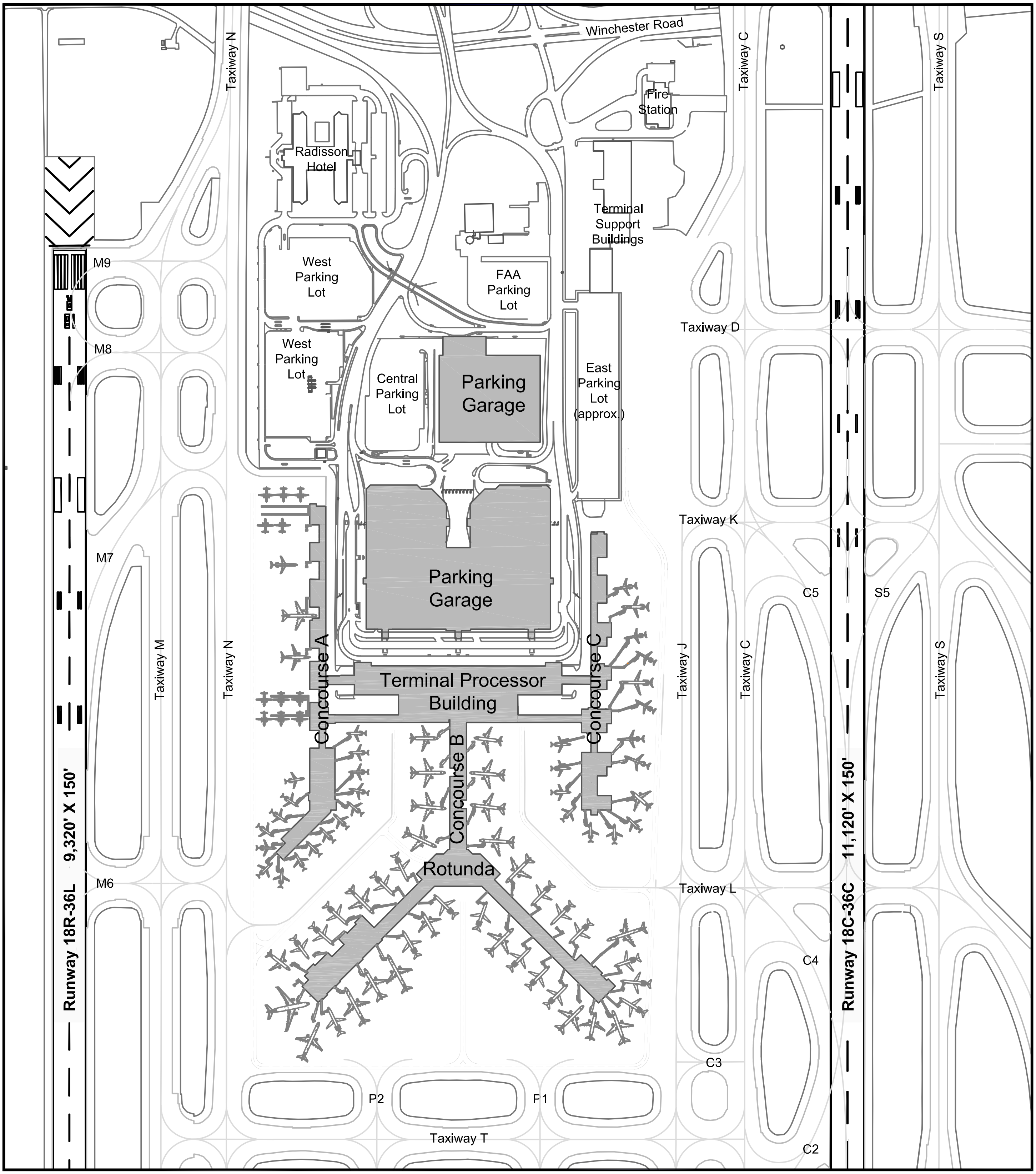

Figure C-1
PASSENGER TERMINAL COMPLEX

Master Plan Update
Memphis International Airport
November 2009

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Table C-1

PASSENGER TERMINAL GROSS AREA (SQ FT)
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Memphis International Airport

	Basement level	Lower level	Passenger level	Mezzanine level	Total
Terminal buildings					
Terminal A	37,208	30,420	42,129	12,208	121,965
Terminal B	32,655	119,699	120,813	38,472	311,639
Terminal C	30,195	30,473	41,115	12,204	113,987
Total	100,058	180,592	204,056	62,884	547,591
Concourses					
Concourse A	39,433	73,694	104,320	--	217,447
Concourse B	51,338	162,091	191,361	--	404,791
Concourse C	35,375	54,944	81,809	--	172,128
Total	126,146	290,729	377,491	--	794,365
Grand Total	226,204	471,321	581,547	62,884	1,341,956

Note: Calculations based on gross areas measured to the outside edge of exterior walls.

Source: Self Tucker Architects, March 2008.

Main Terminal Building

The main terminal building provides approximately 550,000 square feet of space on four levels, including a basement. A three-level terminal parking garage connects to the terminal building on the basement, ground, and second levels. Authority administration space and mechanical, electrical, and plumbing systems are provided on the basement level (see Figure C-2).

The ground level contains both the passenger baggage claims and the baggage handling and sorting areas used by airline personnel. Additionally, there are airline office spaces adjacent to the claim areas to support passenger luggage retrieval, Airport police, Authority building maintenance office space, and storage and mechanical spaces. The Transportation Security Administration (TSA) also operates an employee security screening checkpoint used by airline and other tenants needing access to sterile areas of the building.

Table C-2

PASSENGER TERMINAL SPACE ALLOCATION (SQ FT)
Master Plan Update
Memphis International Airport

Space category	Basement level	Lower level	Passenger level	Mezzanine level	Total
Airline space *(a)*	--	206,243	194,342	--	400,585
Airport administration	39,788	20,233	3,196	27,182	90,399
Baggage claim	--	38,139	1,952	--	40,090
Baggage handling	--	88,211	--	--	88,211
Concessions	--	7,204	83,356	3,976	94,535
Customs and immigration *(b)*	--	38,519	--	--	38,519
Open/vacant	--	477	8,449	13,355 *(e)*	22,281
Other *(c)*	172,184	25,068	20,457	--	217,709
Public space	14,233	38,211	256,169	18,371	326,984
Security screening *(d)*	--	9,017	13,627	--	22,643
Total	226,205	471,321	581,547	62,884	1,341,957

Note: Calculations based on gross areas measured to the outside edge of exterior walls and the center of interior walls.

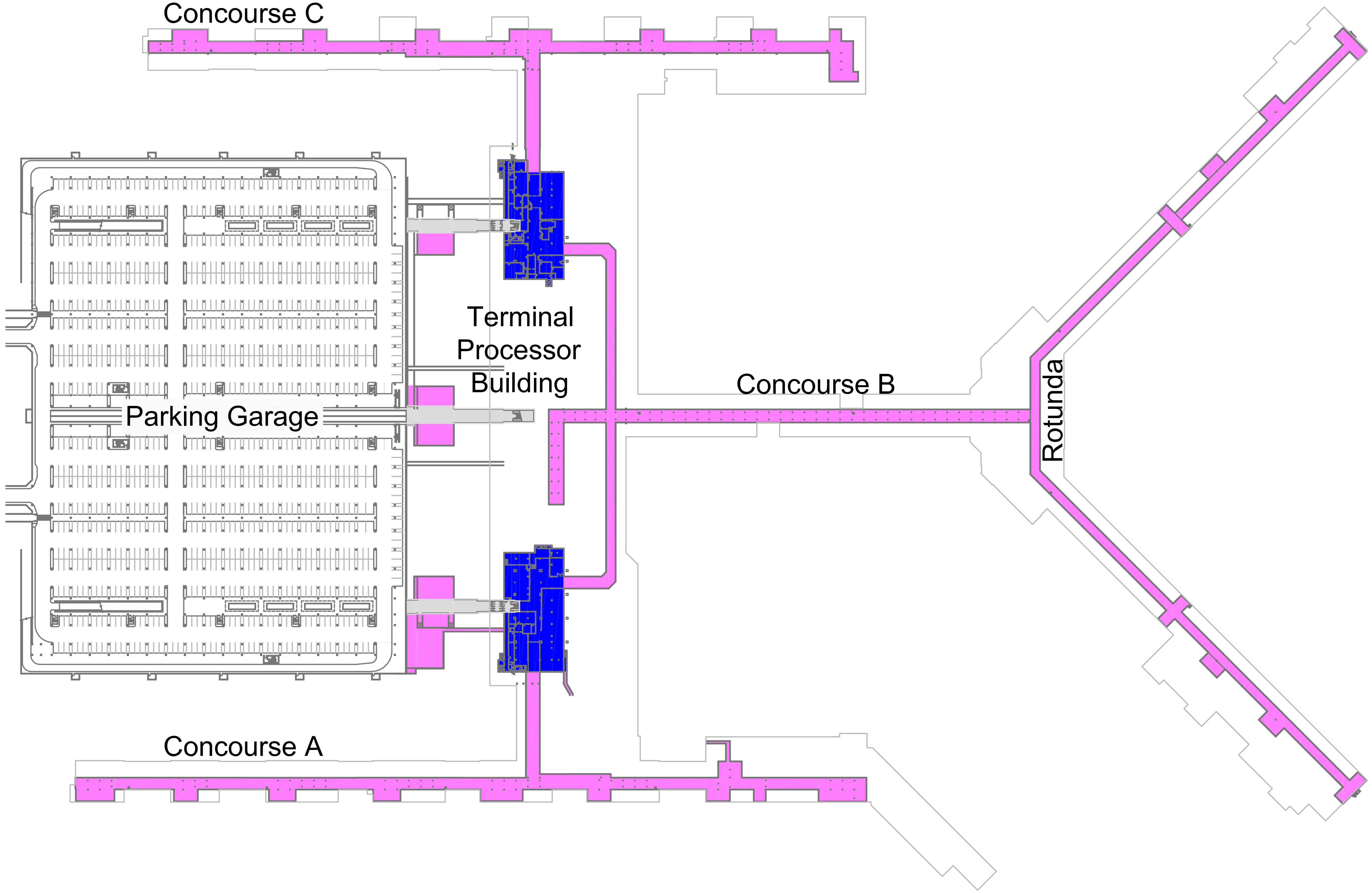
(a) Includes ticket counters, operations space, departure lounges, and secure office space
(b) Includes all space allocated for the Federal Inspection Service
(c) Includes building systems, utilities, and other non-leased spaces within the building
(d) Includes TSA-leased space within the terminal building
(e) Includes vacant Skyport Inn Hotel space in Terminals A and C.

Source: Self Tucker Architects, Inc., based on terminal drawings and interviews with Memphis-Shelby County Airport Authority staff, March 2008.

The second level contains ticket counter check-in positions, airline electronic kiosks for passenger check-in, airline office space, three TSA passenger security screening checkpoints, several concessions spaces in both the sterile and non-sterile areas of the building, a Northwest Airlines World Club lounge, and building mechanical rooms. As of spring 2008, there were several spaces in the non-sterile ticketing and connecting corridors that were vacant and available for tenant lease.

The mezzanine level, which consists of open walkways around the perimeter of each terminal's atrium area as well as enclosed spaces between and at the ends of the terminal buildings, contains primary and executive Authority office space as well as vacant space formerly occupied by the Skyport Inn hotel. Administrative space leased to the concessions' operators is also located on the mezzanine level.

The allocation of space on the ground, second, and mezzanine levels of the main terminal building are depicted on Figure C-3.



LEGEND

- Airport administration
- Building operations, storage, and mechanical
- Public space and circulation

N

0' 100' 200' 400'

Figure C-2
PASSENGER TERMINAL BASEMENT LEVEL

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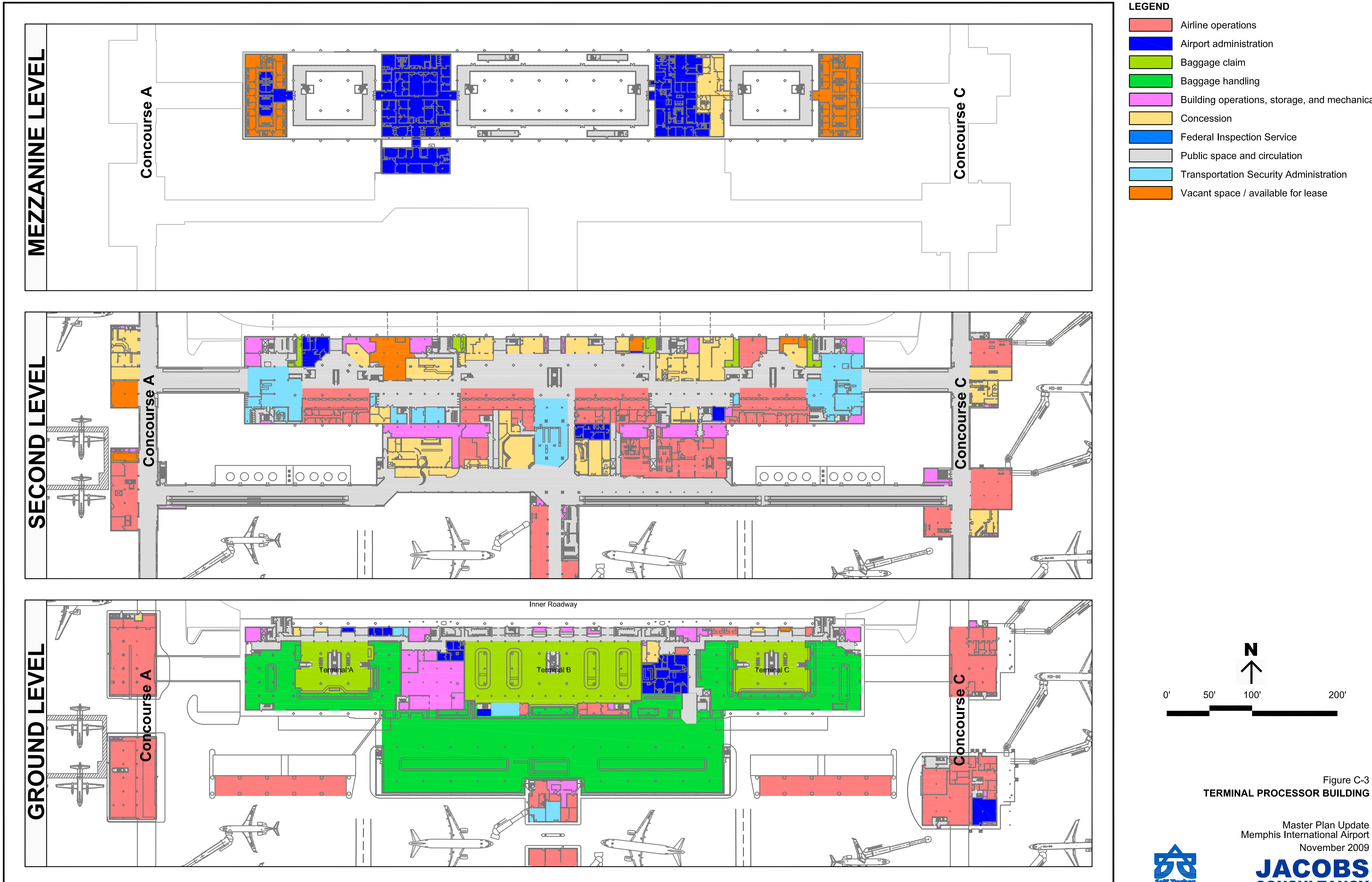

Figure C-3
TERMINAL PROCESSOR BUILDING

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Baggage. Baggage claim facilities are located on the ground level of the main terminal in each of the three buildings. There are two linear claim devices in Terminal A used by Delta Air Lines; four carousel and one linear claim devices in Terminal B used by Continental and Northwest Airlines, and three linear claim devices in Terminal C used by Frontier Airlines, American Airlines, AirTran Airways, United Airlines, and US Airways. All airlines, with the exception of United Airlines, maintain baggage resolution offices in the same terminal as their claim devices to handle passenger baggage inquiries.

Inbound and outbound baggage make-up facilities, in which airline personnel transfer baggage to and from conveyor belt systems onto carts to be transported directly to aircraft, are located on the same level as the claim devices. Baggage originating at the ticketing facilities one level above is transported downstairs via conveyor belt onto baggage carousels or laterals, around which carts are staged and manually loaded. Delta Air Lines has one carousel for outbound baggage make-up in Terminal A; Continental Airlines and US Airways each have a lateral belt for outbound baggage in Terminal B; Northwest Airlines uses two carousels and two lateral belts in Terminal B; AirTran Airways and United Airlines share one lateral belt in Terminal C; and American and Frontier Airlines share one carousel in Terminal C for outbound baggage.

Ticketing. There is a ticketing lobby in each of the three atrium areas on the main terminal's second level that provides positions for airline agents and electronic kiosks to support the checking-in of airline passengers and baggage. In total, there are 93 positions allocated to individual airlines on an exclusive-use basis. The location and number of positions occupied by each airline is summarized in Table C-3. The majority of TSA screening of checked baggage is located in the ticketing lobby. Screening equipment and staff are located behind airline ticket counter positions. Since this is a relatively recent change, airline ticket counters had to be relocated farther away from the wall to allow airline and TSA personnel to have sufficient space in which to work, which further encroached on the open circulation space in each ticketing lobby.

In addition to the baggage and passenger check-in positions provided in the terminal lobbies, skycap service is available to passengers on the curbside of the second-level terminal roadways. Passengers traveling on American Airlines, Delta Air Lines, Northwest Airlines, and United Airlines could obtain a boarding pass and check-in luggage at the curbside. The 14 curbside check-in positions are located along the exterior of the building, with desks for each airline located outside of the appropriate terminal lobby.

Table C-3

AIRLINE TICKETING POSITIONS
Master Plan Update
Memphis International Airport

Airline	Terminal	Agent positions	Kiosk positions *(a)*	Curbside positions	Total
AirTran Airways	C	--	4	--	4
American Airlines	C	4	2	2	8
Continental Airlines	B	2	2	--	4
Delta Air Lines	A	12	8	2	22
Frontier Airlines	C	2	4	--	6
Northwest Airlines	B	6	34	8	48
United Airlines	C	2	4	2	8
US Airways	B	4	3	--	7

(a) Includes kiosks located at both the ticket counter as well as remotely in lobby for passengers not checking baggage.

Source: Self Tucker Architects and Jacobs Consultancy field verification, March 2008.

Passenger Security Screening Checkpoints. There are three passenger security screening checkpoints, one for each terminal lobby, that provide metal detector and x-ray screening of passenger and baggage to facilitate access to the sterile concourse areas. Because the concourses at the Airport are connected to one another via corridors within the sterile area, all of the checkpoints provide access to any terminal gate. In total, there are 10 checkpoint lanes: 2 in Terminal A, 5 in Terminal B, and 3 in Terminal C. A separate queue is provided in Terminal B for first class passengers and elite members of Northwest Airlines' WorldPerks frequent-flyer program. A fourth passenger security screening checkpoint is located at the exit of the FIS on the ground level of Concourse B.

Passenger Concourses

The Airport's three passenger concourses—Concourses A, B, and C—together provide a total of 79 gates available for active loading and unloading of passengers, baggage, and belly cargo. Concourses A and C are linear in a north-south orientation to each side of the main terminal. Concourse B extends southward from the center of the main terminal in a "Y" shape. Both Concourses A and C have sterile connections to Concourse B, allowing for the movement of connecting passengers between gates. The portions of Concourses A and C to the north of the main terminal are single-loaded (i.e., containing passenger gates on only one side), while areas to the south are double-loaded. All portions of Concourse B are double-loaded.

Most of the concourse areas have two levels: an apron level, the majority of which is used by airline tenants, and a passenger level containing passenger gates, departure lounges, concessions, and restrooms. The passenger level in the southern portion of Concourse A, a nine-gate addition that was completed in 2001, has a lower floor elevation than the rest of the concourse and thus does not have any usable apron-level space. This addition was designed and constructed specifically to accommodate the Canadair Regional Jet (CRJ-200) with loading bridges, passenger holdrooms, concessions, and restroom facilities. All concourses contain a partial basement level—shown on Figure C-2—with tunnels used for building mechanical equipment that is directly connected to the main terminal. The basement, ground, and second levels of Concourses A, B, and C are depicted on Figures C-2, C-4, and C-5, respectively. In total, the concourses provide an approximate total of 795,000 square feet of usable space.

Aircraft Gates. Northwest Airlines occupies, on an exclusive-use basis, 67 of the Airport's 79 passenger gates, including all of the gates on Concourse B, all but three gates on Concourse A, and 7 gates on Concourse C. Delta Air Lines uses three gates on Concourse A and the other six passenger airlines use 9 gates on Concourse C. Gates A31 and B44 are not currently in use, although their apron space is used by Northwest Airlines for aircraft parking at adjacent gates A33 and B43, respectively. There are two gates, Gates C20 and C22 at the northern end of Concourse C, that are not currently leased to an airline. A summary of airline gate assignments and aircraft parking capabilities is provided in Table C-4.

Rotunda. In 2005, a renovation to the central portion of Concourse B, where all legs of the "Y" come together, yielded a rotunda space with multiple food, beverage, and retail concessions. The rotunda also contains a mezzanine level that is only accessible to authorized personnel. Northwest Airlines operates a ramp control tower above the rotunda, to oversee the clearance of aircraft to and from their gates located above the passenger level in the central portion of Concourse B.

Federal Inspection Service Screening

Four gates at the southwest end of Concourse B have secure-corridors that connect the passenger loading bridges to the Airport's FIS screening facility, which occupies approximately 40,000 square feet on the apron level beneath Concourse B. The FIS provides immigration processing for passengers arriving from abroad, baggage claim devices, customs screening of baggage, office space for the U.S. Customs and Border Patrol, and a TSA security screening checkpoint. Once arriving passengers and their bags have been processed, an escalator transports them to the passenger concourse level adjacent between Gates B34 and B36.

AIRCRAFT PARKING APRON

Approximately 70 acres of apron are available for aircraft maneuvering and parking at the passenger terminal. The apron is currently configured to accommodate aircraft ranging from small turbo-prop aircraft (Saab 340) to large widebody aircraft (Airbus A330). Currently, there are 88 aircraft parking positions that provide direct access to the terminal via 79 gates. Of these, 76 are equipped with passenger loading bridges while the remaining 12 are accessed via 3 ground-loading gates. The largest aircraft that can be accommodated at each parking position is identified in Table C-4 and depicted on Figures C-4 and C-5.

As shown on Figure C-1, gates on the west side of Concourse A are accessed directly from Taxiway N while a single taxiline connects gates on the east side of Concourse A and west side of Concourse B to Taxiway N. Because of the nearly-symmetrical layout of the passenger terminal, a similar access pattern exists on the eastern side of the complex. Gates on the east side of Concourse C are accessed directly from Taxiway J while a single taxilane connects gates on the west side of Concourse C and the east side of Concourse B to Taxiway J. Gates on the south side of Concourse B are accessed from taxiway intersections P1 and P2.

A system of service roadways circumnavigate the concourses to allow for the safe and efficient movement of ground support equipment and other motorized vehicles on the aircraft apron. These roadways are striped on the apron and depicted on Figures C-4 and C-5. There are several locations beneath all three concourses through which low-clearance ground support equipment can pass, avoiding what can be a lengthy drive around the ends of the concourses.

Table C-4

SUMMARY OF PASSENGER GATES
Master Plan Update
Memphis International Airport

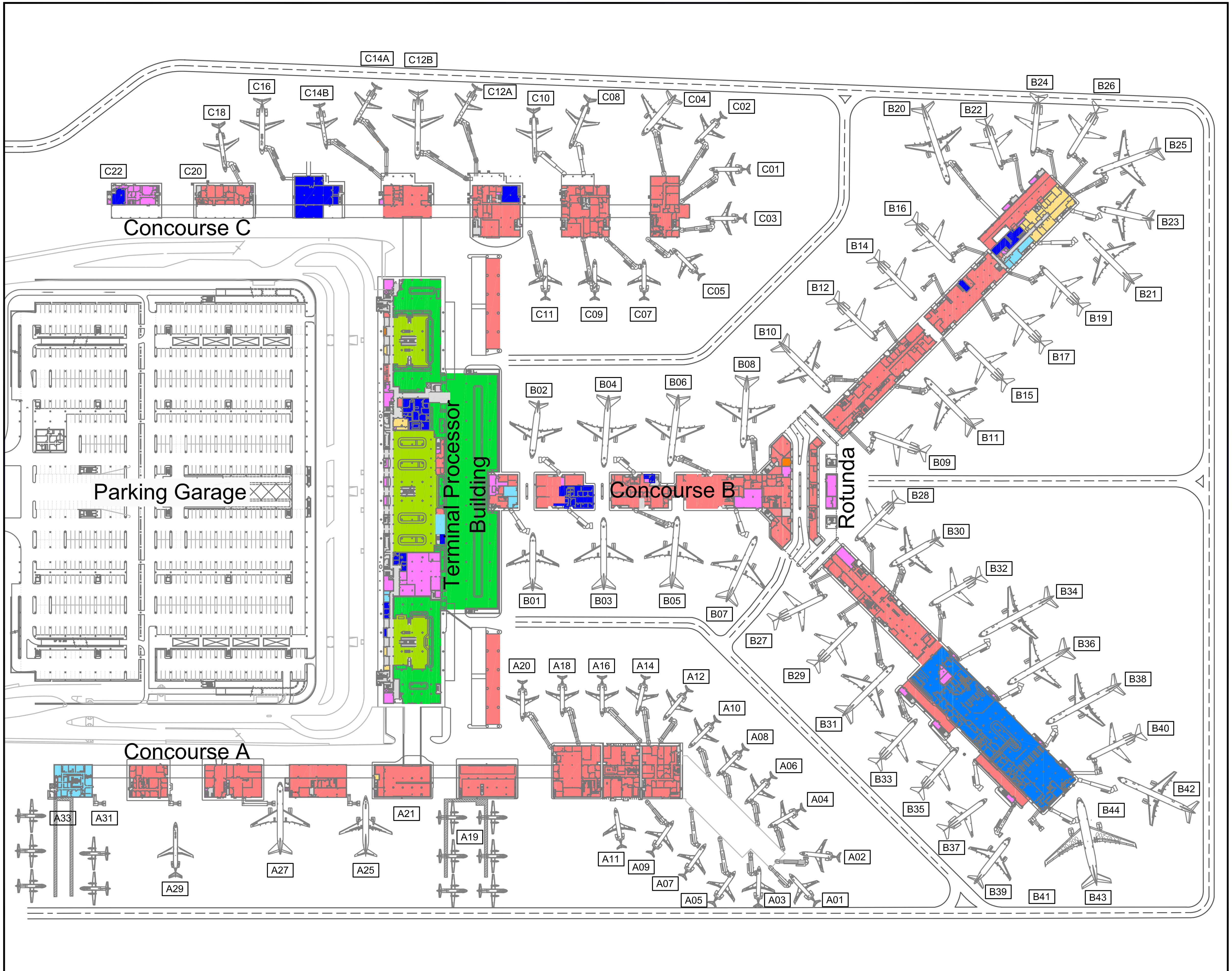
Gate	Airline *(a)*	Gate type	Largest aircraft	Notes
Concourse A				
A1	Northwest Airlines	Bridge	CRJ - 200	
A2	Northwest Airlines	Bridge	CRJ - 200	
A3	Northwest Airlines	Bridge	CRJ - 200	
A4	Northwest Airlines	Bridge	CRJ - 200	
A5	Northwest Airlines	Bridge	CRJ - 200	
A6	Northwest Airlines	Bridge	CRJ - 200	
A7	Northwest Airlines	Bridge	CRJ - 200	
A8	Northwest Airlines	Bridge	CRJ - 200	
A9	Northwest Airlines	Bridge	CRJ - 200	
A10	Northwest Airlines	Bridge	CRJ - 200	
A11	Northwest Airlines	Ground boarding	CRJ - 200	
A12	Northwest Airlines	Bridge	CRJ - 200	
A14	Northwest Airlines	Bridge	CRJ - 200	
A16	Northwest Airlines	Bridge	CRJ - 200	
A18	Northwest Airlines	Bridge	CRJ – 200	
A19	Northwest Airlines	Ground boarding	Saab 340	Gate serves 6 aircraft parking positions
A20	Northwest Airlines	Bridge	CRJ - 200	
A21	Not leased	n.a.	n.a.	Not equipped with loading bridge
A25	Delta Air Lines	Bridge	737 - 800	
A27	Delta Air Lines	Bridge	757 - 200	
A29	Delta Air Lines	Bridge	CRJ - 900	
A31	Northwest Airlines	Bridge	n.a.	Not in use
A33	Northwest Airlines	Ground boarding	Saab 340	Gate serves 5 aircraft parking positions
Concourse B				
B1	Northwest Airlines	Bridge	A320	
B2	Northwest Airlines	Bridge	A320	
B3	Northwest Airlines	Bridge	757 - 200	
B4	Northwest Airlines	Bridge	757 - 200	
B5	Northwest Airlines	Bridge	757 - 200	
B6	Northwest Airlines	Bridge	757 - 200	
B7	Northwest Airlines	Bridge	757 - 200	
B8	Northwest Airlines	Bridge	757 - 200	
B9	Northwest Airlines	Bridge	DC9 - 50	
B10	Northwest Airlines	Bridge	757 - 200	
B11	Northwest Airlines	Bridge	757 - 200	
B12	Northwest Airlines	Bridge	DC9 - 50	
B14	Northwest Airlines	Bridge	DC9 - 50	
B15	Northwest Airlines	Bridge	DC9 - 50	
B16	Northwest Airlines	Bridge	DC9 - 50	
B17	Northwest Airlines	Bridge	DC9 - 50	
B19	Northwest Airlines	Bridge	DC9 - 50	
B20	Northwest Airlines	Bridge	757 - 300	
B21	Northwest Airlines	Bridge	757 - 200	
B22	Northwest Airlines	Bridge	DC9 - 30	
B23	Northwest Airlines	Bridge	A320	
B24	Northwest Airlines	Bridge	DC9 - 50	
B25	Northwest Airlines	Bridge	757 - 200	
B26	Northwest Airlines	Bridge	DC9 - 50	
B27	Northwest Airlines	Bridge	DC9 - 50	
B28	Northwest Airlines	Bridge	DC9 - 50	
B29	Northwest Airlines	Bridge	DC9 - 50	
B30	Northwest Airlines	Bridge	A320	

Table C-4 *(page 2 of 2)*
SUMMARY OF PASSENGER GATES
Master Plan Update
Memphis International Airport

Gate	Airline *(a)*	Gate type	Largest aircraft	Notes
Concourse B *(continued)*				
B31	Northwest Airlines	Bridge	757 - 200	
B32	Northwest Airlines	Bridge	DC9 - 50	
B33	Northwest Airlines	Bridge	DC9 - 50	
B34	Northwest Airlines	Bridge	757 - 300	Can accommodate the 747-400 when Gates B32 and 36 are vacant
B35	Northwest Airlines	Bridge	DC9 - 50	
B36	Northwest Airlines	Bridge	757 - 200	
B37	Northwest Airlines	Bridge	DC9 - 30	
B38	Northwest Airlines	Bridge	757 - 300	
B39	Northwest Airlines	Bridge	A320	
B40	Northwest Airlines	Bridge	DC9 - 50	FIS access
B41	Northwest Airlines	Bridge	A320	FIS access
B42	Northwest Airlines	Bridge	757 - 200	FIS access
B43	Northwest Airlines	Bridge	A330 - 200	FIS access; A330 - 200 prevents using Gate B41
B44	Northwest Airlines	Not used	n.a.	FIS access; Gate not equipped with loading bridge
Concourse C				
C1	Northwest Airlines	Bridge	CRJ - 200	
C2	Northwest Airlines	Bridge	CRJ - 200	
C3	Northwest Airlines	Bridge	CRJ - 200	
C4	Frontier Airlines	Bridge	A319	
C5	Northwest Airlines	Bridge	CRJ - 200	
C7	Northwest Airlines	Bridge	CRJ - 200	
C8	US Airways	Bridge	CRJ - 900	
C9	Northwest Airlines	Bridge	CRJ - 200	
C10	US Airways	Bridge	CRJ - 900	
C11	Northwest Airlines	Bridge	CRJ - 200	
C12A	American Airlines	Bridge	ERJ - 145	
C12B	American Airlines	Bridge	MD - 80	
C14A	Continental Airlines	Bridge	ERJ 145	
C14B	Continental Airlines	Bridge	ERJ - 145	
C16	AirTran Airways	Bridge	717	
C18	United Airlines	Bridge	CRJ - 700	
C20	Not leased	Not used	n.a.	
C22	Not leased	Not used	n.a.	

(a) Includes each airline's regional affiliates.

Source: Memphis-Shelby County Airport Authority records and Jacobs Consultancy site observations, April 2008.



LEGEND

- Airline operations
- Airport administration
- Baggage claim
- Baggage handling
- Building operations, storage, and mechanical
- Concession
- Federal Inspection Service
- Public space and circulation
- Transportation Security Administration
- B11 Gate number

Figure C-4
PASSENGER TERMINAL
GROUND LEVEL

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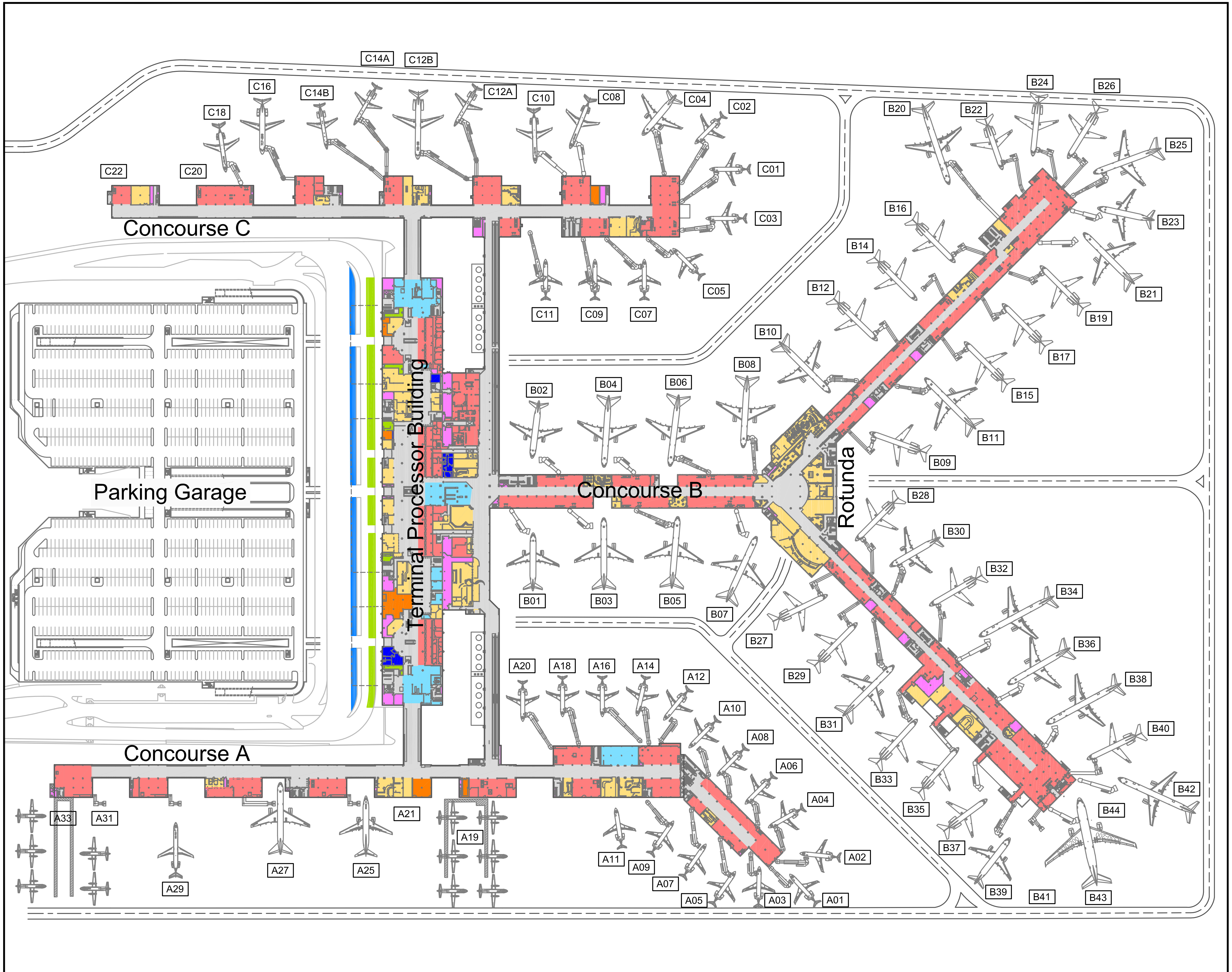

LEGEND

- Airline operations
- Airport administration
- Baggage claim
- Baggage handling
- Building operations, storage, and mechanical
- Concession
- Federal Inspection Service
- Public space and circulation
- Transportation Security Administration
- Vacant space / available for lease
- B11 Gate number

N

0' 100' 200' 400'

Figure C-5
PASSENGER TERMINAL SECOND LEVEL

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Technical Memorandum–D

GROUND TRANSPORTATION AND PARKING

This Technical Memorandum summarizes the Airport's existing ground access and parking facilities, and the current levels of activity occurring at those facilities. Figure D-1 depicts key ground access and parking facilities referenced throughout.

DATA SOURCES AND ASSUMPTIONS

Previously prepared reports, available traffic data, and surveys of on-Airport traffic were reviewed to assess existing levels of activity on the Airport's ground transportation and parking facilities. The following identifies the time and location of traffic surveys conducted as part of this Master Plan (see Figures D-1 and D-2).

- Turning movement counts at the following intersections:

  – Winchester Road and Airways Boulevard (February 15, 2005)
  – Winchester Road and Plough Boulevard (February 17, 2005)
  – Winchester and Swinnea roads (July 22, 2005)
  – Winchester and Tchulahoma roads (August 12, 2005)

- Automatic traffic recorder counts at the locations depicted on Figures D-1 and D-2 (February 12 and March 3, 2008, one week at each location)

- Turning movement counts at the locations depicted on Figures D-1 and D-2 (peak periods between February 15 and 22, 2008)

- Vehicle classification counts on the Upper and Lower level Passenger Terminal curbside roadways (February 17 and 18, 2008)

- Curbside dwell time surveys counts conducted on the Upper and Lower level curbside roadways (February 17 and 18, 2008)

- Pedestrian crosswalk activity survey conducted on the Upper and Lower level curbside roadways (February 17 and 18, 2008)

There are several ground transportation improvements that will be completed in the near term that are considered part of the existing or “baseline” conditions at the Airport. These projects, which are depicted on Figures A-5 and D-1, and described below:

- Construction of a 500-space East surface parking lot to the north of Concourse C.
- Construction of a 3,500-space, seven-level parking garage on area currently occupied by a 976 spaces of the Center surface parking lot.
- Conversion of 700 employee parking spaces controlled by the Authority in the Democrat Road parking lot and construction of a 1,800-space addition to the lot for FedEx employee parking.

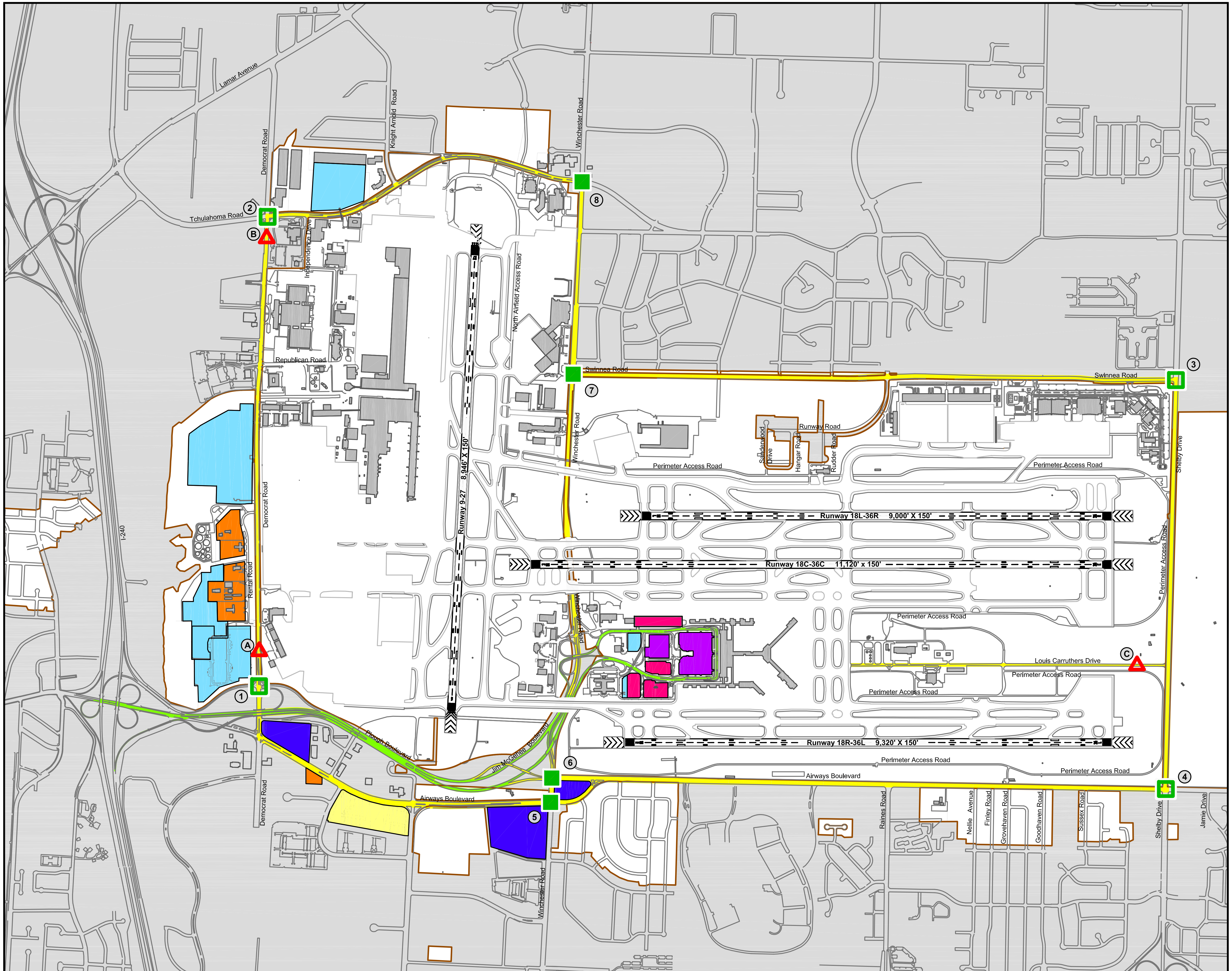
PASSENGER TERMINAL CIRCULATION ROADWAYS

Plough Boulevard, a four-lane divided highway, provides the principal access route between I-240 and the Passenger Terminal complex. As southbound Plough Boulevard enters the Passenger Terminal complex, it merges with a ramp from westbound Winchester Road to form a one-way loop road, which travels counter-clockwise through the complex. The loop road provides access to the Passenger Terminal curbsides, all public and employee parking facilities in the Passenger Terminal complex, commercial vehicle staging areas, and the ATCTA. Drivers departing the Passenger Terminal complex on the loop road have the option of exiting to northbound Plough Boulevard, westbound Winchester Road, or eastbound Winchester Road; or recirculate back to the terminal curbsides and parking facilities.

Figure D-2, in combination with Table D-1 presents hourly traffic volumes on key Passenger Terminal complex roadways during peak periods. Traffic volumes will be adjusted to reflect peak month (May) conditions during subsequent phases of the Master Plan.

TERMINAL CURBSIDE FACILITIES

On both levels curbside parking activity is distributed proportionally amongst the three terminals, based on the level of airline activity associated with each terminal during the survey period. Thus, given the high share of passenger traffic carried by Northwest Airlines, most curbside parking activity occurred in front of Terminal B. The following describes the physical layout and use of the Upper and Lower-level roadways and curbsides.



LEGEND

- Airport property line
- Airport perimeter roadways
- Primary access and terminal circulation
- Employee surface parking
- Off-airport parking facilities
- Public parking--surface
- Public parking--structure
- Rental car facilities
- Memphis Area Transit Authority bus terminal

DATA COLLECTION LEGEND

- Traffic volume count [February 2008]
- Turning movement count [February 2008]
- Turning movement count [2005]
- 1 Intersection identifier [see Table D-10]
- A Traffic volume identifier [see Table D-8]

N

0' 900' 1,800' 3,600'

Figure D-1
GROUND TRANSPORTATION ACCESS AND PARKING FACILITIES

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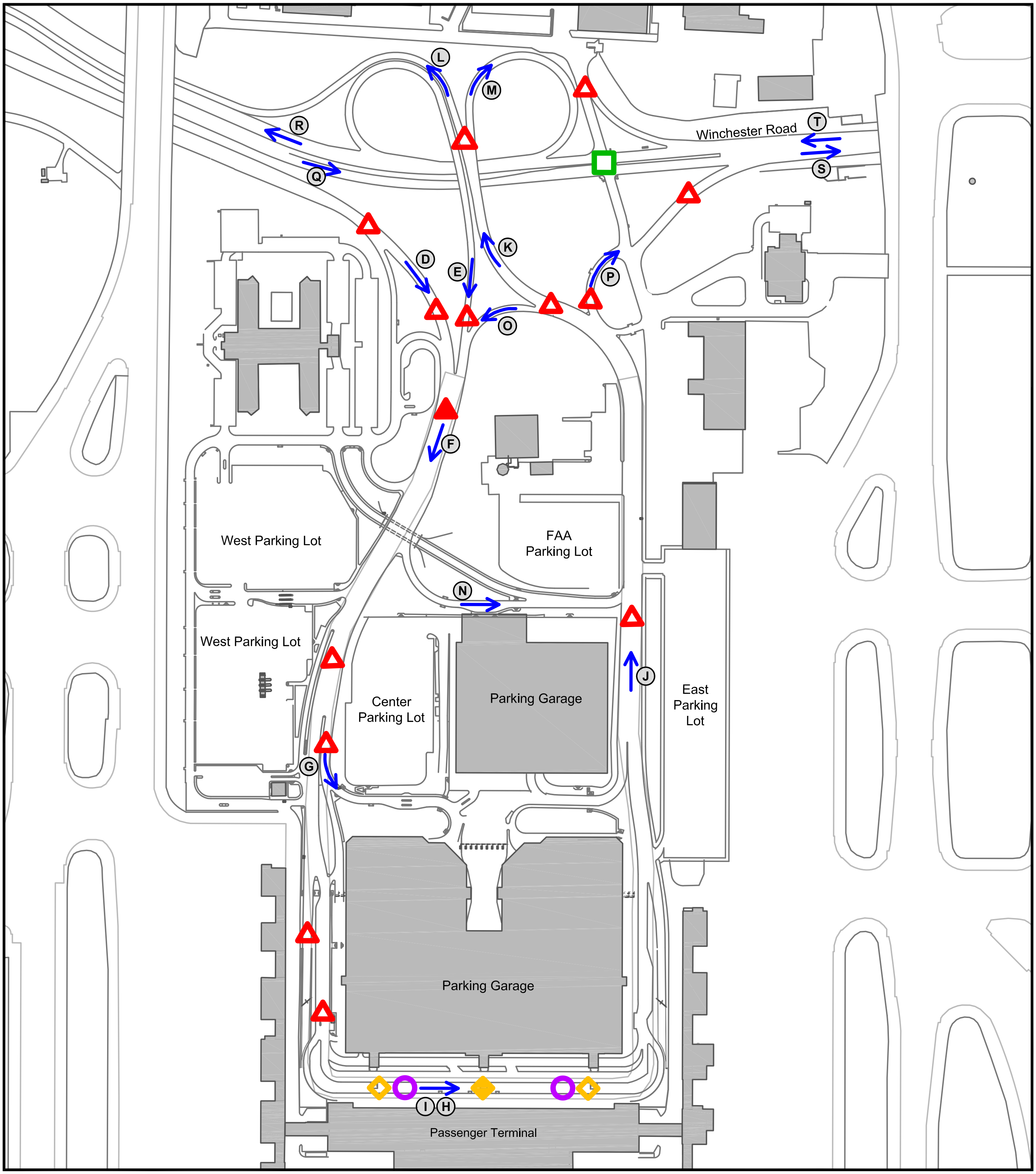

LEGEND

- Traffic volume count [February 2008]
- Traffic volume count [2005 and 2007]
- Turning movement count [February 2008]
- Vehicle classification survey [February 2008]
- Pedestrian survey [February 2008]
- Dwell time survey [February 2008]
- Traffic volume link location
- D Link identifier [see Table D-1]

N

0 200' 400' 800'

Figure D-2

DATA COLLECTION LOCATIONS
PASSENGER TERMINAL COMPLEX

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Upper Level Roadway

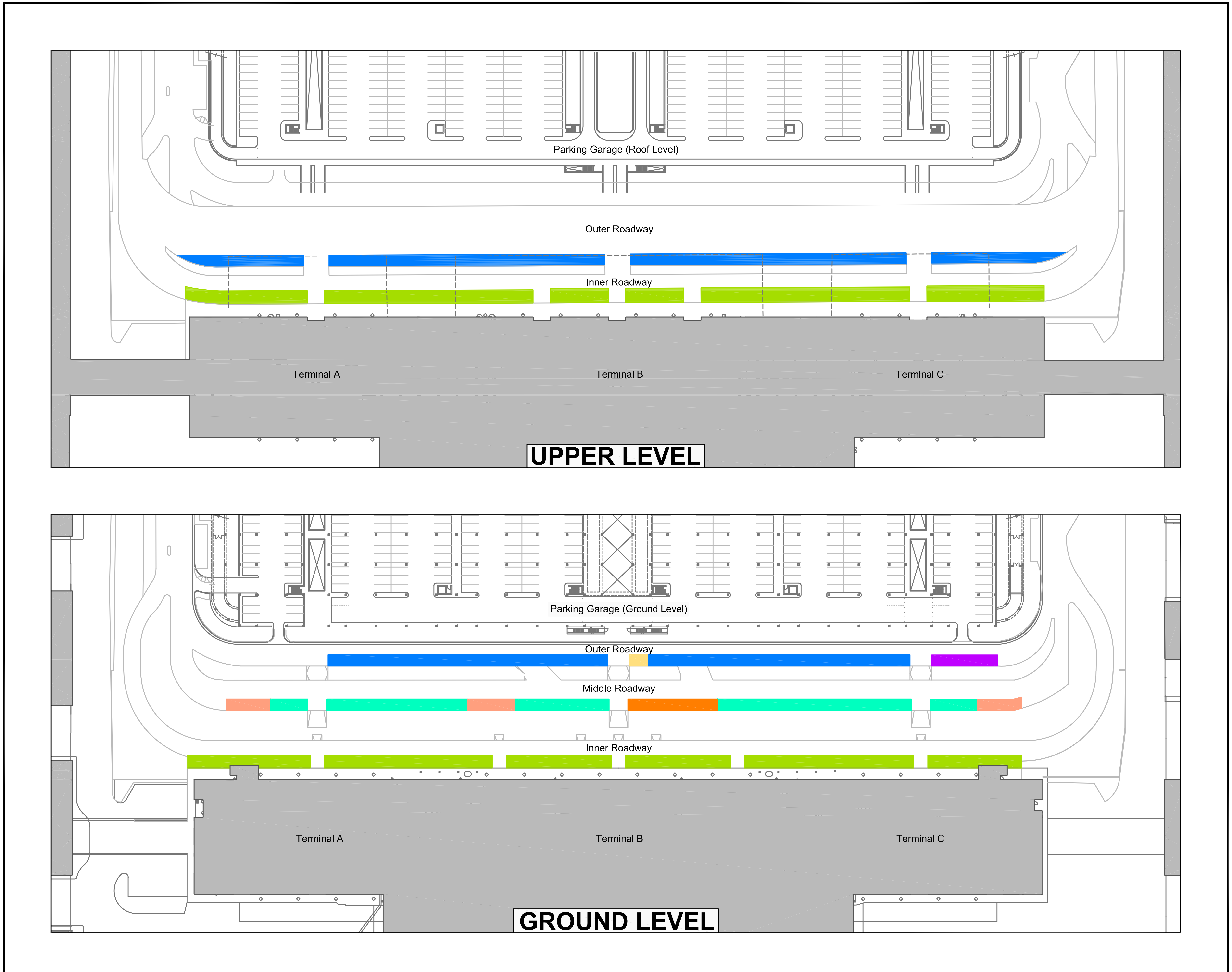
Drivers dropping off passengers at the Passenger Terminal typically use the Upper Level roadway. The Upper Level roadway, shown on Figure D-3, is comprised of an inner and outer roadway. The three-lane inner roadway, used by private vehicles, taxicabs, and limousines, provides approximately 825 linear feet of curbside (not including area reserved for 3 crosswalks) and includes one parking lane, a maneuvering lane, and a through lane (all lanes are approximately 12 feet wide). The two-lane outer roadway, used by all other commercial vehicles, provides approximately 825 linear feet of curbside and includes one 20-foot-wide parking/ maneuvering lane and one 12-foot-wide through lane. Three pedestrian crosswalks provide access across the Upper Level roadway and connect the ticketing lobbies in the Passenger Terminal, the outer curbside, and the roof of the parking garage.

As shown in Table D-1, during the Airport's busiest morning hour, 390 vehicles used the Upper Level roadway (identified in Table D-1 as link "I"). Of these vehicles, approximately 75% used the inner curb and 25% used the outer curb.

Ground Level Roadway

Drivers picking up passengers at the Passenger Terminal typically use the Ground Level roadway. The Ground Level roadway, shown on Figure D-3, is comprised of an inner, middle, and outer roadway. The three-lane inner curbside, used exclusively by private vehicles, provides approximately 810 linear feet of curbside (not including area reserved for 6 crosswalks) and includes one parking lane, a maneuvering lane, and a through lane (all lanes are approximately 10 feet wide). The two-lane middle curbside, reserved for taxicabs and courtesy vehicles operated by rental car and hotel/motel operators, provides approximately 840 linear feet of curbside (not counting area reserved for 4 crosswalks) and includes one 18-foot-wide parking lane and a 13-foot-wide through lane. The two-lane outer curbside, reserved for all other commercial vehicles (including charter vehicles, Airport parking shuttles, off-Airport parking shuttles, MATA public transit buses, and shuttles serving FedEx, FBOs, a hospital, and a nearby military base), provides approximately 855 linear feet of curbside (not counting area reserved for 3 crosswalks) and includes one parking lane and one through lane (both lanes are approximately 12 feet wide).

Six pedestrian crosswalks provide access between the baggage claim areas of the Passenger Terminal and the middle curbside, with three continuing to the outer curbside and ground level of the parking garage. Vehicular access to the middle and outer curbsides is controlled by a gate arm that is activated either automatically by an AVI tag within the vehicle or manually by Authority staff.



LEGEND

Terminal building

Upper Level Roadway

- Commercial vehicles
- Private vehicles, taxicabs, and limousines

Ground Level Roadway

- Dedicated shuttles (e.g., FedEx)
- Hotel courtesy shuttles
- Memphis Area Transit Authority buses
- Miscellaneous commercial vehicles
- Private vehicles
- Rental car courtesy shuttles
- Taxicabs

N

0' 50' 100' 200'

Figure D-3
CURBSIDE ROADWAYS AND FRONTAGE

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Memphis International Airport
November 2009

JACOBS CONSULTANCY

Table D-1

PASSENGER TERMINAL COMPLEX PEAK HOUR TRAFFIC VOLUMES
Master Plan Update
Memphis International Airport

Link identifier *(a, b)*	Morning peak *(c)*	Evening peak *(d)*
D	680	540
E	80	70
F	930	990
G	350	250
H	180	530
I	390	210
J	610	1,160
K	390	710
L	310	600
M	90	110
N	30	60
O	170	380
P	60	100
Q	2,000	1,570
R	2,180	1,740
S	1,900	1,520
T	2,200	1,700

(a) See Figure D-2 for link locations
(b) Links A, B, and C are perimeter Airport roadways
(c) Based on traffic counts conducted Monday, February 26, 2008, between 7 a.m. and 8 a.m.
(d) Based on traffic counts conducted Friday, February 23, 2008, between 6 p.m. and 7 p.m.

Source: Traffic count and intersection turning movement survey, Pickering Firm, February 12 - March 3, 2008.

As shown on Table D-1, during the busiest evening hour, 530 vehicles used the Ground Level roadway (identified in Table D-1 as link H). Of these vehicles, approximately 58% used the inner curbside, 38% used the middle curbside, and approximately 4% used the outer curbside.

Vehicle Classifications

A summary of the vehicular fleet mix on the Ground and Upper Level roadways is provided in Table D-2.

Table D-2

CURBSIDE ROADWAYS VEHICLE CLASSIFICATION AND DWELL TIMES
Master Plan Update
Memphis International Airport

	Fleet mix *(b)*		Dwell time *(c)*	
Vehicle class	Upper Level	Ground Level	Upper Level	Ground Level
Private automobile	75%	64%	101	92
Taxicab	4	9	112	*(d)*
Limousine	<1	<1	--	*(e)*
Hotel/motel courtesy vehicle	7	4	67	*(e)*
Rental car shuttle	6	11	31	*(e)*
Airport public parking shuttle *(a)*	n.a.	3	43	*(e)*
Off-Airport public parking shuttle	7	6	35	*(e)*
Employee parking shuttle *(a)*	n.a.	1	38	*(e)*
Other dedicated shuttles (FedEx, hospital, FBOs, casinos, military)	<1	<1	--	*(e)*
Charter bus	<1	<1	--	*(e)*
Public transit (MATA) *(a)*	n.a.	<1	n.a.	*(e)*
Other (motorcycle, police)	<1	<1	--	*(e)*
Total	100%	100%		

n.a. = Vehicle class does not operate on this level.
-- = Survey sample too limited to identify average dwell time

(a) Vehicle class operates on a schedule.
(b) Vehicle classification and fleet mix is for the peak period.
(c) Dwell times in seconds.
(d) Vehicle class operates on an on-call basis and must have vehicles available at curbside at all times.
(e) Vehicle class allowed to dwell at the curbsides for up to 15 minutes; surveys may not accurately represent amount of time required to load passengers.

Note: Vehicle classification and dwell time surveys conducted Sunday, February 17, 2008, between 5:15 p.m. and 8:15 p.m., and Monday, February 18, 2008, between 6:55 a.m. and 8:55 a.m., Jacobs Consultancy and Pickering Firm.

Source: Automatic vehicle identifier trip transaction logs, Memphis-Shelby County Airport Authority, February 2008.

Curbside Dwell Times

Table D-2 summarizes the results of curbside dwell time surveys conducted during peak periods on the Ground and Upper level roadways. As shown, no dwell time data is provided for commercial vehicles on the Ground Level. Airport policy allows commercial vehicle drivers to park for up to 15 minutes on the Ground Level during each trip (taxicabs are excluded from this limit).

Pedestrian Activity

As described above, the Upper Level curbside is crossed by three crosswalks extending from the Passenger Terminal to the parking garage. On the Ground Level, six crosswalks extend from the doorways to the middle curbside and three crosswalks extend from the middle curbside to the parking garage. Table D-3 presents summary findings regarding the pedestrian traffic in these crosswalks.

Table D-3

PEDESTRIAN SURVEY RESULTS
Master Plan Update
Memphis International Airport

	Ground Level *(a)*	Upper Level *(b)*
Number of pedestrian groups	18	23
Average number of pedestrians per group	6.1	2.4
Average time required to cross roadway (seconds)	12.4	8.1
Total duration of crossings (minutes)	3.7	3.1
Number of groups where traffic enforcement actively controlled the crosswalk	15	1

(a) Survey conducted on Monday, February 18, 2008, between 7:10 a.m. and 7:20 a.m.
(b) Survey conducted on Sunday, February 17, 2008, between 7:00 p.m. and 7:10 p.m.

Source: Traffic surveys, Jacobs Consultancy, February 2008.

PARKING FACILITIES

The following summarizes on- and off-Airport public and employee parking facilities.

On-Airport Public Parking

On-Airport public parking is currently available in a three-level garage and two surface lots as shown on Figure D-1. Short Term parking is available in the garage and Long Term parking is available in both the garage and the surface lots. For passengers using Long Term parking, the Airport provides a shuttle bus between the parking facilities and the Ground Level curbside. Table D-4 summarizes the spaces available in each facility.

Table D-4

ON-AIRPORT PUBLIC PARKING FACILITIES
Master Plan Update
Memphis International Airport

Facility	Existing	Baseline *(a)*
Garages		
Short Term	871	871
Long Term *(a)*	1,878	4,628
Total	2,749	5,499
Surface Lots		
Center	976	--
East *(b)*	--	--
West	699	699
Total	1,675	699
Grand total	4,424	6,198

(a) Baseline includes additional public parking capacity after completion of the planned parking garage.
(b) The East Lot will provide approximately 1,000 additional spaces of public parking on a temporary basis during construction of the planned parking garage.

Source: Memphis-Shelby County Airport Authority, March 2008.

Historical transactions and parking revenues for both Short and Long Term parking facilities since 2002 are provided in Table D-5. Average monthly transactions since 2002 are summarized in Figure D-4. As shown, Short Term transactions vary seasonally with May, June, and July experiencing higher transaction volumes than other months. In contrast, Long Term parking transactions experience less variability throughout the year.

Each day during the year, the Airport counts the maximum number of parked cars in each public parking facility. Table D-6 presents the highest occupancy, and the 10th, 20th, and 30th highest occupancies experienced during 2007 for the Short-Term parking section of the garage, the Long-Term parking facilities, and the combined occupancies.

Table D-5

HISTORICAL PUBLIC PARKING REVENUES
Master Plan Update
Memphis International Airport

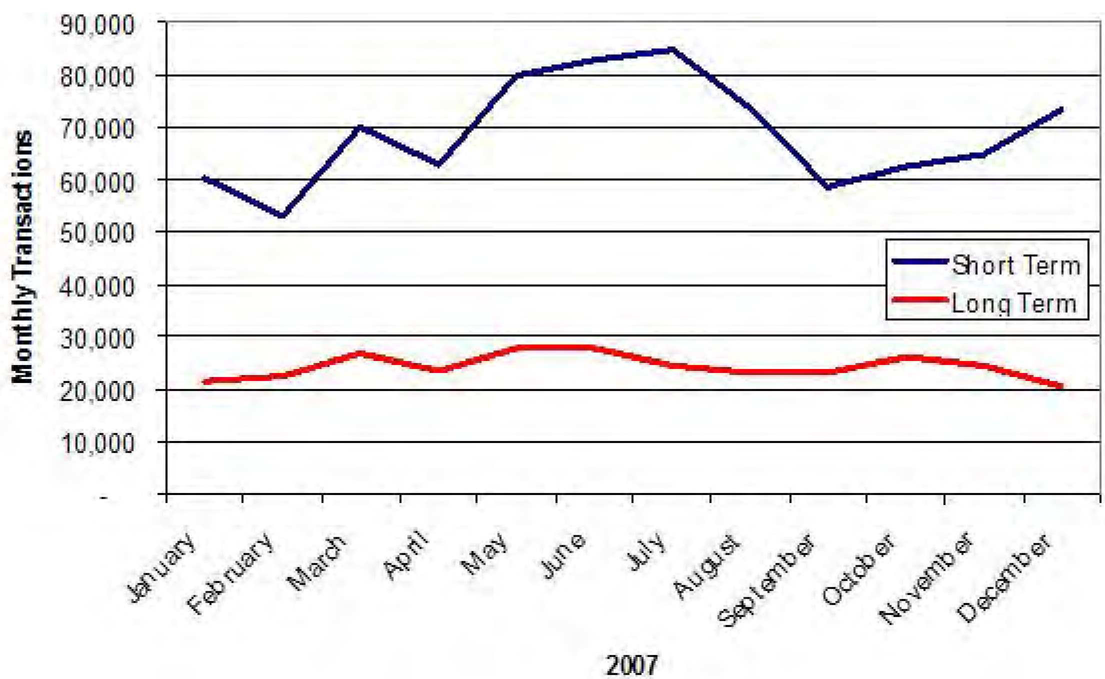
	Short Term		Long Term *(a)*		Total	
	Transactions	Revenues	Transactions	Revenues	Transactions	Revenues
2002	797,573	$2,618,244	280,228	$7,451,924	1,077,081	$10,070,168
2003	725,589	2,585,907	254,937	7,359,889	980,526	9,945,796
2004	773,070	2,794,103	274,619	7,952,448	1,044,689	10,746,551
2005	818,057	3,024,880	287,426	8,609,275	1,105,483	11,634,155
2006	820,496	3,171,550	288,283	9,026,718	1,108,779	12,198,268
2007	823,780	3,217,210	289,436	9,156,676	1,113,216	12,373,886

(a) Includes activity in the Central and West Lots.

Source: Parking activity reports, Memphis-Shelby County Airport Authority, November 2009.

Figure D-4

MONTHLY PARKING TRANSACTIONS
Master Plan Update
Memphis International Airport



MEM548-1

Table D-6

ON-AIRPORT PEAK PARKING OCCUPANCIES
Master Plan Update
Memphis International Airport

Facility	Highest day	10th highest day	20th highest day	30th highest day
Public Parking				
Short Term	1,072	987	835	793
Long Term	3,264	3,071	2,982	2,933
Combined	4,120	3,981	3,785	3,704
Employee Parking				
Surface Lots	1,666	1,585	1,574	1,555

Source: Parking activity reports for calendar year 2007, Memphis-Shelby County Airport Authority, March 2008.

Off-Airport Public Parking

In addition to public parking operated by the Airport, three privately-operated off-Airport parking facilities are available nearby. These facilities are surface lots and offer a mix of covered and uncovered parking. The name, location, capacity, peak occupancy (as estimated by Authority staff), and annual revenues collected by each off-Airport operator are presented in Table D-7.

Employee Parking

Currently, the Airport provides employee parking in the Democrat Road Lot (3,150 spaces) and a portion of the West Lot (205 spaces). The locations of these facilities are depicted on Figure D-1. These surface parking lots accommodate Authority staff in addition to other staff working in the Passenger Terminal complex. Based on Authority estimates, approximately 250 to 300 employee vehicles may be parked in the Short Term parking area during peak periods, and up to 20 vehicles may be parked in the Long Term parking areas. Table D-6 presents the highest occupancy, and the 10th, 20th, and 30th highest occupancies experienced during 2007 for the combined Airport-operated employee parking facilities.

Access to Airport-operated employee parking lots is provided to qualifying personnel via an access control system. The Authority provides a dedicated shuttle bus between the Democrat Road Lot and the Passenger Terminal and allows employees who park in the West Lot to use the public parking shuttle bus serving the West and Center lots.

Table D-7

OFF-AIRPORT PARKING FACILITIES
Master Plan Update
Memphis International Airport

Facility	Location	Capacity	Peak occupancy	Annual revenues
Airport Fast Park	Winchester Rd., between Airways Blvd. and Plough Rd.	500	> 100%	$1.26 million
Fastrack	Democrat Rd., west of Plough Rd.	951	> 100%	$1.96 million
Parkit Here *(a)*	Airways Blvd., north of Winchester Rd.	820	85% (uncovered) 100% (covered)	$0.76 million

(a) Offers covered and uncovered parking.

Source: Memphis-Shelby County Airport Authority staff, March 2008.

FedEx and other tenants outside the Passenger Terminal complex provide employee parking within their lease areas. Of these tenants, only FedEx requires independent parking lots that are not be located immediately adjacent to their employees' work site. FedEx provides approximately 61 acres of employee parking containing approximately 8,200 spaces, which including the lot expansion discussed in "Baseline Conditions."

RENTAL CAR FACILITIES

Eight rental car operators currently serve the Airport. Seven of these brands (Alamo, Avis, Budget, Dollar, Hertz, National, and Thrifty) lease a combined 23 acres of Airport property north of Democrat Road for their ready/return area, customer service building, and service centers. One brand, Enterprise, operates on off-Airport property east of Democrat Road on Airways Boulevard. The location of these facilities is provided on Figure D-1. Rental car operators provide shuttle service between the ready/return areas and the Passenger Terminal.

COMMERCIAL VEHICLE FACILITIES

In addition to the passenger pickup areas provided on the middle and outer curbsides of the Lower Level, the Airport provides two additional parking/staging areas for commercial vehicles:

- **Taxicab Hold Lot –** The Taxicab Hold Lot, a 53-space lot located off of the roadway approaching the Passenger Terminal, immediately south of the West Lot, provides a place for taxicabs to park while waiting to be dispatched to the taxicab queue on the Lower Level roadway. Authority staff estimate this lot rarely approaches capacity during busy periods.

- **Commercial Staging Lane –** The commercial vehicle staging lane, the right lane of the roadway approaching the Passenger Terminal, immediately north of the access point for the Lower Level inner curbside, accommodates up to six courtesy vans (or up to three buses) waiting to enter the middle or outer curbsides of the Lower Level. Authority staff indicate that this lane may periodically fill to capacity, but that is often due to illegal use of the area by private vehicles.

AIRPORT PERIMETER ROADWAYS AND INTERSECTIONS

Access to areas outside of the Passenger Terminal complex is provided via Democrat Road, Airways Boulevard, Shelby Drive, Louis Carruthers Drive, Swinnea Road, and Tchulahoma Road, as shown on Figure D-1. Table D-8, presents hourly traffic volumes on key non-Passenger Terminal complex roadways (locations are identified on Figure D-1), as observed during the February 2008 traffic surveys, during three peak periods.

Table D-8

NON-TERMINAL AREA PEAK HOUR TRAFFIC VOLUMES
Master Plan Update
Memphis International Airport

	Morning peak *(a)*		Evening peak *(b)*		Peak for link and direction	
Link identifier	Westbound/ Northbound	Eastbound/ Southbound	Westbound/ Northbound	Eastbound/ Southbound	Westbound/ Northbound	Eastbound/ Southbound
A	841	327	422	559	967 *(c)*	1,512 *(d)*
B	434	626	530	399	1,126 *(e)*	1,084 *(f)*
C	27	35	84	78	161 *(g)*	328 *(h)*

(a) Monday, 7:00 a.m. to 8:00 a.m.
(b) Friday, 6:00 p.m. to 7:00 p.m.
(c) Wednesday, February 13, 2008, 7:00 a.m. to 8:00 a.m.
(d) Tuesday, February 12, 2008, 4:00 p.m. to 5:00 p.m.
(e) Wednesday, February 13, 2008, 3:00 p.m. to 4:00 p.m.
(f) Tuesday, February 12, 2008, 10:00 p.m. to 11:00 p.m.
(g) Tuesday, February 12, 2008, 5:00 p.m. to 6:00 p.m.
(h) Tuesday, February 12, 2008, 5:00 p.m. to 6:00 p.m.

Source: Traffic surveys, Jacobs Consultancy, February 2008.

Table D-9 summarizes the distribution of the counted vehicles. Table D-10 summarizes peak period intersection turning movement counts conducted for the Master Plan in February 2008 and by the City of Memphis in 2005. Hours shown are for the hour experiencing the highest total intersection volume during four consecutive 15-minute periods.

PUBLIC TRANSIT

The Memphis Area Transit Authority (MATA) operates two bus routes serving the Airport. Route 2A provides service between the Airport Terminal and MATA's North End Terminal in downtown Memphis hourly during weekdays, and every 90 minutes during weekends. Route 32A provides service between the Airport Terminal, FedEx facilities located on Democrat Road, and the north side of Memphis every 90 minutes during weekdays and Saturdays. MATA is currently evaluating corridor options for extending a light-rail system to the Airport Terminal area or to a station located immediately west of the Airport, at the intersection of Winchester Road and Airways Boulevard. The agency also has plans to develop a bus center on the northwest corner of Brooks Road and Airways Boulevard just west of the Airport.

REGIONAL TRANSPORTATION PLANS

The Memphis Area Metropolitan Planning Organization (the MPO) has evaluated the transportation infrastructure needs for the Memphis area and has recommended the following improvements near the Airport:

- **The interchange of I-240 and Plough Boulevard –** Plans for this interchange are currently being developed by the Tennessee Department of Transportation.

- **The interchange of Plough Boulevard and Winchester Road –** Plans for this interchange are currently being developed by the City of Memphis.

- **Winchester Road, between Plough Boulevard. and Swinnea Road –** The MPO has identified improvements to this roadway as "Network Priority 1" (high-priority) and that improvements are planned to be completed by 2016.

- **Extension of the light-rail system to the Airport –** MATA is evaluating alignment corridors to extend the light-rail system to the Passenger Terminal complex or to a station located immediately west of the Airport, at the intersection of Winchester Road and Airways Boulevard.

As plans for these improvements are developed and finalized, the preferred configuration (if available) for these improvements will be incorporated into planning and development alternatives prepared as part of this Master Plan.

Table D-9

VEHICLE CLASSIFICATION – DEMOCRAT ROAD TRAFFIC SURVEY
Master Plan Update
Memphis International Airport

	Westbound				Eastbound			
	Passenger vehicles	Single-unit trucks	Combinati on trucks	Multi-trailer trucks	Passenger vehicles	Single-unit trucks	Combination trucks	Multi-trailer trucks
Link A: Democrat Road, east of Plough Boulevard								
Sunday	78.1%	17.1%	3.7%	1.2%	71.2%	21.1%	5.5%	1.4%
Monday	78.7	16.3	3.7	1.3	72.0	21.0	5.6	1.3
Tuesday	78.1	16.9	3.8	1.2	72.7	20.5	5.5	1.3
Wednesday	79.7	15.9	3.4	1.1	73.4	19.9	5.6	1.2
Thursday	80.8	13.9	3.2	2.0	70.9	20.8	6.6	1.7
Friday	78.1	17.0	3.7	1.1	70.8	21.8	6.4	1.0
Saturday	76.1	16.8	5.8	1.3	70.3	22.5	6.2	1.0
Entire week	78.6	16.3	4.0	1.3	71.8	21.0	5.9	1.3
Link B: Democrat Road, west of American Way/Tchulahoma Road								
Sunday	94.2%	4.1%	1.4%	0.3%	94.5%	3.9%	1.4%	0.2%
Monday	96.0	2.8	1.1	0.2	92.7	4.7	2.2	0.4
Tuesday	94.3	4.5	1.0	0.2	94.5	3.5	1.6	0.3
Wednesday	92.2	5.1	1.9	0.8	95.0	3.7	1.1	0.3
Thursday	92.7	5.5	1.3	0.5	94.2	3.7	1.7	0.4
Friday	92.4	5.8	1.4	0.3	94.5	3.9	1.2	0.3
Saturday	92.3	6.0	1.2	0.5	93.0	5.5	1.1	0.4
Entire week	93.4	4.9	1.3	0.4	94.2	4.0	1.5	0.3

Links A and B are shown graphically on Figure D-1.

Source: Traffic counts and intersection turning movement surveys conducted for the seven-day period beginning Tuesday February 12, 2008, Pickering Firm.

MEM548-1

Table D-10

PEAK HOUR TURNING MOVEMENT COUNTS – AIRPORT PERIMETER INTERSECTIONS
Master Plan Update
Memphis International Airport

Intersection identifier *(a)*	Location	From east			From west			From north			From south		
		Left	Straight	Right	Left	Straight	Right	Left	Straight	Right	Left	Straight	Right
1 *(b)*	Democrat Rd. and Plough Blvd.	45	397	155	94	761	139	--	--	--	106	--	269
2 *(c)*	Democrat Rd. and Tchulahoma Rd.	19	222	38	175	99	192	34	744	570	280	415	11
3 *(d)*	Swinnea Rd. and Shelby Dr.	--	1,753	139	134	1,391	--	160	0	338	--	--	--
4 *(e)*	Airways Blvd. and Swinnea Rd.	313	1,588	166	155	1,162	112	320	742	211	211	478	169
5 *(f)*	Winchester Rd. and Airways Blvd.	164	633	267	125	1,395	80	150	542	284	22	300	118
6 *(g)*	Winchester Rd. and Plough Blvd.	--	1,518	--	--	1,093	194	32	1,045	--	282	1,342	--
7 *(h)*	Winchester Rd. and Swinnea Rd.	8	1,586	430	225	1,031	4	10	0	22	455	1	304
8 *(i)*	Winchester Rd. and Tchulahoma Rd.	165	1,316	91	17	1,316	515	297	459	336	64	719	106

-- = movement not provided at intersection

(a) Intersection locations depicted graphically in Figure D-1.
(b) Friday, February 22, 2008, 7:45 a.m. to 8:45 a.m.
(c) Wednesday, February 20, 2008, 7:30 a.m. to 8:30 a.m.
(d) Monday, February 18, 2008, 3:45 p.m. to 4:45 p.m.
(e) Friday, February 15, 2008, 4:00 p.m. to 5:00 p.m.
(f) Tuesday, February 15, 2005, 12:30 p.m. to 1:30 p.m.
(g) Thursday, February 17, 2005, 8:30 a.m. to 9:30 a.m.
(h) Friday, July 22, 2005, 5:30 a.m. to 6:30 p.m.
(i) Friday, August 12, 2005, 8:15 a.m. to 9:15 a.m.

Source: Intersections 1-4 turning surveys, Jacobs Consultancy, February 2008; Intersections 5-8 turning surveys, City of Memphis, February – August, 2005.

Technical Memorandum–E
AIR CARGO

Air cargo activity at the Airport and surrounding region has grown steadily since the founding of Federal Express (now FedEx) in 1971 by Frederick Smith. The expansion and success of FedEx and other air cargo operators and supporting industries have made Memphis International Airport the busiest air cargo airport in the world. Today, approximately 1,127 acres of Airport land are used for air cargo activities, of which 945 are used by FedEx for their Super-hub facilities. In 2007, the dedicated air cargo carriers operating at the Airport included: FedEx, United Parcel Service (UPS), Air Transport International, Mountain Air, DHL, U.S. Check, Baron Aviation, Kalitta Air, and Bankair, Inc.

Air cargo facilities are depicted on Figure A-2. The FedEx Super-hub sorting facility, aircraft parking aprons, and ancillary support facilities are primarily located in the north airfield, both north and south of Runway 9-27. Because FedEx retains planning authority for their facilities, this Master Plan Update excludes planning related to FedEx facilities; accordingly, FedEx facilities are not inventoried in this memorandum.

UNITED PARCEL SERVICE

UPS operates the Oakhaven Distribution Center, a 300,000 square-foot sorting hub occupying 84 acres on the eastern side of the airfield adjacent to the intersection of Swinnea and Winchester Roads. The hub, which was opened in 1999, is capable of sorting up to 250,000 packages a day that are brought in by both aircraft and trucks. An adjacent aircraft parking apron provides approximately 9 acres for the loading, unloading, and parking of aircraft as large as ADG V.

The facility largely handles packages and freight that originate and are destined for the regional Memphis market. UPS has the option of leasing an additional 50 acres immediately south of the Oakhaven Distribution Center should demand require facility expansion.

U.S. POSTAL SERVICE

The U.S. Postal Service operates a full-service Post Office and 22,000 square-foot sort facility located on a 4-acre site in the support area south of the Passenger Terminal complex. The facility processes incoming and outgoing mail transported through agreements with commercial passenger and cargo carriers operating from the Airport. The Authority is evaluating potential relocation and/or reuse for this site pending future occupancy of the facility by the postal service.

GENERAL AIR CARGO

A 390,000 square-foot Air Cargo Apron is located immediately north of the Passenger Terminal Apron alongside Taxiway C. There are four air cargo warehouses immediately to the west of the apron that were originally planned to provide storage and warehousing for air cargo tenants. However, since many of the carriers that use the apron operate "through-the-fence" and use off-Airport sorting and distribution facilities, the buildings are no longer used for air cargo.

As discussed in "Baseline Conditions," several of these warehouse buildings and the adjacent aircraft parking apron will be demolished in 2008 to accommodate new surface parking lots. At that time, air cargo activities currently using this area will be relocated to the Authority's new cargo development, Cargo Central, on the east side of the airfield. Cargo carriers relocating to Cargo Central include: Air Transport International, Mountain Air, DHL, U.S. Check, Baron Aviation, Kalitta Air, and Bankair, Inc.

CARGO CENTRAL

The Authority began construction on a new 70-acre multi-user air cargo complex in 2006. Phase I was completed in early 2008 and provides users with the following:

- 15 acres of aircraft parking apron sized to simultaneously accommodate six ADG VI aircraft
- 36,000 square feet of specialty office and warehouse space capable of being modified to meet tenant specifications
- Direct access onto local roadway system via Runway and Swinnea Roads
- Secure airfield access to enable vehicles to drive directly to aircraft
- Customs, security, and agricultural screening services
- Land rack and Westpac refueling facility with potential for future storage

As shown on Figure A-5, the ultimate development of the site will accommodate 250,000 square feet of warehouse space and 30 acres of aircraft parking apron. The expansion of warehouse buildings will be phased to meet tenant demand.

Technical Memorandum–F

GENERAL AVIATION AND MILITARY

The Memphis International Airport (the Airport) is home to two Fixed Base Operators (FBOs) serving the general aviation community as well as the 164th Tactical Airlift Wing of the Tennessee Air National Guard, all of which are described in detail below.

GENERAL AVIATION FACILITIES

The Airport's two FBOs—Signature Flight Support and Wilson Air Center—are located in separate areas of the Airport and provide a wide range of services to the general aviation users at the Airport.

Signature Flight Support

As presented on Figures A-3 and F-1, Signature Flight Support (Signature) is located immediately north of Winchester Road between Taxiways N and C and south of Taxiway A. Signature is a wholly-owned subsidiary of BBA Aviation, a worldwide provider of flight support services. This FBO site was previously operated by Memphis Aero Club dating from the 1940s until 1985 when it was purchased by AMR services. In 1999, Signature purchased the FBO and today provides a complete range of general aviation services including aircraft basing, airframe and engine repair and maintenance, flight instruction, ground handling, and aircraft charters. Airfield access is provided via Taxiways A, C, and N. Vehicular access is from Access Road, via Winchester Road.

There are approximately 50 aircraft based at Signature, ranging in size from single engine piston aircraft to corporate jets. In total, the Signature apron encompasses 560,000 square feet, and includes tie-down parking positions for 20 aircraft.

As summarized in Table F-1 and Figure F-1, the Signature site consists of several hangars utilized for aircraft storage and maintenance, as well as the facilities described below.

- **Executive Terminal –** The Executive Terminal is a 5,500 square-foot building that accommodates the FBO's administrative offices, a pilots' lounge and restaurant, and other crew and passenger amenities. The Terminal dates back to 1938, and once served as the Airport's original passenger terminal and administration building.
- **Fuel Farm –** Signature's above ground fuel farm is adjacent to Hangar 4, and consists of two 30,000-gallon jet-A, one 30,000-gallon avgas, and one 12,000-gallon diesel fuel storage tanks. Fuel is transported to the farm via tanker trucks.

Table F-1

GENERAL AVIATION HANGAR INVENTORY
Master Plan Update
Memphis International Airport

Structure	Use	Size (sq ft)	Constructed	Owner
Signature Flight Support				
Hangars 1 & 1A	Aircraft storage and maintenance	26,000	1940	Signature Flight Support
Hangar 2	Aircraft storage (primarily corporate jet)	25,000	2008	International Paper, Inc.
Hangar 3	Aircraft storage	20,000	1970	Signature Flight Support
Hangar 14	Aircraft storage	9,600	1937	Signature Flight Support
Hangar 15	Aircraft storage	15,000	1980	Signature Flight Support
Hangar 16	Aircraft storage	15,000	1965	Signature Flight Support
Hangar 17	Aircraft storage and maintenance	27,000 *(a)*	1995	Richards Aviation
Hangar 18	Aircraft storage and maintenance	27,000 *(a)*	1995	Mid-South Aviation
Hangar 19	Aircraft storage	12,000	1996	Privately Owned
Total		12,000		
Wilson Air Center				
Hangar 1	Aircraft storage and maintenance			
Hangar 2	Aircraft storage and maintenance	6,400	1996	Wilson Air Center
Hangar 3	Aircraft storage and maintenance	6,400	1996	Wilson Air Center
Hangar 4	Aircraft storage and maintenance	6,400	1996	Wilson Air Center
Hangar 5	Aircraft storage and maintenance	9,600	1996	Wilson Air Center
Hangars 6 & 7	Aircraft maintenance	9,600	1996	Wilson Air Center
Hangars 8 & 9	Aircraft storage/office space/passenger lobby	16,000	1996	Wilson Air Center
Total		54,400		

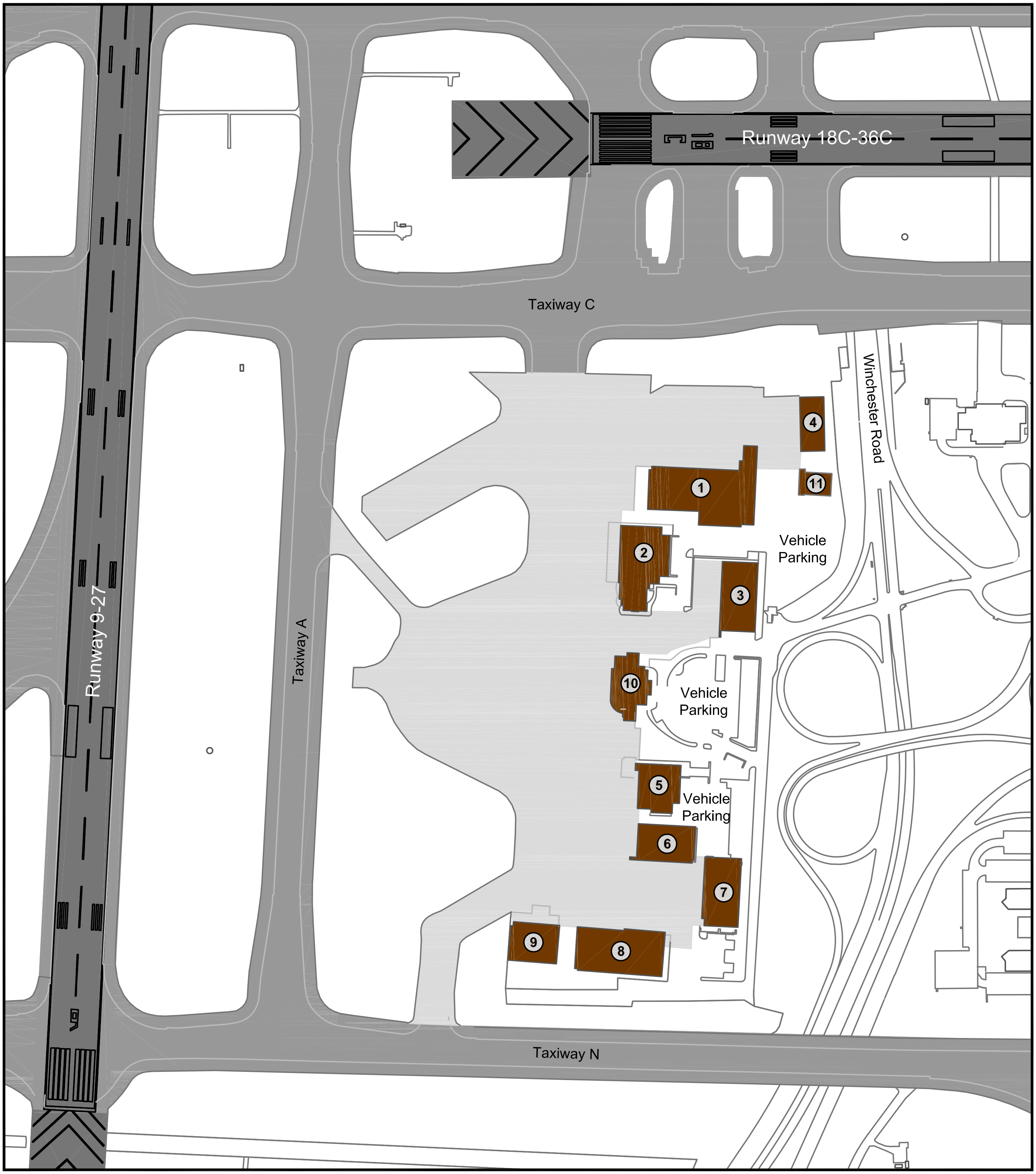
(a) Combined size of Hangars 17 and 18.

Source: Signature Flight Support and Wilson Air Center records, January 2008.

Signature leases 11.2 acres from the Authority and subleases some of its hangars to several general aviation-related tenants including Palmair Charters, Richards Aviation, Mid-South Jets, and Premier Aviation. Signature employs approximately 35 personnel (excluding sublease holders), and has parking spaces for 300 vehicles.

Wilson Air Center

Wilson Air Center (Wilson) is located north of Winchester Road between Taxiway Y and Hurricane Creek. Wilson is owned by Kemmons Wilson Companies and was started in 1996. Wilson, either directly or through sublease holders, offers a wide-range of general aviation services including airframe and engine repair and maintenance, flight instruction, ground handling, and aircraft charters. Airfield access is provided via Taxiways A and Y. Vehicular access is from Winchester Road at the signalized intersection opposite United Parcel Service's Oakhaven Hub truck entrance.



LEGEND

- Apron pavement
- Runway pavement
- Taxiway pavement
- Buildings

FACIILITY INDEX

1. Hangars 1 and 1A
2. Hangar 2
3. Hangar 3
4. Hangar 4
5. Hangar 14
6. Hangar 15
7. Hangars 17 and 18
8. Hangar 16
9. Hangar 19
10. Executive terminal
11. Fuel farm

N

0' 200' 400' 800'

Figure F-1
SIGNATURE FLIGHT SUPPORT

Master Plan Update
Memphis International Airport
November 2009

JACOBS CONSULTANCY

There are approximately 20 aircraft based at Wilson, ranging in size from single engine piston aircraft to corporate jets. In total, the Wilson apron encompasses 610,000 square feet and includes tie-down parking positions for 25 aircraft.

As summarized in Table F-1 and Figure F-2, The Wilson site consists of several aircraft and maintenance hangars, in addition to the facilities described below.

- **Main Terminal –** Wilson's Main Terminal, constructed in 1996, is a 12,000 square foot facility that accommodates the administrative offices, pilots' lounge and restaurant, and other crew and passenger amenities. A 26,000 square foot aircraft canopy is located adjacent to the terminal and covers a significant portion of the itinerant aircraft parking apron adjacent to the building.

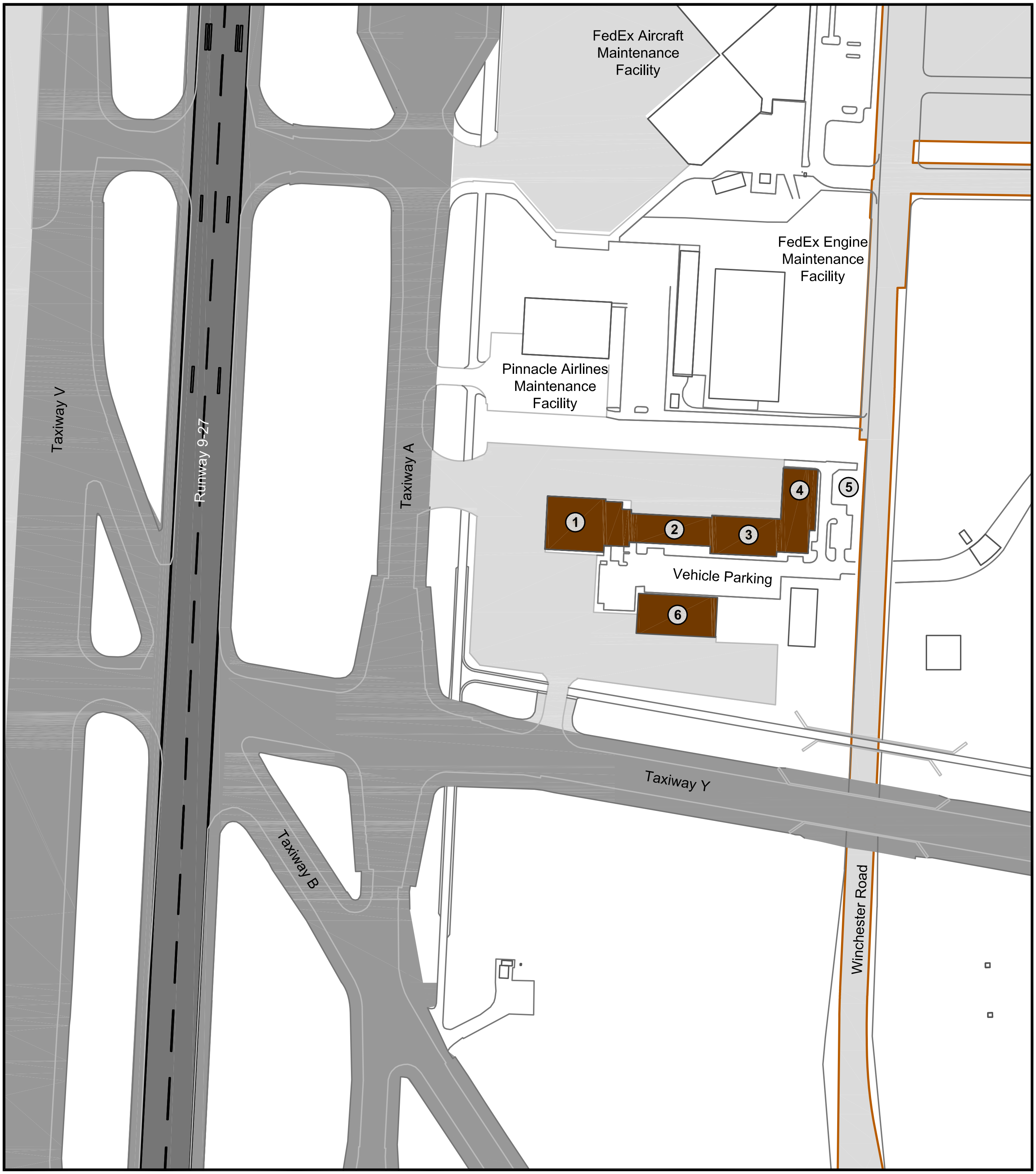
- **Fuel Farm –** Wilson's above ground fuel farm is adjacent to Winchester Road, and consists of two 35,000-gallon jet-A, one 15,000-gallon avgas, and one 2,500-gallon unleaded gasoline storage tanks. Fuel is transported to the farm via tanker trucks. In addition to Wilson customers, UPS uses this fuel farm for their air cargo operations.

Wilson leases 18.5 acres from the Authority and subleases to several aviation related tenants including Carmichael International. Wilson employs approximately 35 persons, excluding sublease holders, and has parking spaces for 210 vehicles. The FBO is currently negotiating with the Authority for lease amendments to allow expansion to the south for development of a corporate jet storage hangar as well as aviation-related offices and support services.

MILITARY FACILITIES

The Airport is home to the 164th Tactical Airlift Wing of the Tennessee Air National Guard (TnANG), which currently operates C5-A Galaxy aircraft. The TnANG recruits, organizes, and trains personnel to provide airlift capability that can assist airborne forces in moving military forces, equipment, and supplies via air drops, air-land, or cargo extraction systems. The TnANG employs approximately 450 full-time and 1,200 part-time personnel.

The TnANG is currently located on a 103-acre site locate along Democrat Road adjacent to the FedEx air cargo facilities. The site is currently leased from the Authority. The TnANG is in the process of constructing new facilities on a 118-acre site in the southeast corner of the Airport's property at Swinnea Road and Shelby Drive; the new facilities will become operational in early 2009. Once the TnANG has relocated, the majority of the existing TnANG facilities will be leased by FedEx to allow expansion of their Democrat Ramp aircraft parking apron.



LEGEND

- Airport property line
- Apron pavement
- Runway pavement
- Taxiway pavement
- Buildings

FACILITY INDEX

1. Main terminal
2. Hangars 1, 2, and 3
3. Hangars 4 and 5
4. Hangars 6 and 7
5. Fuel farm
6. Hangars 8 and 9

N

0' 200' 400' 800'

Figure F-2
WILSON AIR CENTER

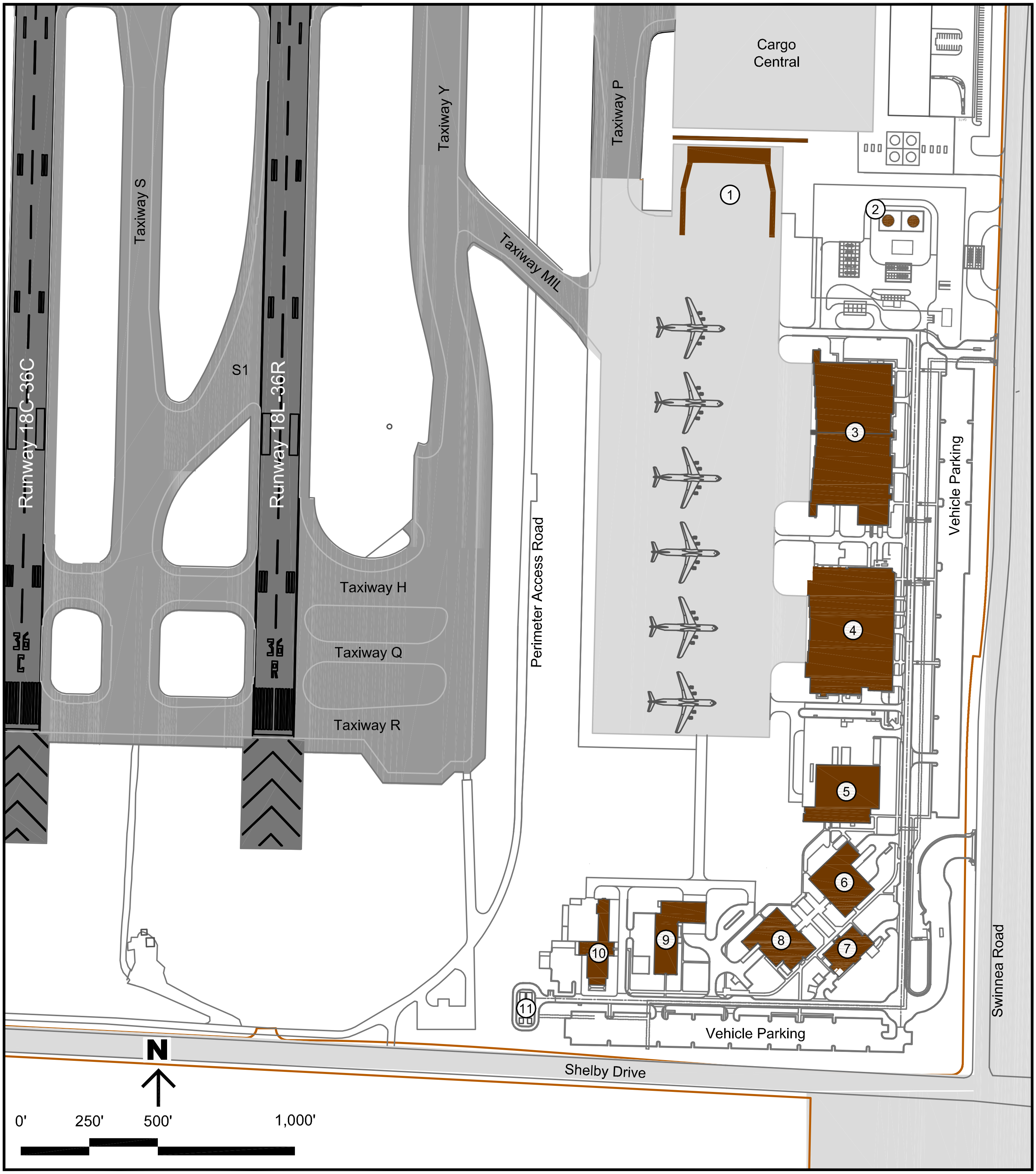
Master Plan Update
Memphis International Airport
November 2009

JACOBS CONSULTANCY

The future TnANG base will contain the following facilities, which are depicted in Figure F-3:

- 154,000 square-foot fuel cell and corrosion control hangar
- 166,000 square-foot C-5 aircraft maintenance facility
- 62,200 square-foot base supply and aerial port facility
- 52,000 square-foot operations and training facility
- 28,000 square-foot communications and security training facility
- 43,800 square-foot squadron operations and flight simulator facility
- 14,200 square-foot fire crash and rescue facility
- 16,600 square-foot base civil engineering facility
- 28,000 square-foot aircraft and vehicle maintenance shop
- 1,300 square-foot munitions storage bunker
- An above-ground fuel farm with two 210,000 jet-storage tanks

The future TnANG will initially have parking positions for six C5-A aircraft on a concrete apron of approximately 1.25 million square feet. Airfield access is provided via Taxiway MIL and Taxiway P to Taxiway Y. The site will have parking for 500 automobiles and two driveways located along Swinnea Road.



LEGEND

Airport property line
Apron pavement
Runway pavement
Taxiway pavement
Buildings

FACILITY INDEX

1. Engine test facility
2. Fuel farm / POL
3. Fuel cell and corosion control hangar
4. Aircraft maintenance and shop hangar
5. Base supply and aerial port
6. Operations and training facility
7. Communications and security facility
8. Squadron operations and flight simulator facility
9. Fire station
10. Ground support equipment shop
11. Munitions storage armament

Figure F-3
TENNESSEE AIR NATIONAL GUARD BASE

Master Plan Update
Memphis International Airport
November 2009

JACOBS CONSULTANCY

Technical Memorandum–G

AIRLINE AND AIRPORT SUPPORT

Memphis International Airport (the Airport) includes both airline and airport support facilities and functions, which are described in detail below.

AIRLINE SUPPORT

Airline support facilities are dedicated to supporting passenger and cargo airline operations. These facilities include aircraft maintenance facilities, airline catering, ground service equipment (GSE) storage and maintenance, fuel storage and dispensing systems, deicing fluid containment and ground run-up enclosures (GRE). The locations of these facilities are shown on Figures A-3 and A-4.

Aircraft Maintenance

Aircraft maintenance facilities are located on the southeast corner of the Airport, south of Runway 9-27, and east of Taxiway Y.

Pinnacle Airlines—a Northwest Airlines' regional/commuter affiliate—operates from a 41,000 square-foot maintenance facility located immediately east of Wilson Air Center. In addition, FedEx performs various maintenance operations from two hangars totaling 175,000 square feet and a 550,000 square foot apron located on the south side of Runway 9-27. As discussed in Baseline Conditions, FedEx is completing construction of a dedicated 185,000 square foot wide-body aircraft maintenance facility and 340,000 square foot apron in this area, which is planed to be complete in 2008.

On occasion, Northwest Airlines performs aircraft maintenance operations on the south side of the Passenger Terminal Apron, when necessary. However, designated space (or facilities) for such maintenance activity is not provided.

Airline Catering and Flight Kitchen

Gate Gourmet Catering Services leases a 5-acre, two-story, 55,000-square-foot facility in the area south of the Passenger Terminal Complex, immediately south of the fuel farm. Gate Gourmet provides in-flight catering amenities to the passenger airlines serving the Airport. Catering vehicles access the facility via Louis Carruthers Drive, and ingress and egress the terminal area via Perimeter Road and Taxiways P1 and P2. There are no plans for additional airline catering and flight kitchen space.

Ground Support Equipment Storage and Maintenance

Passenger airline GSE is currently stored and maintained in the air cargo building and on the Air Cargo Apron located immediately north of the terminal complex. The largest 28,000 square foot building is used by Northwest Airlines; the other approximate 20,000 square foot and 8,000 square foot buildings are used by the remaining passenger carriers.

As presented on Figure A-5, two new GSE storage and maintenance facilities encompassing approximately 30,000 square feet are being constructed directly south of the Passenger Terminal Complex and are expected to be operational in 2008. These facilities will replace the current GSE storage in the air cargo buildings. Once operational, GSE vehicles will ingress and egress the terminal area via Perimeter Road and Taxiways P1 and P2. There are not plans for additional GSE storage or maintenance facilities beyond those currently under construction.

In addition to the above, FedEx stores and maintains its aircraft deicing equipment in a parcel immediately south of its aircraft maintenance facility south of Taxiway A. The FedEx de-icing fleet at the Airport is the world's largest aircraft de-icing fleet.

Fuel Storage and Dispensing System

As shown on Figure A-4, the Airport's primary air carrier fuel farm, which serves the passenger terminal, is located between Runways 18C-36C and 18R-36L, immediately to the south of Taxiway P. Northwest Airlines owns the facility on leasehold from the Authority. There are two 420,000-gallon and three 210,000-gallon tanks capable of storing 1.5 million gallons of fuel at any given time. The fuel farm is only used for short-term fuel storage, given that it is supplied directly from a local refinery. In the event of a pipeline shutdown, the tanks can be supplied from standard tanker trunks.

A hydrant system, which transports jet fuel directly from the fuel farm to individual hydrant locations on the passenger terminal ramp adjacent to aircraft parking positions, serves a majority of the Airport's passenger terminal parking positions. All gates have direct access to the hydrant system except Gates A19, A33, and C8-C22, which are fueled by six tenant-owned tanker trucks capable of holding between 3,000 and 5,000 gallons of fuel each. The hydrant system consists of a looping network of pipes that range in size from six to 18 inches in diameter and are fed from five pumps at the fuel farm. The system is owned and maintained by Northwest Airlines and Delta Air Lines but, since early 2007, operated by Swissport USA, Inc.

In addition to the fuel farm supporting the passenger terminal, there are other aviation fuel facilities located at Signature Flight Support, Wilson Air Center, TnANG, and the FedEx super-hub. FedEx's fuel farm, which is located to the north of Democrat Road along the Airport's northern boundary, is operated by WesPac Pipelines, L.L.C, on leasehold from the Authority.

De-icing Fluid Containment

Each individual air carrier, or their designee, is responsible for acquiring, storing, and applying de-icing fluids when conditions warrant. De-icing fluid is stored at three different locations: (1) 20,000-gallon above-ground tanks located near each de-icing pad (the location of de-icing pads is shown on Figure B-1); (2) 20,000-gallon above-ground tanks adjacent to the fuel farm; and (3) 300- to 500-gallon tanks located north of Concourse C and west of Taxiway C. De-icing fluids are applied by large trucks with a retractable boom that are owned by the air carriers or their designees.

Environmental regulations require that the Authority recover used fluid from the de-icing pad and transport the waste material to a holding tank to prevent it from mixing with other stormwater runoff. This is currently accomplished by collecting fluids in the pavement drainage system surrounding each de-icing pad and diverting the flow from the sanitary sewer system to a pump that transfers the fluids into above-ground storage tanks. There are two 22,000-gallon tanks near most de-icing pads. Liquid transport trucks empty used de-icing fluids from the storage tanks to similar tanks located to the east of Taxiway N and south of Taxiway P. These tanks are discharged via meters through a manhole into the Airport's sanitary sewer system to ensure conformance with regulations.

Ground Run-Up Enclosures

As depicted on Figure A-5, two GREs will be constructed in 2008. One GRE will be located on the north side of the new TnANG Apron and sized to accommodate C-5A aircraft. The other will be located on the FedEx Large Widebody Apron, immediately east of the new hanger building.

AIRPORT SUPPORT

Airport support facilities include Aircraft Rescue and Fire Fighting (ARFF), airport and airfield maintenance, Authority administration, and the Airport Traffic Control Tower (ATCT). Airport support facilities are described below and shown on Figures A-3 and A-4.

Aircraft Rescue and Fire Fighting Facility

The Airport's ARFF is accommodated in a 20,000 square foot facility located on Airport property on the east side of the Airport along Rudder Road, north of Taxiway P (see Figure A-4). The state-of-the-art facility became operational in early 2008. The station includes equipment pursuant to FAA guidance and regulations for ARFF Index D, and houses about 10 staff per shift.

The Airport's other 4,800-square-foot fire fighting station, where the ARFF was located prior to completion of the new facility, is located in the terminal complex, north of the Air Cargo Apron, adjacent to Taxiway C. This facility is equipped to handle both aircraft crash and rescue and structural fires via two based units and is capable of providing services to the Airport and the surrounding municipal area, if necessary.

Airport and Airfield Maintenance

Authority maintenance facilities are located in the northeast section of the Airport, at the intersection of Tchulahula and Winchester roads. The facilities include an approximate 80,000 square foot building used for the storage and maintenance of airfield and airport maintenance equipment. Maintenance equipment includes the following: 9 snow brooms, 3 deicer trucks, 23 large trucks, 5 street sweepers, 19 sedans, 8 vans, 14 sport-utility vehicles, 43 pick-up trucks, 17 mowers and "bush hogs," 11 tractors, and 78 pieces of miscellaneous construction equipment.

Authority staff report the 80,000 square foot facility is in good condition and adequately sized to accommodate operations and the existing maintenance fleet.

Authority Administrative Facilities

The Airport Authority employs approximately 300 staff. Authority offices are located among three separate locations on the Airport. Primary and executive offices are located within approximately 27,000 square feet of the mezzanine level of the Passenger Terminal above the main lobby. Other Authority departments, including the Airport police, building maintenance, and other support functions are located below the main lobby in the baggage claim level of the Terminal. Additional Authority administration, operations, and maintenance functions are accommodated in the 80,000 square foot maintenance facility located at the intersection of Tchulahula and Winchester roads. Remaining Authority functions, including project/construction management support are accommodated in an approximately 18,000 square foot facility named the "Project Center" located on the west side of the Airport, along Airways Boulevard.

Authority employee parking is provided adjacent to each facility, in a 200 space surface lot located in the terminal complex north of the hotel, and the surface lot adjacent to the Rental Car Center on Democrat Road. The Authority operates a shuttle bus to transport employees between this lot and the terminal complex.

Airport Traffic Control Tower

As presented on Figure A-5, a new ATCT is being constructed and will be operational in 2011. The new ATCT is centrally located in the north side of the passenger terminal complex, south of Winchester Road. The new ATCT is designed for Activity Level 12 (ATC12) and will be constructed to a height of 335 feet (eye level 307 feet 2 inches above ground level). The base building will encompass 24,500 square feet and accommodate the Memphis TRACON and administrative functions. The tower cab (all levels) will be 3,467 square feet.

Technical Memorandum–H
INFRASTRUCTURE

This memo summarizes infrastructure in place at the Airport, focusing on the condition of airfield pavements, major utility networks feeding into the Airport, de-icing, and aviation fueling facilities. Mechanical, electrical, and plumbing (MEP) systems within the passenger terminal building are documented and assessed under a separate memorandum.

AIRFIELD PAVEMENTS

The Airport includes approximately 24 million square feet of public airfield pavements under the jurisdiction of the Authority to maintain. The assessment of airfield pavements contained herein is based on the following:

- 2007 Annual Condition Survey conducted by Authority maintenance personnel. The annual survey is one component of an active and on-going Pavement Management Plan administered by the Authority.∗ The survey is visual in nature and does not include non-destructive or similar performance-based testing. Results from the annual survey are stored in a MicroPAVER, version 6.0, software database.

- *Taxiway A Pavement Evaluation Report*, Roy D. McQueen and Associates, Ltd, March 2006.

- *Runway 9-27 Drainage Study and Pavement Evaluation*, Allen and Hoshall, December 2007.

Pavement Assessment

Pavement condition ratings are based on a sliding scale rating system known as the Pavement Condition Index (PCI), where "100" represents excellent conditions and "0" equals total failure. For simplicity, PCI index values are categorized into four broad ranges—excellent/very good, good, fair, and poor.

Results of the pavement assessment are generalized in Table H-1 and shown in detail by pavement location in Table H-2 and Figure H-1. Approximately 80 percent of airfield pavements fall into the "excellent/very good" category, as a majority of these pavements were constructed within the last ten years, and the Authority administers a joint-resealing program, which targets a sixth of total pavement joints annually. Only 5 percent of airfield pavements were classified as "poor," which include Runway 9-27, several areas of the passenger terminal apron, the portion of Taxiway B between Runway 9-27 and Taxiway V, and portions of Taxiway V itself.

∗Pavement assessments conform to the standards outlined in the American Society for Testing and Materials (ASTM) D-5349-03, *Standard Test Method for Airport Pavement Condition Index Survey*.

Table H-1

AIRFIELD PAVEMENT ASSESSMENT SUMMARY
Master Plan Update
Memphis International Airport

PCI range	Pavement condition	Percent of total pavement area
100-71	Excellent/very	86%
70-56	Good	3
55-41	Fair	6
40-0	Poor	5

PCI = Pavement Condition Index.

Sources: Memphis-Shelby County Airport Authority records and Pickering Firm analyses, February 2008.

Near-term Pavement Projects

The Authority is planning to begin engineering design and construction on the following two pavement replacement and rehabilitation projects in 2008-2009:

- Reconstruction of the pavements surrounding the passenger terminal complex, much of which dates back to the 1960's, and is classified as "poor" in the assessment.
- Reconstruction of Taxiway B to the north of Runway 9-27 as well as a relocation and reconstruction of Taxiway V from Taxiway B to its eastern terminus. FedEx has requested that the spacing between Runway 9-27 and Taxiway V be undertaken to increase the depth of their southeast ramp.

Additionally, recent engineering studies recommend the initiation of a concrete pavement restoration program for Taxiway A along its entire length and reconstruction of portions of Runway 9-27, including all taxiway crossings.

Table H-2

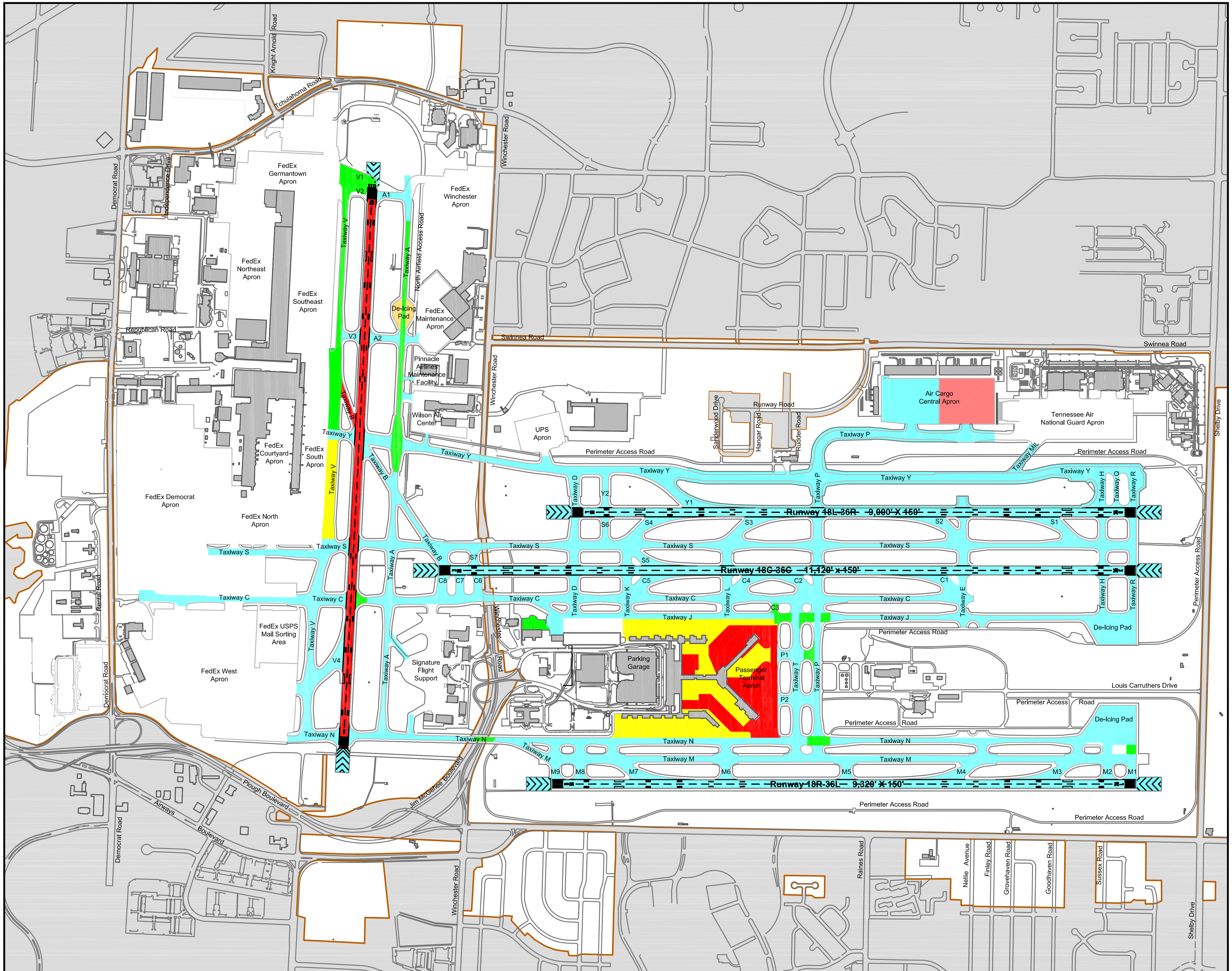
RESULTS OF AIRFIELD PAVEMENT CONDITION ASSESSMENT
Master Plan Update
Memphis International Airport

Airfield component	Segment description	Year constructed	Assessment
Runways			
Runway 9-27	Full length	1989	Excellent/Very Good
Runway 18R-36L	Full length	2002	Excellent/Very Good
Runway 18C-36C	Full length	2000	Excellent/Very Good
Runway 18L-36R	Full length	1995	Excellent/Very Good
Taxiways			
Taxiway A	From Twy N to Twy B	1993	Excellent/Very Good
Taxiway A	From Twy B for 4,000 feet	1989	Good
Taxiway A	From Twy A (Section 03) for 735 feet	1989 - 2006	Excellent/Very Good
Taxiway A1	East end of Rwy 9-27	1989 - 2006	Excellent/Very Good
Taxiway A2	2,400 feet west from east end of Rwy 9-27	1977 - 1989	Excellent/Very Good
Taxiway B	3,780 feet from east end of Rwy 9-27	1987	Poor
Taxiway B	From Rwy 9-27 to Rwy 18C-36C	1992 - 2000	Excellent/Very Good
Taxiway C	From north end to Rwy 9-27	2001 - 2003	Excellent/Very Good
Taxiway C	From Rwy 9-27 to 185 feet south	1991	Good
Taxiway C	185 feet south of Rwy 9-27 to Twy E	1993 - 2000	Excellent/Very Good
Taxiway C1	Full length	2000	Excellent/Very Good
Taxiway C2	Full length	2000	Excellent/Very Good
Taxiway C3	Full length	2000	Good
Taxiway C4	Full length	2000	Excellent/Very Good
Taxiway C5	Full length	2000	Excellent/Very Good
Taxiway C6	Full length	2000	Excellent/Very Good
Taxiway C7	Full length	2000	Excellent/Very Good
Taxiway C8	Full length	2000	Excellent/Very Good
Taxiway D	Full length	1995 - 2000	Excellent/Very Good
Taxiway E	Full length	1995 - 2000	Excellent/Very Good
Taxiway H	Full length	1995 - 2006	Excellent/Very Good
Taxiway J	From Twy K to Twy C3	1989	Excellent/Very Good
Taxiway J	From Twy C3 to Twy P	1989 - 1999	Good
Taxiway J	From Twy P to Twy R	1995	Excellent/Very Good
Taxiway K	Full length	1995 - 2000	Excellent/Very Good
Taxiway L	Full length	1995 - 2000	Excellent/Very Good
Taxiway M	Full length	2002	Excellent/Very Good
Taxiway M1	From Twy N to Twy M	1988	Good
Taxiway M1	From Twy M to Rwy 18R-36L	2002	Excellent/Very Good
Taxiway M2	Full length	1988 - 2002	Excellent/Very Good
Taxiway M3	Full length	2002	Excellent/Very Good
Taxiway M4	Full length	2002	Excellent/Very Good
Taxiway M5	Full length	2002	Excellent/Very Good
Taxiway M6	Full length	2002	Excellent/Very Good
Taxiway M7	Full length	2002	Excellent/Very Good
Taxiway M8	Full length	2002	Excellent/Very Good
Taxiway M9	Full length	1996 - 2002	Excellent/Very Good
Taxiway N	From north end to 2,950 feet south	1996 - 2003	Excellent/Very Good
Taxiway N	From 2,950 feet south and 340 feet long	1996	Good
Taxiway N	From Twy T to 4,800 feet north	1997 - 2003	Excellent/Very Good
Taxiway N	From Twy T and 380 feet south	1997	Good
Taxiway N	From south end to 4,880 feet north	1989 - 2003	Excellent/Very Good
Taxiway P	Full length	1988 - 2006	Excellent/Very Good
Taxiway P1	From Twy T to Apron (Main Terminal)	1999	Excellent/Very Good
Taxiway P1	From Twy P to 174 feet north	1988	Good
Taxiway P2	Full length	1988 - 1999	Excellent/Very Good
Taxiway Q	Full length	2006	Excellent/Very Good
Taxiway R	Full length	1995 - 2006	Excellent/Very Good

Table H-2 *(continued)*
RESULTS OF AIRFIELD PAVEMENT CONDITION ASSESSMENT
Master Plan Update
Memphis International Airport

Taxiways *(continued)*			
Taxiway S	Full length	1992 - 2000	Excellent/Very Good
Taxiway S1	Full length	1995	Excellent/Very Good
Taxiway S2	Full length	1997	Excellent/Very Good
Taxiway S3	Full length	1995	Excellent/Very Good
Taxiway S4	Full length	1995	Excellent/Very Good
Taxiway S5	Full length	1995	Excellent/Very Good
Taxiway S6	Full length	1997	Excellent/Very Good
Taxiway S7	Full length	2000	Excellent/Very Good
Taxiway T	Full length	1999	Excellent/Very Good
Taxiway V	From Twy V1 to Twy Y	1983 - 1987	Good
Taxiway V	From Twy Y to Twy S	1987 - 1993	Fair
Taxiway V	From Twy S to Twy N	2000	Excellent/Very Good
Taxiway V1	Full length	1997	Excellent/Very Good
Taxiway V2	Full length	1997	Excellent/Very Good
Taxiway V3	Full length	1977 - 1985	Excellent/Very Good
Taxiway V4	Full length	2001	Excellent/Very Good
Taxiway Y	Full length	1987 - 2006	Excellent/Very Good
Taxiway Y1	Full length	2001	Excellent/Very Good
Taxiway Y2	Full length	2001	Excellent/Very Good
Aprons			
Air Cargo Apron	North end of Air Cargo Apron to 380 feet south	1974 - 1982	Excellent/Very Good
Air Cargo Apron	Adjacent to the northeast Passenger Terminal Apron	1989	Good
Terminal Apron	Adjacent to Passenger Terminal	1972	Poor
Terminal Apron	Adjacent to Passenger Terminal and Concourse B	1964 - 1972	Fair
Terminal Apron	Adjacent to Passenger Terminal	1972	Poor
Terminal Apron	Adjacent to Passenger Terminal and Concourse A	1972	Fair
Terminal Apron	North end of Concourse A	1964	Good
Terminal Apron	Adjacent to Concourse A	1972	Fair
Terminal Apron	From Twy C to Twy K	1965 - 1989	Excellent/Very Good
Terminal Apron	South of Concourse B – SW Gates	1964 - 1972	Poor
Terminal Apron	South of Concourse B – SE Gates	1964	Fair
Terminal Apron	Adjacent to Concourse B – SE Gates	1964 - 1972	Poor
Terminal Apron	Adjacent to Concourse C	1972	Poor
Terminal Apron	Adjacent to Concourse C	1972	Fair
Terminal Apron	Adjacent to Twy N	1984	Poor
Miscellaneous Airfield Pavements			
Airlink	Entrance to Pinnacle Airlines Hangar	1990	Excellent/Very Good
FedEx Maintenance Entrance	Adjacent to Twy A	1989	Excellent/Very Good
Hold Pad Taxiway J	South end of Twy J	1996	Excellent/Very Good
Hold Pad Taxiway N	South end of Twy N	2000	Excellent/Very Good
Over Run 18C	North end of Rwy 18C-36C	1997	Excellent/Very Good
Over Run 18L	North end of Rwy 18L-36R	1995	Excellent/Very Good
Over Run 18R	North end of Rwy 18R-36L	2002	Excellent/Very Good
Over Run 27	East end of Rwy 9-27	1989	Excellent/Very Good
Over Run 36C	South end of Rwy 18C-36C	1997	Excellent/Very Good
Over Run 36L	South end of Rwy 18R-36L	2002	Excellent/Very Good
Over Run 36R	South end of Rwy 18L-36R	1995	Excellent/Very Good
Over Run 9	West end of Rwy 9-27	1974	Excellent/Very Good
Cargo Central	Cargo Central Apron	2007	Excellent/Very Good
Cargo Central	Entrance to Cargo Central Apron	2007	Excellent/Very Good
Signature Entrance	Adjacent to Twy N	1993	Excellent/Very Good
Signature North Entrance	Adjacent to Twy A	2000	Good
UPS Entrance	Adjacent to Twy Y	1999	Excellent/Very Good
Wilson North Entrance	Adjacent to Twy A	1990	Excellent/Very Good
Wilson West Entrance	Adjacent to Twy Y	1990	Excellent/Very Good

Source: Memphis-Shelby County Airport Authority records, February 2008.



LEGEND

Airport property line

PAVEMENT ASSESSMENT LEGEND

- Excellent
- Good
- Fair
- Poor
- Under construction
- Not evaluated

Note: Pavement condition only shown for pavements maintained by the Memphis Shelby County Airport Authority.

Source: Memphis Shelby County Airport Authority records, Runway 9-27 and Taxiway V studies, and Pickering Firm field verification, February 2008.

Figure H-1
AIRFIELD PAVEMENT ASSESSMENT

Master Plan Update
Memphis International Airport
November 2009

JACOBS CONSULTANCY

UTILITIES

Major Airport utility systems are described in the following sections.

Electricity

Memphis Light, Gas, and Water (MLGW) provides electricity purchased from the Tennessee Valley Authority to the Airport through a grid of 12.47- and 23-kilovolt primary circuits energized from nearby substations. There are no major electrical generation or transmission facilities on Airport property. Electricity consumption for Authority-owned and operated facilities is provided in Table H-3.

A substation on the southeast corner of Airways Boulevard and Winchester Road, owned and maintained by MLGW, contains a single switchgear that provides the primary electrical service to the passenger terminal via two 15 kilovolt circuits. Beyond this point, the Authority has responsibility for the capacity and maintenance on the electricity distribution system, which consists of 13 substations located in and near the passenger terminal. Additionally, the construction of a new parking garage immediately to the north of the passenger terminal's existing parking structure will require MLGW to install a new switchgear adjacent to the intersection of Winchester and Cargo Roads. This switchgear provides electrical service to both the new and existing parking structures via two 10 megavolt circuits.

As described in baseline conditions, the Authority plans to install an emergency generator system in 2008 to provide backup electricity to the passenger terminal in the event of an unexpected power outage. The diesel-powered generator will be located along the west side of Airways Boulevard adjacent to the existing MLGW switchgear and provide continuous emergency power to all areas receiving electrical service from this switchgear.

Natural Gas

MLGW provides natural gas, purchased from Texas Gas Transmissions, L.L.C., to the Airport through a grid of four- to eight-inch pipes located within public rights-of-way beneath the surrounding roadway network. MLGW owns the pipes and related infrastructure up to the point of consumption metering at various Airport facilities. The passenger terminal is served via a single six-inch pipe fed from a line beneath Winchester Road connecting to the terminal to the west of Concourse A. There are no natural gas pumping or storage facilities on the Airport's property. Recent natural gas consumption for Authority-owned and operated facilities is provided in Table H-3.

A 14-inch natural gas transmission pipeline in parallel with a 20-inch crude oil pipeline crosses a portion of the airfield between Runway 18R-36L and Airways Boulevard. The pipes, which are owned by MLGW but operated and maintained by Valero Energy Corporation, provide service to the company's Memphis refinery and do not provide service to the Airport.

Table H-3
HISTORIC UTILITY CONSUMPTION DATA
Master Plan Update
Memphis International Airport

	Electricity (kw/hr)	Natural gas (cubic ft x 00)	Water (gallons)	Jet fuel (gallons)
2005				
January	4,265,834	124,996	9,423	8,451,532
February	4,029,143	127,751	8,385	7,740,929
March	3,215,380	113,985	9,388	10,764,127
April	3,949,941	57,652	8,987	8,452,501
May	3,705,472	23,697	9,432	9,185,464
June	4,375,756	16,460	10,737	9,289,366
July	4,815,447	13,444	12,602	9,353,902
August	4,731,552	11,858	14,733	9,302,781
September	4,817,509	11,496	13,507	9,861,754
October	4,670,564	13,294	9,143	8,171,934
November	3,794,891	25,010	8,922	9,750,749
December	3,652,070	59,055	7,963	9,923,831
Annual total	50,023,559	598,698	123,222	110,248,870
2006				
January	3,858,682	56,638	8,927	7,782,771
February	3,800,800	33,860	7,549	6,795,183
March	3,539,560	59,553	9,242	8,076,837
April	3,748,611	23,659	9,976	7,741,541
May	4,184,013	18,417	7,717	8,165,825
June	4,198,717	14,884	11,321	7,999,811
July	4,536,164	13,723	15,170	8,507,433
August	4,900,266	14,109	13,370	8,584,003
September	4,595,891	16,339	10,279	8,001,660
October	4,102,344	60,267	11,005	8,222,395
November	4,116,524	97,376	8,307	7,626,731
December	4,134,029	86,084	10,452	7,636,321
Annual total	49,715,601	494,909	123,315	95,140,511
2007				
January	4,422,762	134,978	9,437	7,374,644
February	3,903,006	94,934	8,787	6,932,671
March	3,843,244	65,000	8,326	7,312,895
April	4,336,087	40,803	9,984	7,290,595
May	3,772,282	15,633	10,081	8,136,835
June	3,996,489	12,361	12,685	8,202,823
July	4,713,742	11,362	14,888	8,215,693
August	4,284,113	10,738	18,372	8,691,727
September	4,828,707	15,284	14,741	8,103,038
October	4,077,357	48,685	11,970	8,404,514
November	4,049,303	92,446	11,481	7,443,708
December	4,791,969	122,814	9,060	7,500,871
Annual total	51,019,061	665,038	139,812	93,610,014

Source: Memphis Light, Gas, and Water and Memphis-Shelby County Airport Authority fuel records, March 2008.

Water

MLGW provides water service from three pumping stations—Davis, Allan, and Lichterman—to the Airport through a grid of 8- to 24-inch pipes located within public rights-of-way beneath the surrounding roadway network. MLGW owns the pipes and related infrastructure up to the point of consumption metering at various Airport facilities. There are no specific water utility corridors, pumping stations, or storage facilities on the Airport's property. Recent historical water consumption for Authority-owned and operated facilities is provided in Table H-3.

Sanitary Sewer

A series of three basins (i.e. pipe networks) collect and transport wastewater via a gravity flow system to the Nonconnah Interceptor, a 72-inch pipe that runs parallel to Nonconnah Creek on its south side flowing from east to west. Wastewater generated at the Airport is conveyed to the T.E. Maxson Wastewater Treatment Plan, located south of downtown Memphis adjacent to the Mississippi River. The plant is owned and operated by the City of Memphis, Division of Public Works, and is capable of treating 90 million gallons of wastewater per day.

Other than the gravity-induced basins that collect wastewater, there are no major pumping, storage, or treatment facilities at the Airport. None of the basins are currently metered, so exact historical data on wastewater production are not available. However, a rough approximation of wastewater produced is water-consumed, which is provided in Table H-3.

Aviation Fuel

Type A jet fuel is provided to the Airport via a six-inch pipeline from the Valero Energy Corporation's Memphis refinery, located south of downtown Memphis, approximately seven miles from the Airport. This pipeline, which is owned by MLGW but operated and maintained by Valero, enters the Airport beneath Airways Boulevard, turns south under Runway 9-27 and parallels Taxiways M and N before flowing east into the fuel farm. Recent historical jet fuel consumption for the passenger terminal fuel farm is provided in Table H-3.

Airport Drainage

The Airport's stormwater drainage is a gravity flow system that flows into Nonconnah Creek, located one-quarter mile north of the Airport. The Nonconnah Creek then flows west for approximately 6 miles into McKellar Lake, which is part of the Mississippi River. The Airport's drainage system has no pumping stations; however, pumps (maintained and operated by the City of Memphis) are used to drain certain low areas such as the Winchester Tunnel. In addition, there are four detention ponds located throughout the airfield.

Technical Memorandum–I

SURROUNDING LAND USE AND ENVIRONMENTAL CONDITIONS

The potential environmental impacts of the Airport's Recommended Development Plan will be summarized and addressed in detail in Phase II of the Master Plan Update to enable follow-on environmental review (i.e., NEPA) and/or implementation of required permitting processes. This review will be accomplished in accordance with FAA Advisory Circular 150/5070-6B, *Airport Master Plans*, which states "the principal objective of an environmental overview is to document environmental conditions that should be considered in the identification and analysis of airport development alternatives."

This memorandum identified the primary environmental conditions that could affect Master Plan alternatives, recommendations, and implementation of Airport facilities.

ENVIRONMENTAL CONSTRAINTS

Known environmental constraints pertaining to potential master development recommendations are summarized below. In addition to discussions with Authority staff, primary data sources include: the *Final Environmental Impact Statement (EIS), Memphis International Airport*, (FAA, March 1993); and the Airport's most recent Master Plan Update (URS Corporation, September 2000).

Air Quality

U.S. Environmental Protection Agency (EPA) and the Tennessee Department of Environmental and Conservation currently classify Shelby County and the Airport as a "marginal" 8-hour ozone nonattainment area (data indicates the County is almost a "non attainment" area); however Shelby County is in attainment with respect to the remaining criteria pollutants (particulate matter 2.5, particulate matter 10, carbon monoxide, sulfur dioxide, and lead). The primary sources of ozone in the region are stationary emission points and surface transportation modes, including truck and vehicle traffic.

According to Airport staff, emissions limits will be reduced in 2008, and a "non attainment" classification is anticipated. If the County is classified with non attainment status, any federally funded airport improvement project may be subject to general conformity regulations as promulgated under the Clean Air Act.

With regard to ongoing air quality mitigation, only Pinnacle Airlines operates a 100% clean technology (electric) GSE fleet. Clean technology GSE represents around 10% of the total Airport GSE fleet.

Wetlands

Wetlands and waters of the U.S. are regulated under the *Clean Water Act*, as amended in 1977, and Executive Order 11990, *Protection of Wetlands*, as implemented by DOT Order 5660.1A, *Preservation of the Nation's Wetlands*. Numerous wetland delineations have been prepared for various areas of the Airport site since 1993 to support land acquisition or facility development. Based on these reviews and the prominence of wetland sites on Airport property, it is anticipated that undeveloped areas will likely include wetland sites, and that development of these sites will require mitigation of wetland impacts. Potential development projects affecting wetlands will require permits from the U.S. Army Corps of Engineers and appropriate in-kind mitigation as required by Federal, state, and local regulations.

Floodplains

The majority of the area alongside Hurricane Creek is designated by the Federal Emergency Management Agency (FEMA) as an area that would be inundated by a 100-year flood event. Sections of Hurricane Creek that were reconstructed during the construction of Runway 18L-36R between Runway Road and Shelby Drive were designed and engineered to accommodate a 100-year flood event. Additionally, the portion of the creek from Democrat Road to Christine Road that flows through a concrete channel is also able to accommodate the 100-year flood event. However, the remaining natural and unlined sections located to the north of Democrat Road, between Christine and Runway Roads, and south of Shelby Drive remain subject to 100-year flood events. Design and engineering of future facility development in this area would have to accommodate proper mitigation techniques.

Historic, Architectural, Archaeological, and Cultural Resources

According to the 1993 EIS, there are no archaeological sites or historic properties that would be affected by development at the Airport; although seven historic, or potentially historic cultural resources or areas were identified north and west of the Airport. In 2001, a 66-grave abandoned cemetery was discovered beneath the FedEx West Apron during an extension to Taxiway C. Coordination was accomplished with the Tennessee Historical Commission and the graves were cataloged and re-interred in a nearby Shelby County cemetery.

Wildlife Areas

According to the 1993 EIS, there are no wildlife or waterfowl refuges, wild and scenic rivers, nor coastal zones located within the Airport environs.

Hazardous Materials

Hazardous materials are regulated by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund) of 1980 and the Resource Conservation and recovery Act (RCRA) of 1976, as amended in 1986. Several potentially hazardous sites are located on Airport property. A number of site-specific investigations associated with individual development projects have been conducted to varying degrees of detail. According to Authority staff, the only known on-Airport site that could potentially require remediation is the Airport's primary air carrier fuel farm, which is located between Runways 18C-36C and 18R-36L, immediately to the south of Taxiway P. Northwest Airlines owns the facility on leasehold from the Authority.

Compliance Permits

The Authority maintains a storm water discharge permit, Storm Water Pollution Prevention (SWPP) Plan, and Spill Prevention, Control and Countermeasure Plan (SPCC) for the entire Airport site, excluding areas leased by FedEx and the fuel farm. FedEx and Northwest Airlines maintain separate storm water discharge permits, SWPP Plans, and SPCC Plans for their on-Airport facilities and the Fuel Farm. Depending on the nature and extent of future development, existing permits would need to be modified to reflect future conditions.

De-icing Procedures

While Memphis rarely experiences heavy snowfalls, there were 53 days in both 2006 and 2007 that necessitated some type of de-icing fluid application. Approximately 100,000 to 150,000 gallons of glycol is applied each year.

Treatment of aircraft during winter weather and icing conditions with de-icing fluids (i.e., glycol) take place at four de-icing pads located throughout the airfield. As shown on Figure B-1, three pads are located at the southern end of the airfield adjacent to Taxiways J, N, and Y; the fourth is located to the north and south side of Taxiway A adjacent to the FedEx aircraft maintenance facility.

Current environmental regulations require that the Authority recover used fluid from the de-icing pad and transport the waste material to a holding tank so that it can not be mixed with other stormwater runoff. This is currently accomplished by collecting fluids in the pavement drainage system surrounding each de-icing pad and diverting the flow from the sanitary sewer system to a pump that transfers the fluids into above-ground storage tanks. There are two 22,000-gallon tanks near most de-icing pads. Liquid transport trucks empty used de-icing fluids from the storage tanks to similar tanks located to the east of Taxiway N and south of Taxiway P. These tanks are discharged via meters through a manhole into the Airport's sanitary

AIRPORT ENVIRONS

The Airport environs, depicted on Figure A-1, include portions of five jurisdictions: the City of Memphis; Shelby County; Desoto County, Mississippi; and the cities of Southaven and Horn Lake, Mississippi. Transportation planning assistance is provided by the Metropolitan Planning Organization (MPO), which plays a key role in determining transportation infrastructure in the vicinity of the Airport.

Information provided in the following sections was primarily compiled in the 2005 *Memphis International Airport FAR Part 150 Noise Compatibility Study Update* (URS Corporation, July 2005).

Existing Land Uses

Generalized existing land uses in the Airport environs are depicted on Figure I-1. Land uses surround the Airport are primarily a mix of vacant, commercial, industrial, and residential development. In the surrounding community to the east land use is predominantly low density residential. The area immediately south of the Airport is predominantly vacant with some commercial and light industrial. Areas northwest of the airport, but south of Interstate 240 are primarily commercial and industrial; while areas southwest between Airways Boulevard and Interstate 55 are a mix of vacant and residential. Areas north of the Airport south of Interstate 240 are primarily vacant and commercial; areas north of the Interstate are largely residential.

The location of schools, churches, and other pubic/institutions were documented in the 2005 Part 150 Update.

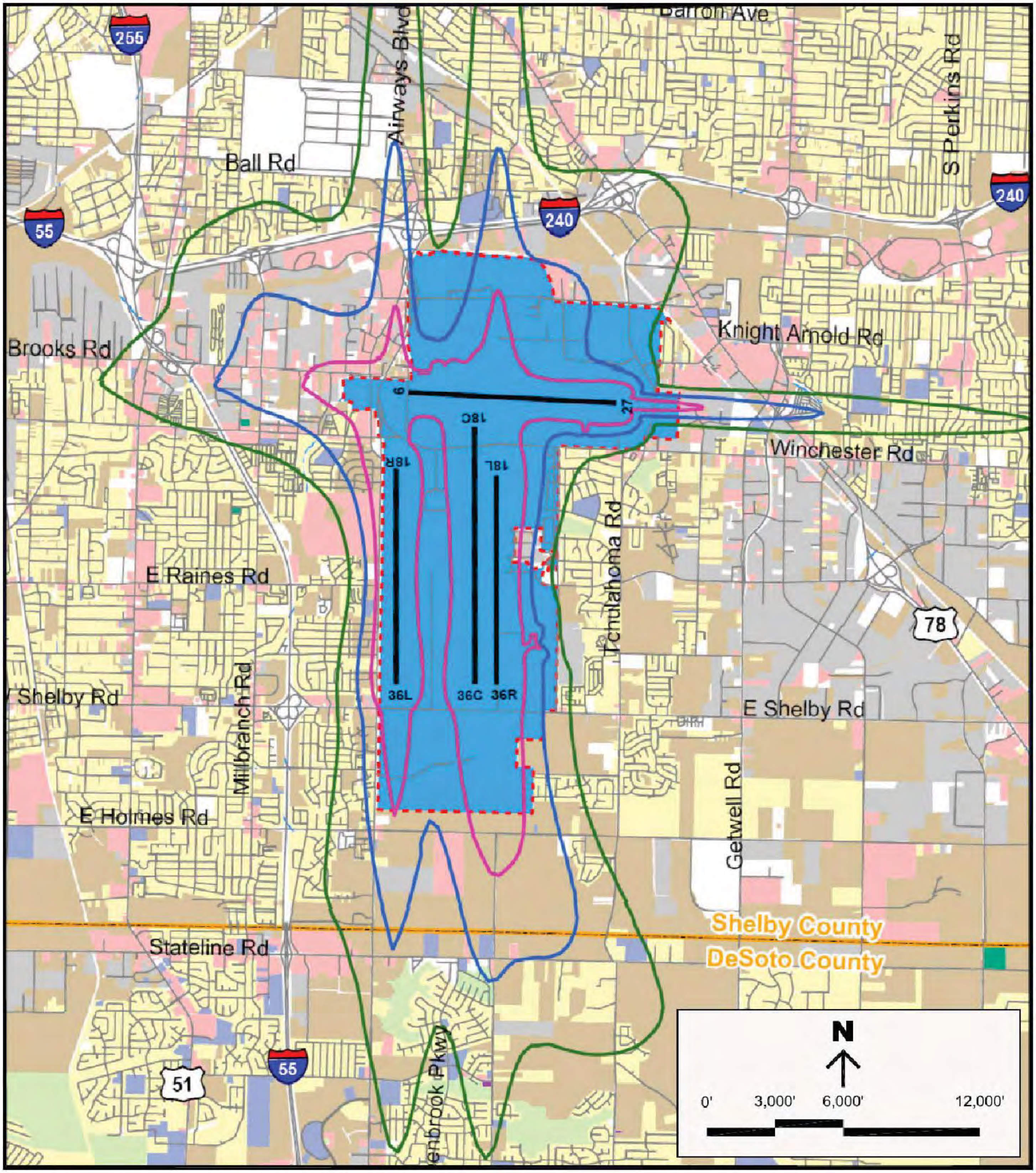
Aircraft Noise Exposure

FAA-approved projected noise exposure contours for 2009 were developed for the 2005 Part 150 Update and are presented on Figure I-1. As presented, the future 65 day-night average sound level (DNL) noise exposure contour is projected to encompass areas north, south, east, and west of the Airport commensurate with aircraft operations on all four runways. Predominant areas of incompatible land use are located east of the airport resulting from arrival operations on Runway 27; and north of the airport, north of Interstate 240 resulting from arrival and departure operations on the north-south parallel runways.

The 2009 noise exposure contours encompasses approximately seven schools and 8,750 housing units; of which approximately 3,800 were not compatible with noise levels above 65 DNL (not previously mitigated with sound attenuation). In summary, the 2009 contour represented a 5% decrease in exposure incompatible housing units, which was attributed to a change in the Airport fleet mix to quieter, newer technology aircraft.

Noise Abatement and Mitigation

Recommendations of the 2005 Part 150 Update include (1) establishing preferential corridors for VFR departures; (2) designating calm wind orientations for maintenance run-ups to minimize noise exposure; and (3) extending the residential and nonresidential noise mitigation programs to areas exposed to DNL 65.



LEGEND

2009 DNL 65

2009 DNL 70

2009 DNL 75

Airport property line

County boundary

LAND USE LEGEND

Airport

Commercial

Industrial

Institutional

Public

Residential

Unknown

Parks / open space

Vacant

Note: Airport property line is generalized for planning purposes.
Source: FAR Part 150 Noise Compatibility Study, URS Corporation, 2005.

Figure I-1
OFF-AIRPORT LAND USE AND PROJECTED NOISE EXPOSURE

Master Plan Update
Memphis International Airport
November 2009

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The Airport includes the following informal noise abatement procedures identified in prior noise abatement planning studies for the Airport dating back to 1992 and confirmed in the 2005 Part 150 Update:

- Turbojet aircraft shall not be authorized to turn nor assigned a heading which will result in an aircraft altitude below 3,000 feet AGL traversing the residential areas north of Holmes Road and east and west of the extended centerline of Runways 18R/L.

- Turbojet aircraft departing Runway 27 shall not be authorized a turn south until leaving 3,000 feet AGL to two miles from the departure end of the runway to protect residential areas.

- Engine run-ups may only be conducted in designated run-up areas between 6:00 am and 10:00 pm, except in emergency situations.

As shown on Figures A-2 and I-1, various properties in the immediate airport environs have been acquired by the Authority since 2004, primarily for noise compatibility purposes. These incompatible land uses were located in the 65 DNL and primarily include the current Airport property west of Airways Boulevard and the large parcel south of Shelby Drive. On February 1, 2008, the FAA released a new guidance document, *Management of Acquired Noise Land: Inventory - Reuse – Disposal*, which contains information on airport sponsor compliance with Grant Assurance 31, Written Assurances on Acquiring Land. The FAA document includes information on the management, retention and disposal of land acquired for noise compatibility purposes, including criteria for determining whether disposal is required. All recent and relevant FAA guidance on the reuse of airport property acquired for compatibility purposes will be considered in ensuing Master Plan Update tasks when the future use of these parcels is considered.

SUSTAINABILITY FRAMEWORK

The aviation industry is rapidly integrating sustainability concepts into all aspects of the industry. This usually includes a strategic element, where management sets a policy direction followed by tactical measures which include specific actions to implement the strategy.

At airports, there is wide-ranging and growing sustainability policy and tactical implementation. Use of LEEDTM principles for new facilities is increasing, although that standard marginally addresses aviation issues. Airlines are modernizing fleets and implementing significant operational changes to improve efficiency and reduce natural resources impacts. Aircraft equipment manufacturers are developing more sustainable products along with consideration for aircraft end-of-life disposition.

Sustainability for airports involves developing a systematic approach to responsibly address the concerns of stakeholders on environmental, social, and economic impacts. Sustainability strives to achieve a balance between these areas, and this balance can be different from city to city. Each of these categories carries importance to both the Airport and surrounding community.

- **Environmental** - Refers to the natural resources that are used or impacted as a result of Airport System operations and the ecosystem system in which they are located.

- **Social** - Refers to contributing to the surrounding community with practices that promote social interaction and the cultural enrichment of the region. Typically, this involves placing emphasis on the region's social capital.

- **Economic** - Refers to the continued business viability of the Airport System, the tangible assets created by the System's capital investments, and the direct and indirect economic impact on the region. This includes the value added to public and private sectors through investments in partnerships, tax payments and other contributions.

The alternatives analysis for the Master Plan Update will incorporate appropriate sustainability factors from the three categories above to assist in selecting the best overall alternatives that can be sustainable over the long term.

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FINAL WORKING PAPER

AVIATION DEMAND FORECASTS
MASTER PLAN UPDATE
Memphis International Airport

Prepared for

Memphis-Shelby County Airport Authority
Memphis, Tennessee

January 2010

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January 2010

Chicago • Cincinnati • Dallas • London • Ottawa • San Francisco • Washington, D.C.

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Section 1

INTRODUCTION

This report details the aviation demand forecasts for Memphis International Airport (the Airport) over the forecast period defined as calendar years 2007 through 2027. The year 2007 was selected as the base year since it is the most recent complete calendar year for which aviation activity records are available. The projections are based on unconstrained demand which assumes that there are no physical, regulatory, environmental, or other impediments to aviation activity growth. This analysis focuses on the future demand levels of enplaned passengers, passenger aircraft operations, cargo tonnage, and air cargo aircraft operations. In addition, projections of aircraft operations are provided for general aviation and military operations. All annual data is presented for calendar years unless otherwise stated.

AIRPORT BACKGROUND

Memphis International Airport is the primary commercial service airport for the City of Memphis and the surrounding eight county region. The Airport is also the third largest connecting hub in the worldwide route system of Northwest Airlines which includes service on its mainline operation, and service by its regional affiliate, Northwest Airlink. Northwest Airlink includes service provided by wholly owned subsidiaries Compass Airlines and Mesaba Aviation and privately owned Pinnacle Airlines (operating under a service agreement). In this report Northwest mainline and Northwest Airlink are referred to as "Northwest" unless specifically noted).

Northwest has had a dominant share of Airport enplanements since 1986 when it purchased Republic Airlines. In 2007, Northwest accounted for approximately 81% of total enplanements at the Airport.

The Airport currently has scheduled nonstop commercial passenger service by most of the U.S. mainline carriers* and/or their regional affiliates including AirTran Airlines, American Airlines, Continental Airlines, Delta Air Lines, United Airlines, and US Airways. In May 2007, the Airport had an average of 274 daily departures to 81 nonstop domestic markets. The majority of this service was provided on mainline jet or regional jet aircraft. In addition, the Airport had an average of five daily departures to four international markets including daily nonstop service to Amsterdam by Northwest. In 2007, the Airport was the 35th busiest passenger airport in the U.S. according to Airports Council International–North America (ACI-NA) preliminary statistics.

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*U.S. mainline carriers include AirTran Airways, American Airlines, Delta Air Lines, ContinentalAirlines, Frontier Airlines, jetBlue Airlines, Northwest Airlines, Southwest Airlines, United Airlines and US Airways.

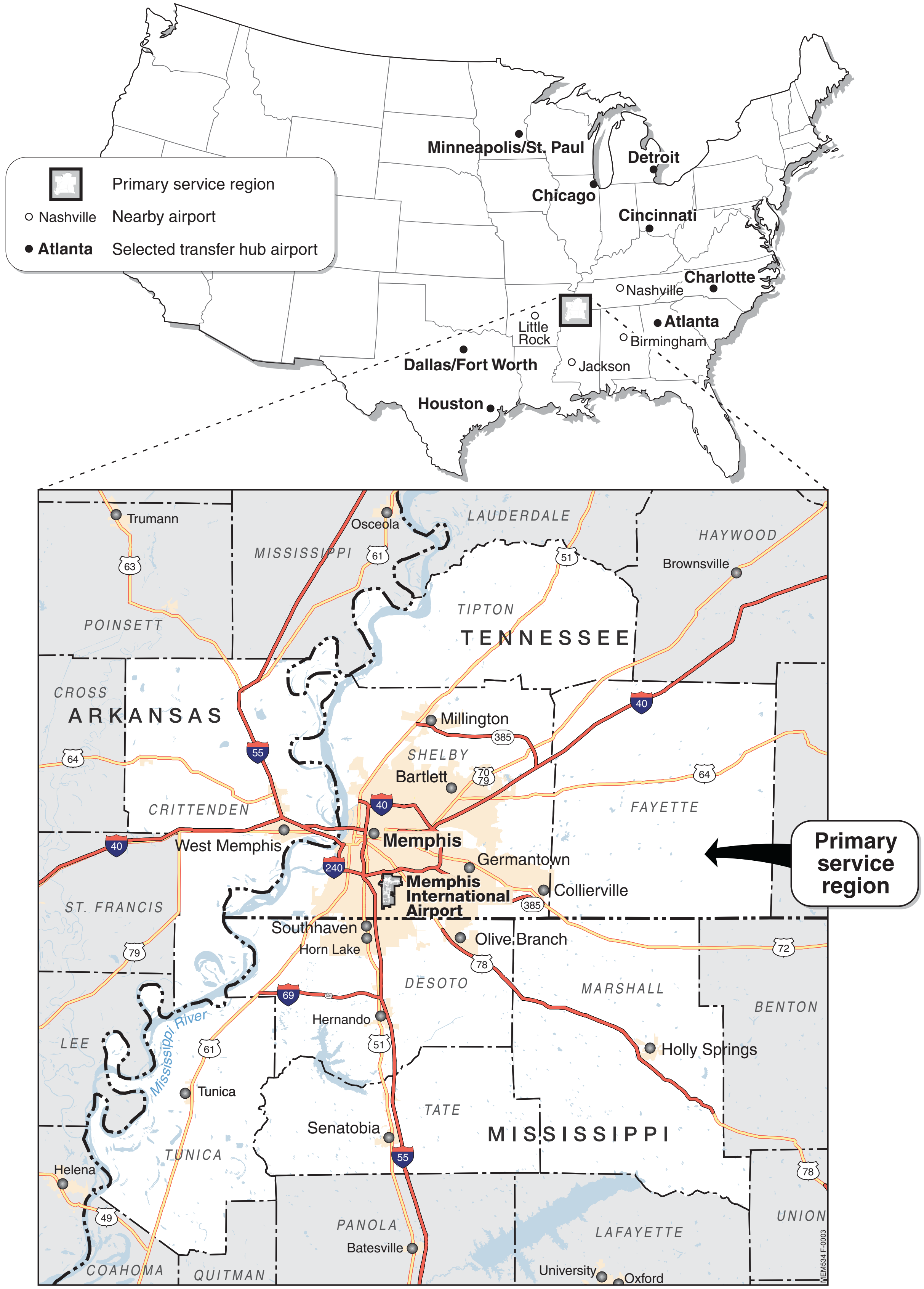
The Airport is also the location of the largest hub in the FedEx worldwide network and is known as the FedEx "Super Hub." FedEx operates the world's largest fleet of air cargo aircraft and processes over 3.3 million packages per day at the Memphis Super Hub. FedEx serves both domestic and international markets from Memphis. In 2007, the Airport was the world's busiest cargo airport for the 16th consecutive year, according to ACI-NA preliminary statistics.

AIRPORT SERVICE REGION

As shown on Figure 1, the primary geographical area served by the Airport is the Memphis Metropolitan Statistical Area (MSA). The Memphis MSA consists of eight counties: Fayette, Shelby, and Tipton counties in Tennessee; DeSoto, Marshall, Tate, and Tunica counties in Mississippi; and Crittenden County in Arkansas. The Airport service region is the geographic area from which the Airport is estimated to draw the majority of its passengers and other demand for aviation-related services. The majority of this area is within a one-hour drive time from the Airport. Approximately 72% of the population of the Airport service region resides in Shelby County, Tennessee.

The Airport also draws passengers from a secondary service area including northern Mississippi and eastern Arkansas, particularly those areas within a 2-hour drive time of the Airport. Other regional airports identified on Figure 1, but outside the Airport's primary air service region include: Little Rock National Airport approximately 135 miles to the west; Jackson-Evers International Airport approximately 219 miles to the south; Nashville International airport approximately 219 miles to the northeast; and Birmingham International Airport approximately 237 miles to the southeast.

In addition to the frequency of airline service, the availability of low cost airline service at an airport extends the limits of the overall service region. As shown in Table 1, the four regional airports in the secondary service area had significantly larger shares of low-cost carrier (LCC) service than the Airport in May 2007. The large shares of low cost carrier service at the regional airports reflect Southwest Airlines service at the airports in Birmingham, Jackson, Little Rock, and Nashville, as well as Frontier and JetBlue service at Nashville. Memphis is served by AirTran and Frontier airlines which together accounted for only 4.8% of total scheduled seats in 2007. Although low cost carrier service is available at the regional airports, the effect of that service is offset by the service availability and frequency offered at the Airport. For example, in May 2008, the Airport served 103 nonstop destinations with 281 average daily departures, compared with service to 23 nonstop destinations with 58 average daily departures at Little Rock.



LEGEND

- Primary airport service region
- Urban areas
- State boundary
- County boundary

N

8 0 8 16

Graphic Scale in Miles

Figure 1

AIRPORT SERVICE REGION

Master Plan Update
Memphis International Airport

December 2009

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Table 1

DOMESTIC AVERAGE FARE AND AVERAGE YIELD
Master Plan Update
Memphis International Airport

Airport	Distance from Memphis *(a)*	Fare	Yield *(b)*	2007 Total scheduled seats	Percent of scheduled seats on LCCs *(c)*
Memphis International	12	$207	22.0	7,669,400	4.8%
Little Rock National	135	176	18.7	1,779,928	40.1
Jackson-Evers International	219	190	19.3	1,090,909	42.0
Nashville International	219	155	16.9	7,289,304	58.5
Birmingham International	237	176	18.9	2,499,696	41.4

(a) Estimated distance from downtown Memphis to each airport provided by Google-Map data online service.
(b) Cents per passenger-mile.
(c) LCC = low cost carrier, including AirTran, Frontier, Southwest, jetBlue.

Sources: U.S. Department of Transportation, *Origin-Destination Survey* online database and Official Airline Guides, Inc. online database. June 2008.

ECONOMIC BASIS FOR AVIATION DEMAND

The economy of an airport's service region is an important determinant of long-term passenger demand at that airport. This section presents a discussion of the economic basis for airline traffic at the Airport and a summary of the economic outlook for the Airport service region.

Population

Table 2 shows historical and projected population for the Memphis MSA, the State of Tennessee, and the United States. Between 1997 and 2007, the Memphis MSA population increased an average of 1.7% per year. During this same period, population in the State of Tennessee and the United States as a whole increased 1.4% and 1.2% per year, respectively.

Table 2

HISTORICAL AND PROJECTED POPULATION
Master Plan Update
Memphis International Airport

	Memphis MSA *(a)*	State of Tennessee	United States
Historical			
1987	1,039,000	4,783,000	242,289,000
1997	1,081,000	5,378,000	267,784,000
2007	1,281,000	6,157,000	301,621,000
Projected			
2012	1,327,900	6,410,000	317,592,000
2017	1,373,000	6,730,000	333,735,000
2027	1,479,000	7,455,000	371,249,000
	Average annual increase		
Historical			
1987-1997	0.4%	1.2%	1.0%
1997-2007	1.7	1.4	1.2
1987-2007	1.1	1.3	1.1
Projected			
2007-2017	0.7%	0.9%	1.0%
2017-2027	0.7	1.0	1.1
2007-2027	0.7	1.0	1.0

(a) The Memphis Metropolitan Statistical Area (MSA) presented here is the 2000 Bureau of Economic Analysis (BEA) definition which includes Fayette, Shelby and Tipton counties in Tennessee; DeSoto, Marshall, Tate and Tunica counties in Mississippi; and Crittenden County in Arkansas. Prior to 2003, the BEA definition of the Memphis MSA excluded Marshall, Tate and Tunica counties in Mississippi.

Sources: Historical – U.S. Census Bureau.
Projected – NPA Data Services, Inc.

Metropolitan Area Economy

Nonagricultural employment in the Memphis MSA is presented in Table 3. Between 1997 and 2007, nonagricultural employment in the Memphis MSA increased an average of 1.3% per year. During the same period, employment in the State of Tennessee and the United States increased 0.8% and 1.2% per year, respectively.

Table 3

HISTORICAL AND PROJECTED NONAGRICULTURAL EMPLOYMENT (THOUSANDS)
Master Plan Update
Memphis International Airport

	Memphis MSA *(a)*	State of Tennessee	United States
Historical			
1987	437,600	2,011,700	102,088,000
1997	563,300	2,584,000	122,690,000
2007	642,700	2,796,600	137,623,000
Projected			
2012	676,000	2,982,000	146,821,000
2017	709,000	3,171,000	156,364,000
2027	788,000	3,623,000	179,503,000
	Average annual increase		
Historical			
1987-1997	2.6%	2.5%	1.9%
1997-2007	1.3	0.8	1.2
1987-2007	1.9	1.7	1.5
Projected			
2007-2017	1.0%	1.3%	1.3%
2017-2027	1.1	1.3	1.4
2007-2027	1.0	1.3	1.4

(a) The Memphis Metropolitan Statistical Area (MSA) presented here is the 2000 Bureau of Economic Analysis (BEA) definition which includes Fayette, Shelby and Tipton counties in Tennessee; DeSoto, Marshall, Tate and Tunica counties in Mississippi; and Crittenden County in Arkansas. Prior to 2003, the BEA definition of the Memphis MSA excluded Marshall, Tate and Tunica counties in Mississippi.

Sources: Historical – U.S. Census Bureau.
Projected – NPA Data Services, Inc.

Employment in the Memphis MSA is expected to increase at an annual rate of 1.0% from 2007 to 2027 compared to 1.3% for Tennessee and 1.4% for the U.S. over the same period. As of April 2008, according to the U.S. Department of Labor, Bureau of Labor Statistics, the Memphis unemployment rate was 5.5%, compared with 5.1% for Tennessee and the national average of 5.0%.

According to data published by the U.S. Department of Commerce, Bureau of Economic Analysis, in 2006 (the latest year for which data are available), per capita income in the Memphis MSA was $35,113, approximately 95.6% of the national average of $36,714.

Major Employers. Table 4 lists the largest employers in the Memphis MSA as of May 2007. The list of top employers reflects the importance of FedEx, as well as the education, government, and health care industries with respect to employment in the region. The list also demonstrates the diversity of the various employer entities located in Memphis.

Table 4

MEMPHIS MSA TOP EMPLOYERS – 2007
Master Plan Update
Memphis International Airport

Employer	Number of employees *(a)*	Industry
Federal Express Corporation	30,000	Transportation
Memphis City Schools	15,240	Primary and secondary education
United States Government	14,700	Federal government
Methodist Healthcare	8,717	Integrated health care delivery system
City of Memphis	6,741	City government
Baptist Memorial Healthcare Corp.	6,585	General medical hospitals and health service
Shelby County Government	6,513	County government
Naval Support Activity Mid-South	6,372	Military installation
Wal-Mart Stores, Inc.	6,000	Discount general merchandise
Harrah's Entertainment	5,541	Casino entertainment, management and development
Tennessee State Government	5,247	State government
Shelby County Schools	5,200	Primary and secondary education
University of Tennessee Health Science Center	3,750	Health science university
DeSoto County School District	3,600	Primary and secondary education
The Kroger Co.	3,500	Retail groceries
First Horizon National Corp.	3,423	Financial service, insurance and investments
St. Jude Children's Research Hospital	3,066	Medical research hospital
Technicolor Video Services, Inc.	2,800	Retail provider of video tapes, DVDs, software
Memphis Light, Gas and Water	2,700	Utility services
UTC-Carrier Corp.	2,700	Split-system condensing units and heat pumps
The University of Memphis	2,605	Post-secondary graduate and legal education
Regional Medical Center at Memphis	2,600	General medical center
International Paper Company	2,500	Paper, packaging & forest products
The ServiceMaster Co.	2,411	Landscaping, disaster restoration, cleaning services
Walgreen Co.	2,275	Retail drugs and sundries

(a) Full-time equivalent employees.

Source: Memphis BizJournal, April 27-May 3, 2007.

Industry Shares of Nonagricultural Employment. Table 5 presents data on the percentage distribution of nonagricultural employment by industry sector in 2000 and 2007. Services (totaling 28.8%) and trade, transportation and utilities (27.3%), and government (13.8%) accounted for over two-thirds of the Memphis MSA's nonagricultural employment in 2007.

Table 5

NONAGRICULTURAL EMPLOYMENT BY SECTOR
Master Plan Update
Memphis International Airport

	Memphis MSA *(a)*		State of Tennessee		United States	
Industry sector	2000	2007	2000	2007	2000	2007
Trade, transportation and utilities	28.3%	27.3%	21.7%	21.9%	19.9%	19.3%
Professional and business services	12.0	13.0	11.1	11.5	12.6	13.1
Government	13.6	13.8	14.6	15.1	15.8	16.1
Education and health services	10.2	12.0	10.3	12.5	11.5	13.3
Leisure and hospitality	10.5	11.3	8.6	9.9	9.0	9.8
Manufacturing	10.1	8.2	18.1	13.6	13.1	10.1
Financial activities	5.3	5.2	5.2	5.2	5.8	6.0
Information	1.6	1.2	2.0	1.8	2.8	2.2
Other services	4.1	3.8	3.5	3.7	3.9	4.0
Natural resources, mining, and construction	4.4	4.1	4.8	4.9	5.6	6.1
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

(a) Metropolitan Statistical Area.

Source: U.S. Department of Labor, Bureau of Labor Statistics. June 2008.

Transportation and Distribution. As shown in Table 5, the share of employment in trade, transportation and utilities in the Memphis MSA (27.3%) is approximately 41% higher than the national average (19.3%). The large share of employment in the transportation sector reflects the importance of Memphis as a national transportation and distribution center and its history as a port on the Mississippi River. The role of Memphis as a transportation hub has been supported by the expansion of railroads, the interstate highway system, and the Airport, which together continue to provide the economic basis for its development as America's Distribution Center.

Historically, Memphis has been a key processing, trading, and distribution center for the agricultural areas of the Mississippi delta, and it is the regional trading center for farmers from portions of six states. Memphis is the nation's leading trading center for cotton and hardwood and is one of the largest centers for the processing of soybeans, grains, meat, and other agricultural products.

Favorable barge transportation rates and port facilities that allow the convenient transfer of commodities between barge and rail or highway transport modes contribute to making Memphis the fourth largest inland port in the nation. Several barge lines provide service between the inland waterway system and the Memphis port, where over 17 million tons of freight are handled annually.

Memphis is the third largest rail freight center in the United States and is one of only three U.S. cities served by five or more Class I railroads. The metropolitan area is an important motor carrier hub. Several federal and interstate highways converge at Memphis and two highway bridges cross the Mississippi River. The City's central geographic location allows rapid rail and truck service to many parts of the country. (Over 150 metropolitan statistical areas and approximately 43% of the U.S. population are located within 600 miles of Memphis.) The importance of Memphis as an intermodal transfer point has been reinforced by the development of several modern rail-truck freight and container transfer centers.

Air cargo and passenger services provided at the Airport are important to the Memphis economy. FedEx provides overnight and other freight services throughout the world via its express package sorting facility at the Airport. FedEx is the largest employer in the Memphis MSA, with 30,000 employees. As discussed in the later section Historical Airline Traffic, the Airport is a passenger transfer hub for Northwest Airlines, which employs approximately 2,000 people in the Memphis MSA.

Memphis has several major warehousing, distribution, and centralized inventory and customer fulfillment centers, with associated communications and information technology facilities that support its role as a transportation hub and an increasingly important port of entry into the United States. The Memphis MSA's warehouse, distribution, and related industrial facilities account for over 130 million square feet and include some of the largest distribution centers in the nation. During the past decade, Memphis has developed as a center for information technology, complementing and extending its role as a distribution center.

The transportation, distribution, and communications industries are expected to continue to be important contributors to the economic development of the Memphis MSA. Its central location and well-established transportation infrastructure are seen as providing important competitive advantages over other metropolitan areas in attracting manufacturing and other business activity.

Government. Major U.S. government employers in the Memphis MSA are the City of Memphis, which employs about 6,700 people and the U.S. Navy, which operates the Bureau of Naval Personnel and other facilities at Millington in Shelby County and employs about 6,400 people.

The federal government, Shelby County, and the State of Tennessee together employ about 26,500 people in the Memphis MSA, and the Memphis and Shelby County school systems collectively employ about 24,000 people.

Services. Memphis is a leading medical center with 13 hospitals and 34 nursing homes. According to the Memphis Area Chamber of Commerce, the total health care contribution to the Memphis economy each year is over $5 billion. Approximately 11% of the MSA's employment is in health care-related industries, including over 13,000 people employed in biomedical research, pharmaceuticals, and education. St. Jude Children's Research Hospital is a world leader in research and treatment of pediatric diseases. A recent billion-dollar expansion of the facility added approximately 1,200 jobs, bringing its total employment to over 3,000. In addition, a new biotechnology research park is being built in the Memphis MSA by the Baptist Memorial Healthcare Corporation. About 45,000 students attend the University of Memphis; the University of Tennessee, Memphis; and 8 other institutions of higher education in Memphis.

Since 1993, Tunica, Mississippi, located about 35 miles south of the Airport, has become a center for gambling casinos and resorts along the Mississippi River. Nine casinos are in operation and associated hotels provide over 6,000 rooms. The casinos complement other Memphis area attractions and have increased the number of visitors to the Airport service region.

Leisure and Hospitality. The leisure and hospitality sector is of increasing importance to the Memphis MSA economy, accounting for approximately 11.3% of total employment in 2007, up from 10.5% in 2000, as shown in Table 5. According to the Memphis Convention and Visitors Bureau, the Memphis region attracts over 9 million visitors and generates about $2.85 billion in visitor expenditures annually, as shown in Table 6. A recent book published by Life Books "Dream Destinations: 100 of the World's Best Vacations" named Memphis to its list of best tourism destinations because of its diverse attractions and increasing popularity as a historical destination.

From Table 6, it is seen that historical visitor expenditures have increased at an annual rate of 4.4% from 1995 to 2006 (latest data available). Memphis has over 50 tourism attractions including Graceland and the Beale Street Historic District. To accommodate visitor traffic, the number of hotel rooms in the Memphis MSA has also increased from approximately 14,000 in 1995 to over 19,500 in 2006, as shown in Table 7.

Table 6

TOURISM ECONOMIC IMPACT (MEMPHIS AND SHELBY COUNTY)
Master Plan Update
Memphis International Airport

Year	Visitor expenditures (millions)	Employment (thousands)	Employment payroll (millions)
1995	$1,785.11	38.73	$ 952.25
1996	1,898.43	46.33	1,194.39
1997	2,022.64	47.84	1,263.60
1998	2,116.26	50.42	1,481.24
1999	2,202.20	51.31	1,564.36
2000	2,310.70	51.31	1,627.47
2001 *(a)*	2,244.51	45.19	1,570.80
2002	2,327.80	50.35	1,732.82
2003	2,370.26	50.65	1,772.25
2004	2,455.99	49.33	1,770.02
2005	2,639.58	49.60	1,830.99
2006	2,854.13	50.41	1,873.65
	Average annual increase (decrease)		
1995-2000	5.3%	5.8%	11.3%
2000-2006	3.6	(0.3)	2.4
1995-2006	4.4	2.4	6.3

(a) Employment and employment payroll are estimate for 2001.

Source: Memphis and Shelby County Tourism Economic Impact Study, 2006.

Table 7

HOTEL AND MOTEL ROOMS (MEMPHIS AND SHELBY COUNTY)
Master Plan Update
Memphis International Airport

Year	Hotel and motel rooms	Percent occupancy
1995	14,002	70.5%
1996	14,398	68.1
1997	15,261	66.4
1998	15,856	64.9
1999	17,191	61.6
2000	18,019	59.7
2001	18,659	58.0
2002	19,951	57.0
2003	20,650	57.1
2004	20,321	58.3
2005	19,562	63.9
2006	19,544	63.6

	Average annual percent change
1995-2000	5.2%
2000-2006	1.4
1995-2006	3.1

Source: Memphis and Shelby County Tourism Economic Impact Study, 2006.

Income

Table 8 shows historical and projected per capita income for the Memphis MSA, the State of Tennessee, and the United States. Per capita income in the Memphis MSA has historically been higher than in the State and slightly lower than in the United States as a whole. Between 1987 and 2007, per capita income increased an average of 2.0% per year compared to the same for Tennessee and 1.7% for the United States. Over the forecast period, per capita income for the Memphis MSA is expected to increase at annual rate of 1.8% compared to 1.8% for Tennessee and 1.6% for the United States.

Table 8

HISTORICAL AND PROJECTED PER CAPITA INCOME
Master Plan Update
Memphis International Airport

	Memphis MSA *(a)*	State of Tennessee	United States
Historical			
1987	21,242	19,695	23,059
1997	26,334	23,922	26,647
2007	31,321	29,018	32,283
Projected			
2012	34,596	32,048	35,197
2017	37,662	34,901	37,917
2027	44,803	41,688	44,506
	Average annual increase		
Historical			
1987-1997	2.2%	2.0%	1.5%
1997-2007	1.7	1.9	1.9
1987-2007	2.0	2.0	1.7
Projected			
2007-2017	1.9%	1.9%	1.6%
2017-2027	1.8	1.8	1.8
2007-2027	1.8	1.8	1.6

Note: In 2000 dollars, except percentages.

(a) The Memphis Metropolitan Statistical Area (MSA) presented here is the 2000 Bureau of Economic Analysis (BEA) definition which includes Fayette, Shelby and Tipton counties in Tennessee; DeSoto, Marshall, Tate and Tunica counties in Mississippi; and Crittenden County in Arkansas. Prior to 2003, the BEA definition of the Memphis MSA excluded Marshall, Tate and Tunica counties in Mississippi.

Sources: Historical – U.S. Census Bureau.
Projected – NPA Data Services, Inc.

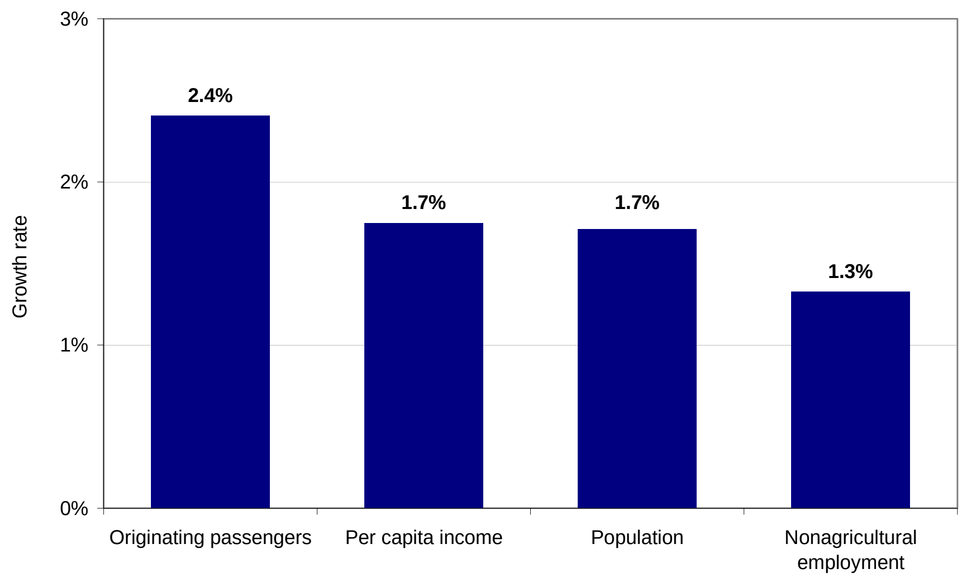
Economic Summary

Since the early 1980s, Memphis has earned its reputation as America's Distribution Center. The transportation, distribution, and communications facilities provided in the Memphis MSA are key reasons that Memphis has been successful in attracting new industry and business activity. Other advantages of the Memphis MSA cited by the University of Memphis, Bureau of Business and Economic Research; the Memphis Area Chamber of Commerce; and other economic analysts include a productive labor force, ample developable land, a relatively low cost of living, relatively low tax rates, and the availability of electrical power from the Tennessee Valley Authority at rates lower than in most other major metropolitan areas. Analysts of the Memphis economy also expect that as the national and global economies expand, Memphis will continue to attract domestic and international business activity and, with it, increased passenger and cargo activity at Memphis International Airport.

Figure 2 shows that the historical growth rate of 2.4% for originating passengers at the Airport is greater than the rates for per capita income, population, and nonagricultural employment. Further historical trends in passenger activity at the airport are presented in the following section.

Figure 2

HISTORICAL ORIGINATING PASSENGERS AND ECONOMIC GROWTH (1997-2007)
Master Plan Update
Memphis International Airport



Sources: Originating passenger growth rate based on Memphis-Shelby County Airport Authority activity records; population, nonagricultural employment, and per capita income data sourced in Tables 2, 3, and 8 of this report.

Section 2

HISTORICAL AVIATION DEMAND

Table 9 illustrates that the Airport has scheduled service by most of the mainline carriers and/or their regional affiliates. As of May 2008, this included 8 mainline airlines and 12 regional airlines. Frontier Airlines began service in May 2007, but following their bankruptcy filing in April 2008, they have ceased scheduled service to the Airport in June 2008 as part of a system-wide capacity and cost reduction plan.

Table 9

SCHEDULED AIRLINES
Master Plan Update
Memphis International Airport

Mainline	Regional
Air Tran Airways	American Eagle *(b)*
American Airlines	Atlantic Southeast Airlines *(c)*
Continental Airlines *(a)*	Chautauqua Airlines *(c)*
Delta Air Lines	Comair *(c)*
Frontier Airlines	Compass Airlines *(d)*
Northwest Airlines	Express Jet *(e)*
United Airlines *(a)*	Mesa Airlines *(f)*
US Airways *(a)*	Mesaba Aviation *(d)*
	Pinnacle Airlines *(d)*
	PSA *(f)*
	SkyWest *(c)(g)*
	Trans States Airlines *(b)*

(a) These air carriers are the published operators, however, only their regional affiliates provide service at Memphis.
(b) Affiliated with American Airlines.
(c) Affiliated with Delta Air Lines.
(d) Affiliated with Northwest Airlines.
(e) Affiliated with Continental Airlines.
(f) Affiliated with US Airways.
(g) Affiliated with United Airlines.

Source: Official Airline Guides, Inc. online database, May 2008.

As shown in Table 10, Northwest has historically held the dominant market share at the Airport. While Northwest has continued its hubbing operation at the Airport, its market share has decreased slightly from about 83% to about 80% of total enplaned passengers between 2003 and 2007. While Northwest continues to dominate the Memphis market, AirTran, American, and US Airways have increased their market share over the 2003 to 2007 period.

Table 10

AIRLINE MARKET SHARES OF ENPLANED PASSENGERS
Master Plan Update
Memphis International Airport

Airlines *(a)*	2003 Enplaned passengers	2003 Share of total	2005 Enplaned passengers	2005 Share of total	2007 Enplaned passengers	2007 Share of total
Air Tran Airways	118,405	2.2%	147,041	2.7%	168,519	3.1%
America West	24,944	0.5	47,654	0.9	-	0.0
American Airlines	141,782	2.6	199,312	3.7	207,710	3.9
Continental Airlines	97,710	1.8	99,684	1.8	101,436	1.9
Delta Air Lines	353,557	6.5	365,000	6.7	253,632	4.7
Frontier Airlines	--	0.0	--	0.0	46,386	0.9
Northwest Airlines						
Mainline *(b)*	2,927,885	54.2	2,747,939	50.5	2,595,909	48.5
Regional	1,534,074	28.4	1,616,506	29.7	1,706,936	31.9
	4,431,397	82.6	4,364,445	80.2	4,302,845	80.3
United Airlines	95,226	1.8	120,221	2.2	99,509	1.9
US Airways	81,329	1.5	92,479	1.7	171,390	3.2
Other airlines *(c)*	28,913	0.5	7,749	0.1	5,187	0.1
Total	5,403,825	100.0%	5,443,585	100.0%	5,356,614	100.0%

(a) Includes passengers enplaned on regional affiliates.
(b) Includes KLM.
(c) Includes various regional airlines and unscheduled charter airlines.

Source: Memphis-Shelby County Airport Authority records, June 2008.

An analysis of scheduled airline departures and scheduled airline seats is presented in Table 11. The results of this analysis demonstrate the dominance of Northwest which has increased its scheduled seat market share from 75.7% in 2000 to 80.0% in 2008. During the same period, American Airlines has almost doubled its scheduled seat market share from 2.8% in 2000 to 5.1% in 2008, while Delta Air Lines' market share has fallen considerably from 10.2% in 2000 to 4.1% in 2008.

Table 11

AVERAGE DAILY SCHEDULED AIRCRAFT DEPARTURES AND SEATS
Master Plan Update
Memphis International Airport

	Total scheduled daily departing seats								
Average daily seats	2000	2001	2002	2003	2004	2005	2006	2007	2008
Airline *(a)*									
AirTran	424	476	424	429	566	570	562	785	679
America West *(b)*	--	--	--	134	169	172	175	--	--
American	632	728	815	673	725	934	1,021	1,079	1,065
Continental	438	516	519	444	495	459	414	435	484
Delta	2,267	2,176	1,681	1,604	1,593	1,558	1,246	1,032	867
Frontier	--	--	--	--	--	--	--	281	144
Northwest	16,795	20,989	16,192	18,247	16,769	18,375	17,485	17,389	16,819
United	535	420	300	339	400	463	429	405	349
US Airways	569	572	714	339	394	495	354	585	617
Other	540	517	294	286	--	--	76	--	--
Total	22,200	26,394	20,940	22,493	21,111	23,025	21,763	21,991	21,024

	Share of total scheduled daily departing seats								
Percent of total	2000	2001	2002	2003	2004	2005	2006	2007	2008
Airline *(a)*									
AirTran	1.9%	1.8%	2.0%	1.9%	2.7%	2.5%	2.6%	3.6%	3.2%
America West *(b)*	0.0	0.0	0.0	0.6	0.8	0.7	0.8	0.0	0.0
American	2.8	2.8	3.9	3.0	3.4	4.1	4.7	4.9	5.1
Continental	2.0	2.0	2.5	2.0	2.3	2.0	1.9	2.0	2.3
Delta	10.2	8.2	8.0	7.1	7.5	6.8	5.7	4.7	4.1
Frontier	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.7
Northwest	75.7	79.5	77.3	81.1	79.4	79.8	80.3	79.1	80.0
United	2.4	1.6	1.4	1.5	1.9	2.0	2.0	1.8	1.7
US Airways	2.6	2.2	3.4	1.5	1.9	2.1	1.6	2.7	2.9
Other	2.4	2.0	1.4	1.3	0.0	0.0	0.4	0.0	0.0
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

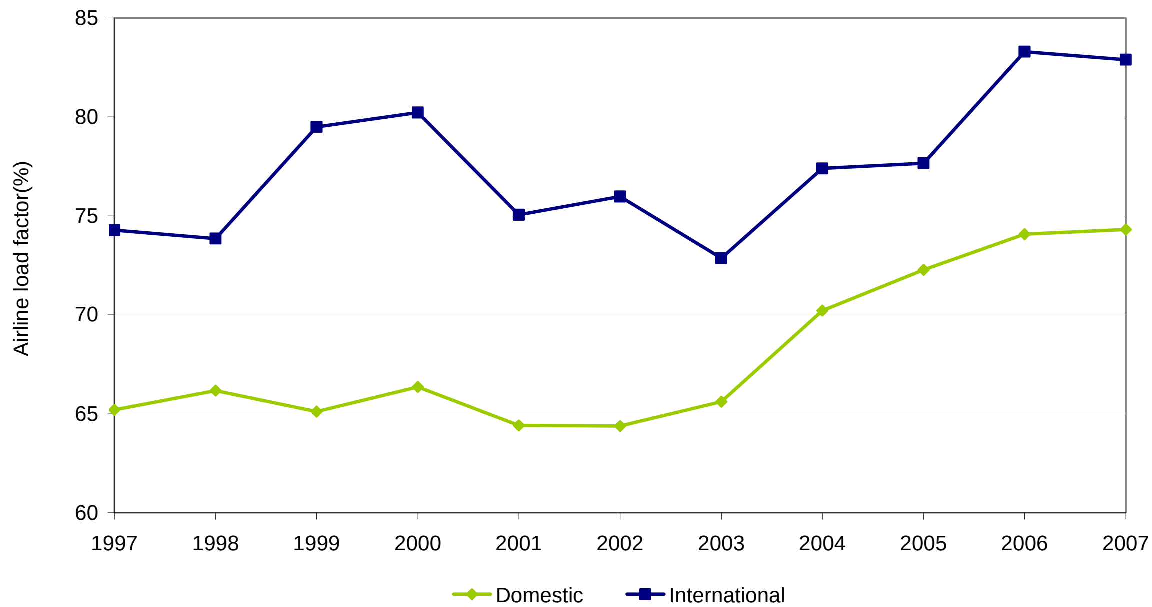
(a) Includes service on mainline and regional affiliates.
(b) America West merged with US Airways in 2005 and reported scheduled departures as America West through 2006.

Source: Official Airline Guides, Inc. online database, June 2008.

An aircraft's load factor is the percentage of available seats that are filled by passengers. From 1997 through 2002, domestic load factors from Memphis remained near 65%, but beginning in 2003 they increased steadily to approximately 74% in 2007 (see Figure 3). International load factors, which tend to be higher than domestic because of less scheduled capacity on international routes, has also increased significantly from 2003 to 2007. The forecast assumes that domestic and international load factors will increase gradually over the forecast horizon.

Figure 3

HISTORICAL AIRLINE LOAD FACTORS
Master Plan Update
Memphis International Airport



Source: U.S. Department of Transportation T100 database.

ENPLANED PASSENGER TRENDS

As shown in Table 12, total enplaned passengers at the Airport increased from approximately 4.9 million in 1997 to 5.4 million in 2007, which equates to an annual compound growth rate of approximately 0.8%. Over this historical period there has been a significant amount of variability in the long-term historical trends as shown on Figure 4. Enplaned passenger traffic decreased from its 1987 peak through 1993. This decrease was primarily the result of scheduling changes made by Northwest after it acquired Republic Airlines and its connecting Airport operation in 1986. Northwest reduced the number of connecting banks at the Airport as part of a system-wide adjustment following their merger with Republic Airlines which resulted in a temporary reduction in enplaned passengers at the Airport. There was also a national economic recession in the early 1990s which contributed to this decrease.

Table 12

HISTORICAL DOMESTIC AND INTERNATIONAL ENPLANED PASSENGERS
Master Plan Update
Memphis International Airport

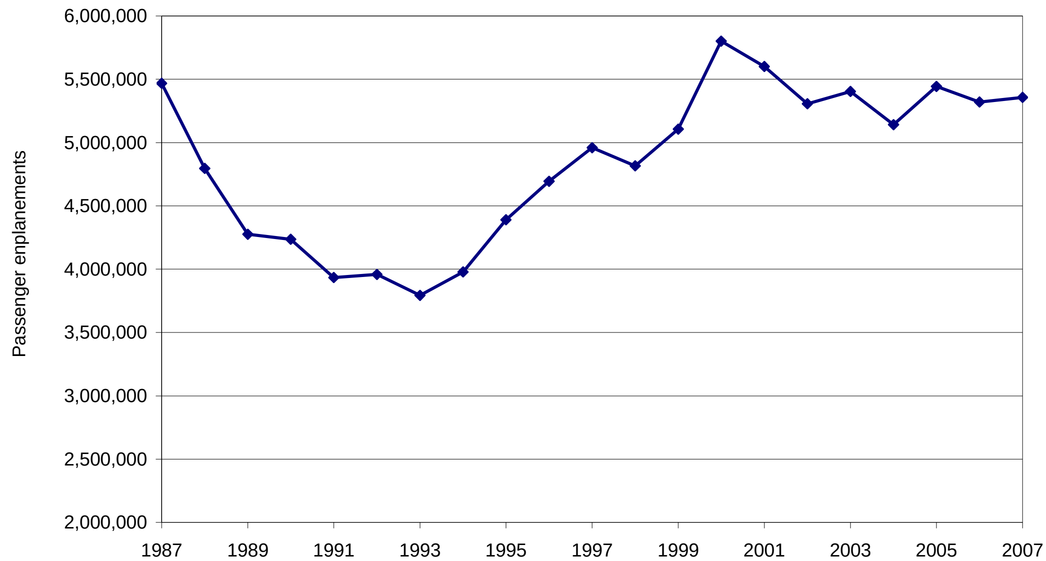
Year	Domestic	Domestic share	International	International share	Total	Annual average increase (decrease)
1987	5,413,367	99.0%	54,856	1.0%	5,468,223	--%
1988	4,745,357	98.9	50,523	1.1	4,795,880	-12
1989	4,234,414	99.0	41,385	1.0	4,275,799	-11
1990	4,193,147	99.0	42,417	1.0	4,235,564	-1
1991	3,893,910	99.0	39,664	1.0	3,933,574	-7
1992	3,926,519	99.2	32,507	0.8	3,959,026	1
1993	3,763,912	99.2	29,298	0.8	3,793,210	-4
1994	3,949,716	99.3	28,431	0.7	3,978,147	5
1995	4,324,572	98.5	65,149	1.5	4,389,721	10
1996	4,582,660	97.6	112,002	2.4	4,694,662	7
1997	4,828,150	97.4	130,370	2.6	4,958,520	6
1998	4,686,129	97.3	130,208	2.7	4,816,337	-3
1999	4,975,711	97.4	130,314	2.6	5,106,025	6
2000	5,654,848	97.5	146,220	2.5	5,801,068	14
2001	5,466,791	97.6	134,481	2.4	5,601,272	-3
2002	5,155,488	97.2	150,985	2.8	5,306,473	-5
2003	5,227,644	96.7	176,181	3.3	5,403,825	2
2004	4,989,685	97.0	152,170	3.0	5,141,855	-5
2005	5,286,306	97.1	157,279	2.9	5,443,585	6
2006	5,150,732	96.8	169,214	3.2	5,319,946	-2
2007	5,175,715	96.6	180,899	3.4	5,356,614	1
	Average annual increase (decrease)					
1987-1997	-1.1%	-0.2%	9.0%	10.1%	-1.0%	
1997-2002	1.3	0.0	3.0	1.6	1.4	
2002-2007	0.1	-0.1	3.7	3.5	0.2	
1997-2007	0.7	-0.1	3.3	2.5	0.8	
1987-2007	-0.2	-0.1	6.1	6.3	-0.1	

Source: Memphis-Shelby County Airport Authority records, June 2008.

Historically, domestic enplanements have accounted for the majority of Airport enplanements ranging from 99.0% in 1987 to 96.6% in 2007. International enplanements have been gradually increasing their share rising from 1.0% in 1987 to 3.4% in 2007. Although international enplanements represent a small percentage of total enplanements, they have been increasing at a much faster annual rate than domestic enplanements. From 1997 to 2007, international enplanements increased at an annual rate of 3.3% versus an annual rate of 0.7% for domestic enplanements over the same period.

Figure 4

HISTORICAL ENPLANEMENTS
Master Plan Update
Memphis International Airport



Source: Memphis-Shelby County Airport Authority records, June 2008.

Originating Passengers

Originating passengers are those passengers who begin their trip at an airport in contrast to connecting passengers who are those passengers that arrive at an airport on an inbound flight and then change planes en route to their final destination. Originating passengers at the Airport have increased from approximately 1.5 million in 1990 to 2.4 million in 2007 as shown in Table 13. Originating passenger share of total enplanements has also generally increased from approximately 35.8% in 1990 to 44.1% in 2007. From 1997 to 2007, originating passengers have increased at an annual rate of 2.4% compared to 2.0% for domestic U.S. originating enplanement over the same period.

This growth has followed a trend similar to national patterns with steady growth from 1997 through 2000 and then a decline in traffic from 2000 through 2002 as a result of September 11th and generally poor national economic conditions. This short but significant decline in traffic was followed by a period of relatively strong growth that occurred at an annual rate of 5.2% from 2002 through 2007. This period of relatively rapid growth, began in 2003 as traffic at Memphis, and on a national basis, recovered from the effects of September 11th and the weak economic conditions in the early 2000s. Growth in originating traffic at the Airport was also supported by the increase in scheduled departures and seats on Northwest from 2000 to 2005 (see Connecting Passengers section). Significant originating traffic growth at Memphis occurred on a number of airlines in addition to Northwest, including AirTran and American. In addition, Frontier Airlines initiated new service at the Airport in May of 2007.

Table 13

HISTORICAL ORIGINATING AND CONNECTING PASSENGERS
Master Plan Update
Memphis International Airport

Year	Originating	Originating share	Connecting *(c)*	Connecting share	Total	Annual average increase (decrease)
1990 *(a)*	1,518,350	35.8%	2,717,214	64.2%	4,235,564	--%
1992	1,436,920	36.5	2,496,654	63.5	3,933,574	-7
1992	1,458,840	36.8	2,500,186	63.2	3,959,026	1
1993	1,472,180	38.8	2,321,030	61.2	3,793,210	-4
1994	1,612,980	40.5	2,365,167	59.5	3,978,147	5
1995	1,742,410	39.7	2,647,311	60.3	4,389,721	10
1996	1,804,370	38.4	2,890,292	61.6	4,694,662	7
1997	1,861,850	37.5	3,096,670	62.5	4,958,520	6
1998	1,921,860	39.9	2,894,477	60.1	4,816,337	-3
1999	1,970,140	38.6	3,135,885	61.4	5,106,025	6
2000	2,035,870	35.1	3,765,198	64.9	5,801,068	14
2001	1,854,170	33.1	3,747,102	66.9	5,601,272	-3
2002	1,835,880	34.6	3,470,593	65.4	5,306,473	-5
2003	1,917,630	35.5	3,486,195	64.5	5,403,825	2
2004	2,061,620	40.1	3,080,235	59.9	5,141,855	-5
2005	2,178,340	40.0	3,265,245	60.0	5,443,585	6
2006	2,266,770	42.6	3,053,176	57.4	5,319,946	-2
2007 *(b)*	2,361,735	44.1	2,994,879	55.9	5,356,614	1
	Average annual increase (decrease)					
1990-1997	3.0%		1.9%		2.3%	
1997-2002	-0.3		2.3		1.4	
2002-2007	5.2		-2.9		0.2	
1997-2007	2.4		-0.3		0.8	
1990-2007	2.6		0.6		1.4	

(a) Data for origin and destination enplanements available from 1990 to present.
(b) Estimate shown for 2007 originating passengers.
(c) Connecting passengers are calculated by subtracting origin and destination enplanements from total enplanements.

Sources: Originating passenger totals from U.S. Department of Transportation *Origin-Destination Survey* online database; total enplanements from Memphis-Shelby County Airport Authority records, June 2008.

Connecting Passengers

As a major connecting hub airport in the national route system of Northwest, a significant amount of enplanements connect at the Airport (see Table 13).

From 1990 (earliest available data) to 2007 the majority of the Airport's passengers were connecting, and the annual share of connecting passengers ranged from approximately 64.2% in 1990 to a high of 66.9% in 2001 and to a low of 55.9% in 2007. During this period there was a significant amount of variability in the number of connecting passengers from year to year. Connecting passengers ranged from approximately 2.7 million in 1990 to a peak of 3.8 million in 2000 and have declined to approximately 3.0 million in 2007. From 1990 to 2007, connecting passengers increased at an annual rate of 0.6%.

The 2000 peak in connecting passengers occurred following the addition of a fourth daily connecting bank by Northwest in 2000. A connecting bank is a scheduled group of arriving and departing flights arranged to transfer connecting passengers during a specific period of the day. Northwest's fourth connecting bank was operational from January 2000 through September 2001 when it was discontinued following the slowdown in national traffic after September 11. The fourth connecting bank was reinstated in June 2002 and maintained until January 2004 when it was again discontinued. Although the fourth connecting bank was discontinued in 2004, Northwest increased scheduled seats in 2005 by adding departures to their flight schedule.

Table 14 lists the Airport's top 25 domestic origin and destination markets. These markets accounted for 61.9% of the total domestic origin and destination passengers at the Airport in 2007. The five largest markets for Airport passengers are Atlanta, New York City, Washington, D.C., Orlando, and Los Angeles. Table 14 also presents the average daily scheduled nonstop departures to the origin-destination markets.

Table 15 presents the percent of average daily scheduled seats to the Airport's top 25 origination-destination airports. To all but seven markets, Northwest controls a dominant scheduled seat market share. Each of the seven markets not dominated by Northwest is a hub airport for other airlines. For example, Northwest provides only 18% of the scheduled seats to Atlanta, which serves as the primary hub for both AirTran and Delta. In total, 65% of the scheduled seats to the top 25 origination-destination markets are provided by Northwest.

Table 14

DOMESTIC PASSENGER ORIGIN-DESTINATION PATTERNS
Master Plan Update
Memphis International Airport

Market	Air miles from Memphis	Percent of total originating passengers *(a)*	Daily scheduled nonstop departures *(b)*
Atlanta	384	6.7%	17
New York *(c)*	960	5.1	8
Washington D.C. *(d)*	753	4.6	5
Orlando	683	4.3	5
Los Angeles *(e)*	1,578	4.1	3
Chicago *(f)*	417	3.7	12
Dallas/Fort Worth *(g)*	425	2.6	8
Las Vegas	1,385	2.5	2
Miami/Fort Lauderdale *(h)*	941	2.4	5
Denver	819	2.3	6
Charlotte	554	2.1	9
San Francisco *(i)*	1,767	2.0	1
Houston *(j)*	530	2.0	10
Detroit	583	2.0	7
Philadelphia	868	1.9	3
Minneapolis	603	1.9	8
Boston	1,097	1.8	2
Tampa	744	1.7	3
Phoenix	1,268	1.4	3
Raleigh/Durham	669	1.4	3
Seattle	1,824	1.3	1
Jacksonville	648	1.3	3
Pittsburgh	566	1.1	3
Indianapolis	331	1.0	3
Columbus	449	1.0	3
Subtotal - top 25 markets		61.9%	133
Subtotal - other markets		38.1%	148
Total - all markets		100.0%	281

(a) Percentage of originating passengers for January though September 2007.
(b) Official Airlines Guides, Inc. online database.
(c) John F. Kennedy, LaGuardia, and Newark Liberty International airports.
(d) Baltimore/Washington International, Washington Dulles International, and Reagan Washington National airports.
(e) Los Angeles International, Bob Hope (Burbank), John Wayne (Orange County), Ontario International, and Long Beach airports.
(f) O'Hare International and Midway International airports.
(g) Dallas/Fort Worth International and Dallas Love Field airports.
(h) Miami International and Fort Lauderdale International airports.
(i) San Francisco International, Mineta San Jose International, and Oakland International airports.
(j) George Bush Intercontinental and William P. Hobby airports.

Source: U.S. Department of Transportation *Origin-Destination Survey* online database, June 2008.

Table 15

DAILY DEPARTING SEATS TO TOP ORIGIN-DESTINATION MARKETS
Master Plan Update
Memphis International Airport

Market	Percent of average daily scheduled seats: Northwest Airlines	Percent of average daily scheduled seats: Other airlines	Other airline
Atlanta	18%	82%	AirTran, Delta
New York	81	19	Continental
Washington D.C.	100	0	--
Orlando	77	23	AirTran, Delta
Los Angeles	100	0	--
Chicago	39	61	American, United
Dallas/Fort Worth	29	71	American
Las Vegas	93	7	Frontier
Miami/Fort Lauderdale	83	17	American
Denver	44	56	Frontier, United
Charlotte	26	74	US Airways
San Francisco	100	0	--
Houston	38	62	Continental
Detroit	100	0	--
Philadelphia	100	0	--
Minneapolis	100	0	--
Boston	100	0	-
Tampa	100	0	--
Phoenix	46	54	US Airways
Raleigh/Durham	100	0	--
Seattle	100	0	--
Jacksonville	100	0	--
Pittsburgh	100	0	--
Indianapolis	100	0	--
Columbus	100	0	--
Subtotal - top 25 markets	65%	35%	
Subtotal - other markets	95%	5%	
Total - all markets	79%	21%	

Source: U.S. Department of Transportation *Origin-Destination Survey* online database, June 2008.

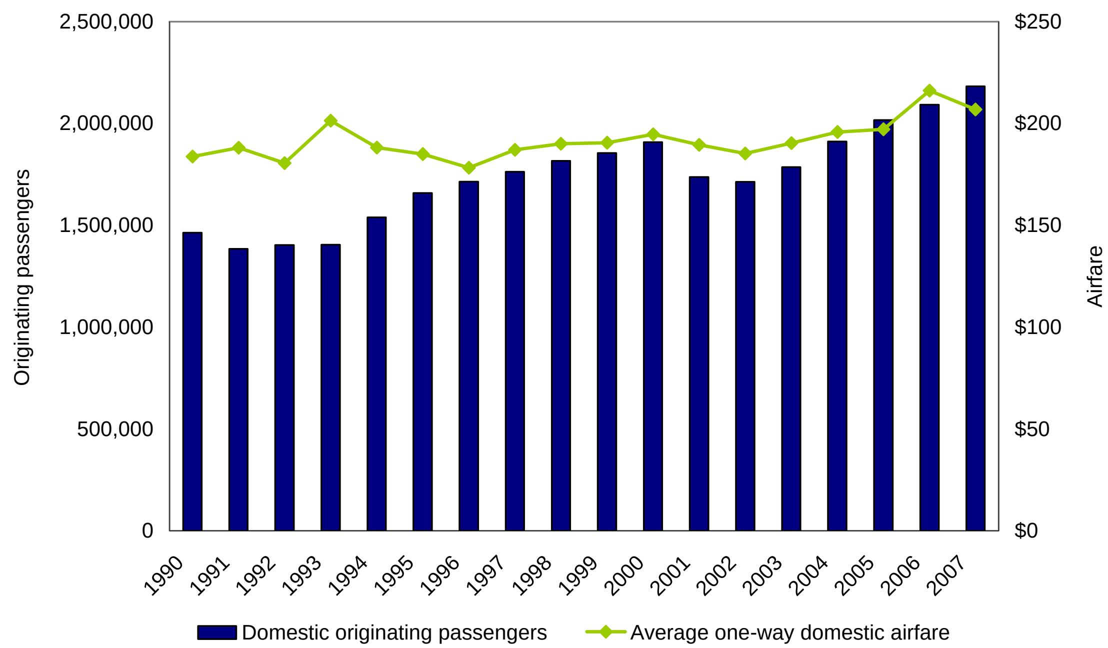
AIRFARE AND AIRLINE YIELD

The cost of air travel often has a significant correlation to the demand for air service. Presented on Figure 5 is a comparison of changes in average airfares (not inflation adjusted) for Memphis and domestic originating passengers for the period 1990 to 2007.

The cost of air service as measured by air fares or airline yields (revenue per passenger mile) is typically higher at airline hub airports where the market is dominated by a primary carrier. As presented in Table 16, airline yields at Memphis for the period 2000 through 2007 are considerably higher than those of the U.S. Also contributing to higher yields in Memphis are the shorter trip lengths which are a function of the large number of regional markets that Memphis serves (see Table 20) and the relatively small amount of service provided by low-fare carriers.

Figure 5

AIRFARES AND ORIGINATING PASSENGERS
Master Plan Update
Memphis International Airport



Source: U.S. Department of Transportation OD1A database.

Table 16

AVERAGE DOMESTIC AIRLINE YIELD AND TRIP LENGTH
Master Plan Update
Memphis International Airport

	Memphis		United States	
Year	Average yield (cents)	Average trip length (miles)	Average yield (cents)	Average trip length (miles)
2000	23.6	825	16.4	1,061
2001	22.6	839	14.9	1,089
2002	21.7	855	14.2	1,112
2003	21.6	881	14.1	1,139
2004	21.6	907	13.5	1,156
2005	22.0	897	13.8	1,151
2006	23.8	909	15.0	1,145
2007	22.0	942	15.0	1,145

Source: U.S. Department of Transportation OD1A database, June 2008.

Table 17 provides a comparison of average domestic airfare, airline yield, and trip length for the top 20 connecting hubs ranked in terms of domestic connecting passengers for 2007. Notably, Memphis has the second highest airline yield of this group of 20 connecting airports behind only Cincinnati. This fact can be attributed to the number of short-haul and medium-haul markets served from Memphis. In addition, most of the airports on this list with the exception of Cincinnati, Detroit, Minneapolis/St. Paul and Memphis have significant low-fare competition either at the hub airport or within the airport market. For example, Chicago-O'Hare has little low-fare airline service, but Chicago Midway is a major hub for Southwest Airlines which has a dampening effect on airline yields at Chicago-O'Hare.

Table 17

DOMESTIC AVERAGE FARE AND YIELD
Master Plan Update
Memphis International Airport

City (airport) *(a)*	2007 Fare	2007 Yield (cents)	Average trip length (miles)	Hub airline *(b)*
Atlanta	$180	20.5	878	Delta
Charlotte	184	20.0	922	US Airways
Chicago-Midway	118	13.2	898	Southwest
Chicago-O'Hare	167	16.9	994	United/American
Cincinnati	269	28.4	947	Delta
Cleveland	175	16.4	1,065	Continental
Dallas/Fort Worth	185	17.8	1,044	American
Denver	163	15.2	1,068	United
Detroit	162	15.8	1,021	Northwest
Houston-Bush	194	16.8	1,150	Continental
Las Vegas	147	12.0	1,230	Southwest
Los Angeles	195	12.6	1,550	United
Memphis	207	22.0	942	Northwest
Minneapolis/St. Paul	189	17.4	1,085	Northwest
Philadelphia	163	14.2	1,153	US Airways
Phoenix	154	13.2	1,170	US Airways
Salt Lake City	180	16.5	1,096	Delta
San Francisco	223	13.1	1,699	United
Seattle	187	12.6	1,485	Alaska
Washington-Dulles	202	14.9	1,354	US Airways

(a) Top 20 domestic hub airports, ranked in decreasing order of connecting passengers.
(b) Including regional airline affiliates.

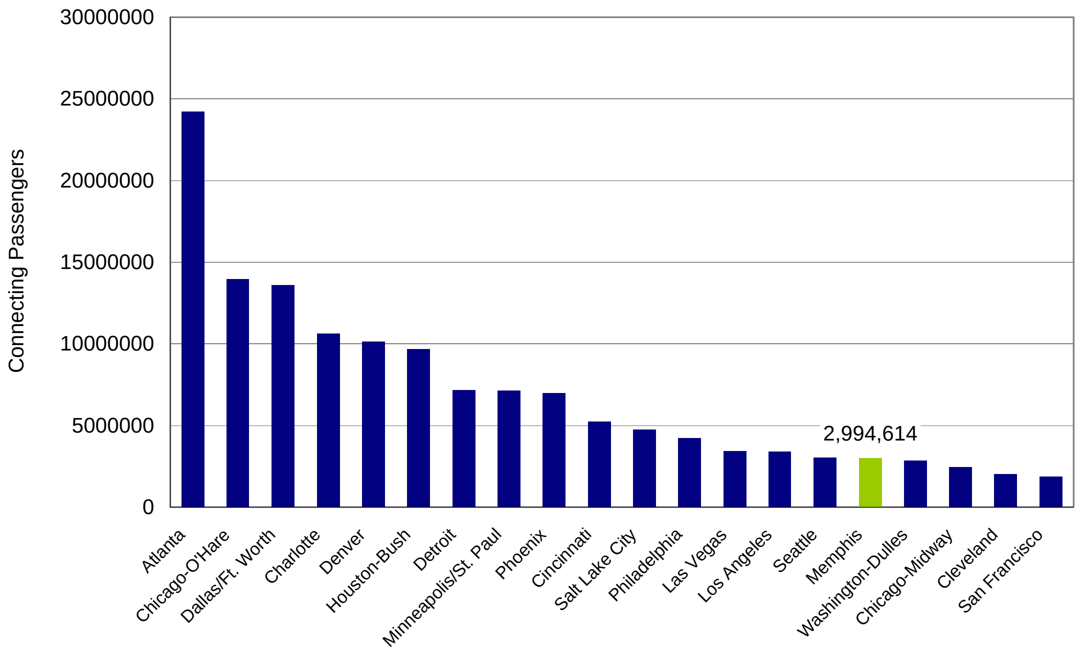
Sources: U.S. Department of Transportation OD1A database and Official Airline Guides, Inc. online database, June 2008.

AIRPORT'S ROLE AS A CONNECTING HUB

Figure 6 is a graphical depiction of connecting traffic at the top 20 domestic connecting hubs of which Memphis ranks 16th with approximately 3.0 million domestic connecting passengers.

Figure 6

CONNECTING PASSENGERS
Master Plan Update
Memphis International Airport



Source: U.S. Department of Transportation OD1B database.

Table 18 presents data on scheduled air service for May 2007 (measured by available seats on scheduled airline departures) at the top 20 domestic connecting airports. The commonality among most of the hub airports is the high percentage of seats provided by the hub airline. The average scheduled seat market share for the hub carrier in this group is approximately 65%. At Memphis, Northwest controls a 79% scheduled seat market share which is similar to the market share of Northwest at Detroit and Minneapolis/St. Paul, but lower than the most dominated hubs such as Continental at Houston-Bush with 90.5%, Delta at Cincinnati with 88.9%, and US Airways at Charlotte with 86.6%.

AIRPORT'S ROLE IN NORTHWEST AIRLINES' SYSTEM

Based on 2007 revenue passenger miles, Northwest ranks as the nation's fifth largest domestic airline. Memphis serves as a connecting hub in the international route system of Northwest Airlines. In addition to Memphis, Northwest operates major domestic connecting hubs at Minneapolis/St. Paul International and Detroit Metropolitan Wayne County airports.

Table 18

SCHEDULED AIR SERVICE
Master Plan Update
Memphis International Airport

City (airport) *(a)*	Average daily scheduled seats: Domestic	International	Total	Primary hub airline *(b)*	Average daily scheduled seats	Airline share of airport total
Atlanta	133,028	15,644	148,672	Delta	103,711	69.8%
Charlotte	57,715	3,780	61,495	US Airways	53,240	86.6
Chicago-Midway	38,417	198	38,614	Southwest	29,570	76.6
Chicago-O'Hare	111,789	20,927	132,716	United	62,496	47.1
				American	48,862	36.8
Cincinnati	26,573	1,282	27,855	Delta	24,750	88.9
Cleveland	20,672	611	21,283	Continental	13,504	63.4
Dallas/Ft. Worth	95,160	9,767	104,927	American	88,809	84.6
Denver	80,418	3,842	84,260	United	42,949	51.0
Detroit	58,554	6,462	65,016	Northwest	49,043	75.4
Houston-Bush	60,098	13,417	73,516	Continental	66,542	90.5
Las Vegas	76,131	4,013	80,145	Southwest	30,922	38.6
Los Angeles	78,313	29,002	107,315	United	20,606	19.2
Memphis	21,218	774	21,991	Northwest	17,389	79.1
Minneapolis/St. Paul	56,805	3,755	60,560	Northwest	47,281	78.1
Philadelphia	54,938	6,770	61,708	US Airways	38,147	61.8
Phoenix	75,218	3,177	78,395	US Airways	35,310	45.0
Salt Lake City	34,877	1,027	35,905	Delta	24,794	69.1
San Francisco	45,195	14,191	59,386	United	28,038	47.2
Seattle	51,288	4,121	55,409	Alaska	28,134	50.8
Washington-Dulles	33,576	10,311	43,887	US Airways	27,311	62.2

Note: Totals may not add due to rounding.

(a) Top 20 domestic connecting hub airports.
(b) Including regional airline affiliates.

Source: Official Airline Guides, Inc. online database for May 2007.

Internationally, Northwest is part of a major transatlantic joint venture operation with Air France-KLM through KLM's hub in Amsterdam. Northwest also operates an extensive Pacific route network with a connecting hub at Tokyo's Narita International Airport. In addition, Northwest is a member of the SkyTeam global alliance that includes partner airlines Air France-KLM, Continental, Delta, Alitalia, Aeromexico, CSA Czech Airlines, Korean Air, Aeroflot, and others.

Presented in Table 19 is the relative scale of Northwest's Memphis operation in terms of average daily scheduled departures and seats. As shown, Memphis is Northwest's third largest hub behind Minneapolis/St. Paul and Detroit and larger than the international operations at Tokyo-Narita.

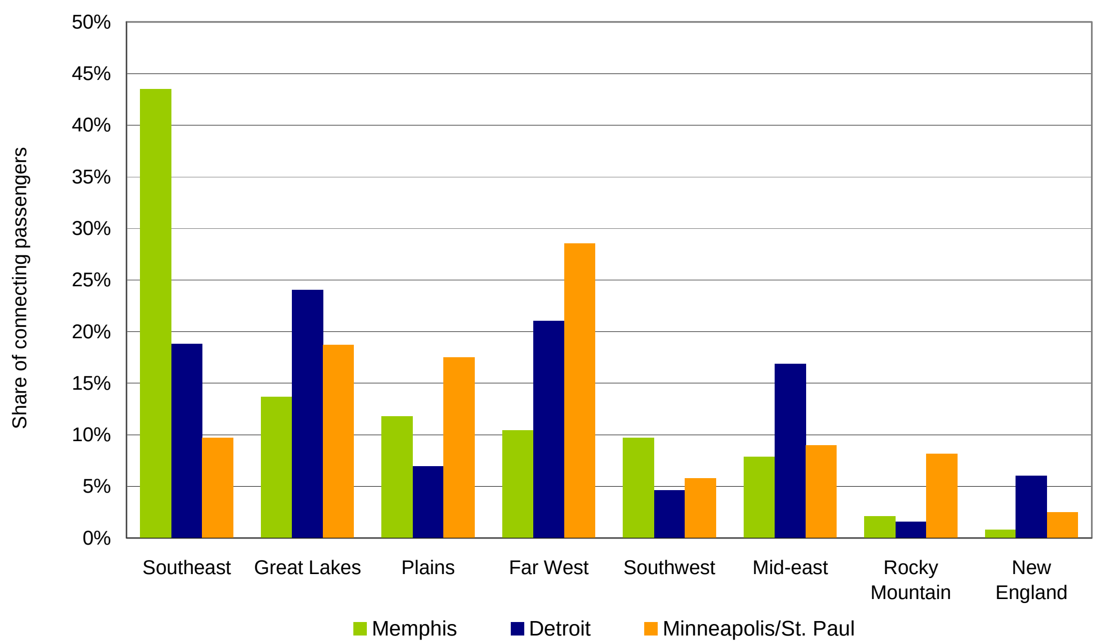
Figure 7 presents the geographical regions that Memphis, Detroit and Minneapolis/St. Paul serve based on the origination point for Northwest's connecting passengers in 2007. Approximately 43% of the Airport's connecting passengers originate their trip from the Southeastern U.S. while the next highest shares come from the Great Lakes (14%) and Plains (12%) regions. In contrast, Minneapolis/St. Paul's largest share of connecting passengers (29%) originates in the Far West region and Detroit's largest share originates in the Great Lakes region (24%).*

Figure 7

NORTHWEST AIRLINE HUB CONNECTING TRAFFIC FLOWS

Master Plan Update

Memphis International Airport



Source: U.S. Department of Transportation OD1B database.

*Regions shown as defined by the U.S. Bureau of Economic Analysis.

Table 19

NORTHWEST AIRLINES SERVICE AT ITS TOP 10 AIRPORTS
Master Plan Update
Memphis International Airport

City (airport)	2000	2001	2002	2003	2004	2005	2006	2007	Average annual % change 2000-2007
	Average daily scheduled departures								
Detroit	522	518	500	505	545	550	490	477	-1.3%
Minneapolis/St. Paul	502	491	493	503	539	526	453	444	-1.7
Memphis	233	242	221	240	217	225	221	217	-1.0
Indianapolis	17	17	16	17	20	43	41	41	13.0
New York - LaGuardia	19	20	18	19	20	23	21	23	2.5
Tokyo-Narita	18	18	19	20	21	22	22	23	3.2
Washington-National	19	19	17	19	20	26	23	23	2.6
Chicago-O'Hare	26	25	23	23	22	22	20	20	-3.5
Los Angeles	22	21	18	17	19	19	20	18	-2.5
Boston	19	19	16	16	18	21	18	18	-0.9
	Average daily scheduled seats								
Detroit	54,591	53,091	50,335	51,039	54,519	53,532	48,829	47,571	-1.9%
Minneapolis/St. Paul	54,199	53,622	52,348	53,209	55,849	53,903	48,076	47,485	-1.9
Memphis	19,119	19,928	18,291	18,960	17,046	17,620	16,754	16,504	-2.1
Indianapolis	2,087	1,989	1,865	2,086	2,178	3,820	3,577	3,524	7.8
New York - LaGuardia	2,845	2,878	2,619	2,743	2,849	2,981	2,808	2,973	0.6
Tokyo-Narita	7,297	7,122	7,411	7,012	7,256	7,076	6,880	6,976	-0.6
Washington-National	2,550	2,432	2,172	2,519	2,572	2,834	2,677	2,703	0.8
Chicago-O'Hare	3,011	2,869	2,504	2,575	2,429	2,412	2,323	2,424	-3.0
Los Angeles	4,722	4,291	3,432	3,294	3,507	3,473	3,541	3,339	-4.8
Boston	3,273	3,039	2,644	2,457	2,571	2,584	2,476	2,520	-3.7

Source: Official Airline Guides, Inc. online database by calendar year, June 2008.

Table 20 describes the air service provided by Northwest from Memphis in terms of length of haul. Approximately 45% of all Northwest's scheduled seats are for departures to markets less than 500 miles from Memphis. An additional 45% of scheduled seats are within 500 to 1,000 miles and about 10% are on flights over 1,000 miles. The focus on short- and medium-haul routes from Memphis is consistent with its large base of connecting passengers which originates within the Southeast region.

Table 20

NORTHWEST SERVICE BY LENGTH OF HAUL
Master Plan Update
Memphis International Airport

Markets	Number of markets	Percent of scheduled seats
Long-haul (over 1,000 miles)	8	9.4%
Medium-haul (500-1,000 miles)	32	45.5
Short-haul (under 500 miles)	45	45.2
Total	85	100.0%

Source: Official Airline Guides, Inc., online database, May 2007.

Recent historical growth trends for Northwest's domestic and international enplanements at its three domestic hubs are presented in Table 21. From 2003 to 2007, total enplanements have increased fastest at Detroit at an annual rate of 1.7%. Domestic traffic also increased fastest at Detroit at the annual rate of 1.4% while international traffic grew fastest at Memphis at an annual rate of 7.1%.

Table 21

NORTHWEST AIRLINES ENPLANED PASSENGERS BY HUB AIRPORT
Master Plan Update
Memphis International Airport

Hub airport	2003	2004	2005	2006	2007	Average annual increase (decrease) 2003-2007
Minneapolis/St. Paul						
Domestic	12,002,125	12,969,588	13,139,569	12,418,741	12,126,821	0.3%
International	933,675	1,016,366	1,073,916	1,027,647	1,085,205	3.8%
Total	12,935,800	13,985,954	14,213,485	13,446,388	13,212,026	0.5%
Detroit Metropolitan						
Domestic	10,971,445	11,869,031	12,191,482	11,870,865	11,580,626	1.4%
International	1,325,139	1,524,256	1,583,342	1,531,310	1,592,387	4.7%
Total	12,296,584	13,393,287	13,774,824	13,402,175	13,173,013	1.7%
Memphis						
Domestic	4,293,774	3,944,304	4,208,134	4,127,048	4,122,072	(1.0%)
International	137,623	146,473	156,311	168,270	180,773	7.1%
Total	4,431,397	4,090,777	4,364,445	4,295,318	4,302,845	(0.7%)

Note: Includes Northwest Airlines mainline and its regional affiliates.

Sources: Memphis International Airport – Memphis-Shelby County Airport Authority records. Other airports – U.S. Department of Transportation T-100 database, June 2008.

The type of aircraft used to provide scheduled seating capacity by Northwest at Memphis has changed significantly from 2000 to 2007. Table 22 demonstrates that from 2000 to 2007, the number of scheduled departures on mainline aircraft and turboprop aircraft decreased by approximately 33% and 63% respectively. This decrease was offset by an increase of scheduled departures on regional jets by over 200%. These changes resulted in a decrease in total scheduled seats of approximately 14% from 2000 to 2007. These trends are indicative of how airlines have adjusted aircraft type and capacity to improve operating economics.

Table 22

NORTHWEST AIRLINES SCHEDULE PROFILE BY AIRCRAFT TYPE
Master Plan Update
Memphis International Airport

	Average daily scheduled departures								Percent change
	2000	2001	2002	2003	2004	2005	2006	2007	2000-2007
Northwest Airlines *(a)*									
Mainline jet	120	121	110	99	90	91	81	81	-32.5%
Regional jet	35	62	64	99	97	105	110	108	208.6
Turboprop	78	59	46	41	0	29	9	29	62.8
Total	233	242	221	240	217	225	221	217	-6.9

	Percent of average daily departures							
Northwest Airlines *(a)*								
Mainline jet	52%	50%	50%	41%	41%	40%	37%	37%
Regional jet	15	25	29	41	45	47	50	50
Turboprop	34	24	21	17	14	13	13	13
Total	100%	100%	100%	100%	100%	100%	100%	100%

	Average daily scheduled seats								Percent change
	2000	2001	2002	2003	2004	2005	2006	2007	2000-2007
Northwest Airlines *(a)*									
Mainline jet	14,365	14,392	13,029	12,041	10,805	11,056	10,156	10,130	-29.5%
Regional jet	2,186	3,590	3,728	5,510	5,211	5,583	5,619	5,399	147.0
Turboprop	2,583	1,950	1,535	1,409	1,034	980	981	975	-62.3
Total	19,134	19,932	18,292	18,960	17,049	17,619	16,756	16,504	-13.8

	Percent of average daily scheduled seats							
Northwest Airlines *(a)*								
Mainline jet	75%	72%	71%	64%	63%	63%	61%	61%
Regional jet	11	18	20	29	31	32	34	33
Turboprop	14	10	8	7	6	6	6	6
Total	100%	100%	100%	100%	100%	100%	100%	100%

(a) Includes Northwest Airlines mainline and its regional affiliates.

Source: Official Airline Guides, Inc., online database, June 2008.

AIR CARGO

The air cargo industry is a diverse collection of companies and services, with differing business strategies, market roles, and ability to respond to changes in the economic and operating environment. The following is a basic overview of the key participants, their respective customer base, and the various types of modal competition that exists within the industry. The information assists in understanding how the air cargo industry responds to, and sometimes drives, the shifts in economic cycles and shipping patterns. Table 23 provides a summary of the different types of cargo airlines and their associated cargo capacities.

Table 23

AIR CARGO CARRIER TYPES AND THEIR BUSINESS CHARACTERISTICS
Master Plan Update
Memphis International Airport

Carrier type	Characteristics	Illustrative carriers	Customers	Desired airport characteristics
Belly	Baggage holds of passenger aircraft	Delta, Continental, US Airways	Wholesale, mail, retail	Passenger airport
Mixed	Baggage holds of passenger aircraft and main decks of all-cargo aircraft	Northwest, Lufthansa, Cathay Pacific	Wholesale, mail, retail	Passenger airport
Integrated	Main decks of all-cargo aircraft	FedEx, UPS, DHL	Retail	Airport near population
All-cargo	Main decks of all-cargo aircraft	Cargolux, Evergreen Airlines, Atlas Air	Wholesale	Airport near population

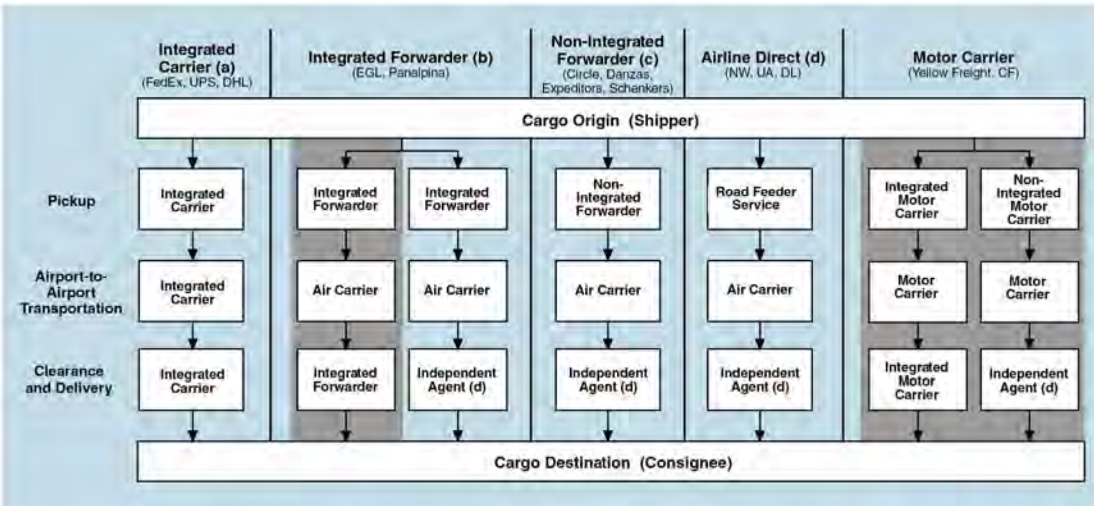
In addition to the various air cargo carriers summarized on Table 23, there are other operators that participate in the transportation of cargo, including freight forwarders and motor carriers. Figure 8 presents an illustration of the services provided by the various types of operators, and depicts how these key components conduct business as they transport cargo from the shipper to consignee.

In terms of determining the routing of air cargo, and particularly the use of airport gateways, the integrated carriers and the freight forwarders are the primary drivers of the air cargo industry, as further discussed below.

The Integrated Carriers. The integrated carriers (DHL, FedEx, and UPS) have continued to dominate the domestic express market and their focus on increasing market share in the international cargo market since the early 1990's. These companies employ sophisticated sorting equipment, closed-loop business strategies, and precisely choreographed networks of local stations and regional sorting hubs to ensure the delivery of shipments to virtually every address in the domestic U.S. overnight and most worldwide destinations in two days. These companies continue to grow in size with a surge of corporate acquisitions (e.g., freight forwarding and trucking companies) over the past several years that effectively increased their service offerings to a much wider base of potential customers.

Figure 8

AIR CARGO SERVICES AND SERVICE PROVIDERS
Master Plan Update
Memphis International Airport



LEGEND

North American market

Notes: (a) Integrated carriers are all-cargo air carriers that own and operate all the equipment and services necessary to provide complete door-to-door customer services.

(b) Integrated forwarders are companies that provide all the services necessary to provide complete door-to-door customer services, typically using air carriers for airport-to-aiport transportation.

(c) Non-integrated forwarders are companies that consolidate freight and arrange complete transportation services using air carriers for airport-to-airport transportation and other comparies for pickup and/or clearance and delivery.

(d) Independent agents are comparies providing only cargo clearance and/or delivery services to air carriers and non-integrated forwarders.

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However, while delivery speed and reliability—two qualities that integrated carriers possess in abundance—are important aspects of daily shipping requirements, other modes of transport (e.g. truck, rail) are increasingly providing competitive shipping services at a cost below that of air cargo. For example, trucking is estimated to be 10 to 12 times cheaper than air transportation, and therefore every major U.S. integrated carrier has invested heavily in the development of time-definite regional and transcontinental surface distribution networks. Over the past decade, FedEx acquired American Freightways and Caliber Group (RPS and Caliber Logistics), two of the largest independent trucking companies in the nation, and UPS expanded its Supply Chain Services (SCS) activity through additional infrastructure investments. DHL has also responded to these trends recently acquiring two of the world's largest freight forwarders, Danzas and Exel, in order to respond to recent customer demand.

Freight Forwarding Community. Typically, freight forwarders are intermediaries that link shippers with freight carriers (airlines, trucking companies, railroads, ocean carriers) without owning the actual means of transport. Freight forwarders attempt to (1) consolidate shipments from multiple customers and (2) leverage their larger volumes with the transportation providers to lower the carriers' rates for transport. Forwarders are a vital component of the air cargo industry because they can organize freight transportation more efficiently and cost-effectively than end-customers themselves, and they take responsibility for organizing and monitoring door-to-door delivery. Finally, by pooling traffic from multiple shippers, the forwarding community helps produce smoother and more predictable demand patterns for the airlines, which is a main reason why the freight forwarding community is so vital to the industry.

While the integrated carriers have attempted to grow their international activity, the freight forwarding community is still responsible for over three-quarters of the world's international cargo volumes. As discussed, the freight forwarding community relies on the wide range of destinations and the lower cost capacity on passenger aircraft for a large proportion of overall capacity but is increasing its reliance on main deck capacity (aircraft cargo hold) of freighter aircraft to accommodate larger consolidations and outsized shipments. This relationship has become even more important as the cargo capacity in the belly holds of passenger airlines has become less reliable due to increased security requirements. The relationship is also important because of the overall reduction in cargo capacity in passenger aircraft, especially in the U.S. domestic market, due to the rapid growth in low cost carriers (that specialize in quick gate turnaround times) and use of regional jet aircraft that have minimal to no cargo capacity.

Air Cargo Market Outlook

Although economic activity is the primary influence affecting the world air cargo industry, it is still necessary to recognize the effects of other factors, some of which are influenced by airline activities. Examples of airline activities that influence air cargo development include the acquisition of aircraft, increase of capacity in a certain region or route, and expansion of services, which have had particularly favorable impacts on the express and small-package market in the past decade. Factors beyond the control of airlines and the cargo community as a whole include inventory management techniques, globalization, market liberalization, national (or airport) development programs, and continuing introduction of new air-eligible commodities, all of which play significant roles in air cargo growth.

According to Airports Council International (ACI) data, approximately 55% of the world's air cargo activity is accommodated by the top 30 international airports (including import and export cargo at each airport). When examining only North American airports, the percentage of air cargo is much more disproportionate. As shown in Table 24, the top ten cargo airports handled approximately 18.4 million metric tons of cargo in 2007 which represents 61% of the total air cargo handled at all North American airports (30 million metric tons).

Table 24

TOTAL ENPLANED AND DEPLANED CARGO – TOP 10 DOMESTIC RANKINGS
Master Plan Update
Memphis International Airport

	Airport	2007 tons	% Change 2006-2007
(1)	**Memphis (MEM)**	**3,849,345**	**4.0%**
(2)	Anchorage (ANC)	2,826,499	0.7
(3)	Louisville (SDF)	2,078,290	4.8
(4)	Miami (MIA)	1,877,876	(1.5)
(5)	Los Angeles (LAX)	1,922,982	5.1
(6)	New York (JFK)	1,595,577	(2.8)
(7)	Chicago (ORD)	1,524,419	(2.2)
(8)	Indianapolis (IND)	1,056,517	1.2
(9)	Newark (EWR)	943,174	(2.7)
(10)	Dallas/Fort Worth (DFW)	724,957	(3.5)
	Total	18,399,636	

Sources: Airports Council International and Memphis-Shelby County Airport Authority, June 2008.

The three busiest North American cargo airports are largely driven by transit cargo activity—Memphis and Louisville are the national sort centers for FedEx and UPS, respectively, and Anchorage is a major technical stop (fuel stop, crew changes, etc.) location for cargo flights on trans-Pacific routes. Indianapolis and Newark are similar in that FedEx is responsible for a disproportionate amount of total airport cargo activity. The traditional gateways such as John F. Kennedy (New York), Los Angeles, Chicago O'Hare, and Miami international airports will continue to accommodate very large volumes of cargo due to the large number of widebody international passenger flights and the associated cargo capacity in their belly compartments.

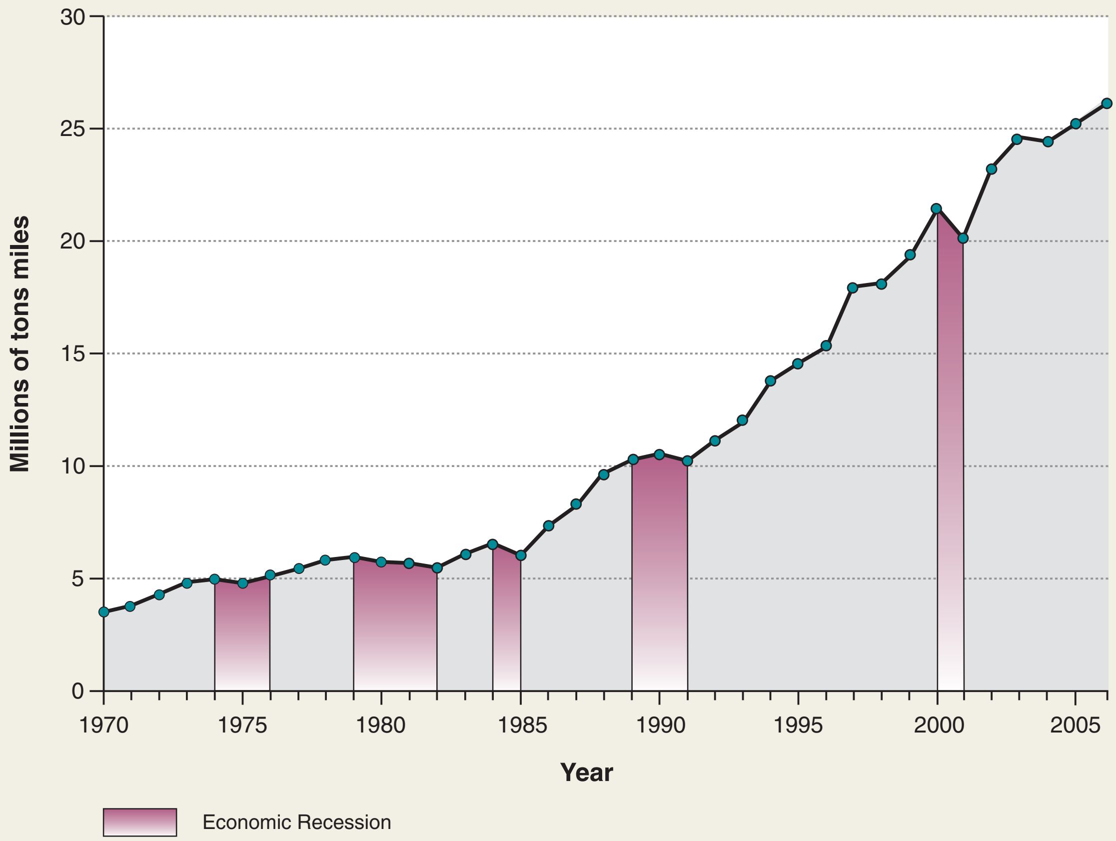
Historical Trends. Many events have affected the air cargo industry growth pattern over the past 30 years. Worldwide economic recession, the threat of terrorism and increased security requirements, as well as regional military/political unrest have all resulted in a short-term reduction in air tonnage levels. However, the long-term trends show a continual increase in cargo demand, averaging almost 5% per year. As shown on Figure 9, temporary periods of decline have historically been followed by resumption of growth. A result of the overall growth of the air cargo traffic is a commensurate expansion of on-airport facilities to accommodate the activity increases. Additional airfield infrastructure (longer runways, aircraft ramp, taxiways) and landside facilities that include ramp-accessible warehouse, truck and vehicular maneuvering space, and customer parking space has been an important ingredient to the growth in air cargo demand.

Figure 9

HISTORICAL U.S. AIR FREIGHT TRAFFIC

Master Plan Update

Memphis International Airport



Note: Includes all U.S. major, national, and regional passenger and cargo airlines.

Source: Air Transport Association of America, March 2007.

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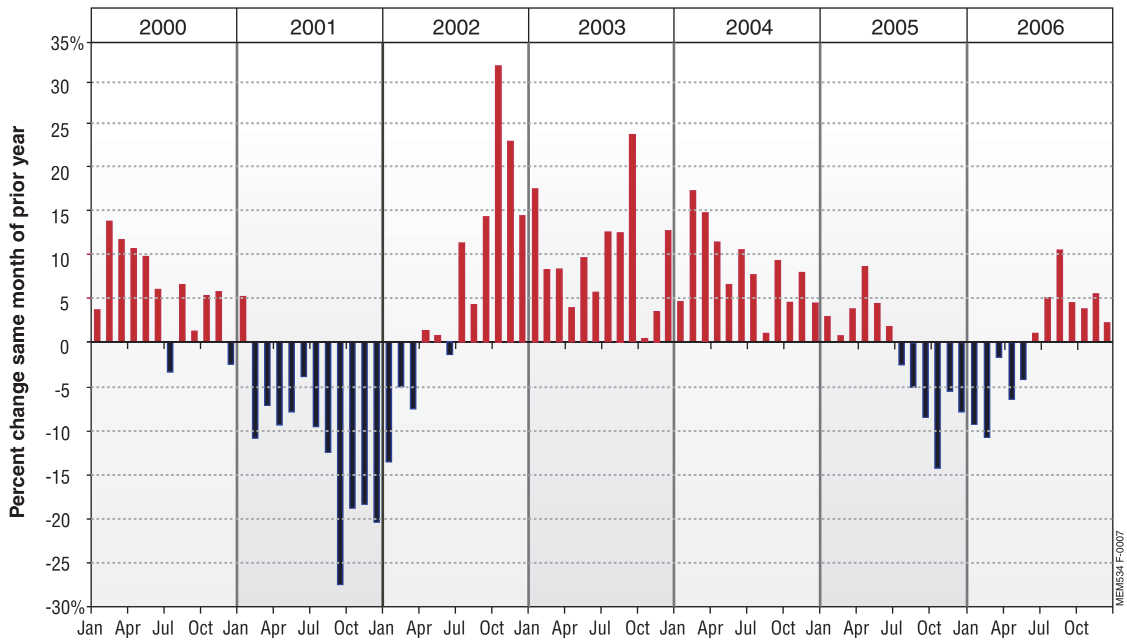
Figure 10 presents an analysis of cargo activity on a monthly basis for the period 2000 through 2006 and shows that worldwide cargo activity (in terms of freight ton miles) grew at 7.1% in 2000 but declined 5.9% during 2001. This decline was the result of the simultaneous worldwide economic slowdown, the collapse of the "technology bubble", and the events of September 11, 2001. As indicated in Figure 10, a recovery in traffic began in mid-2002 and continued through mid-2005, largely driven by trade between the U.S. and Asia, as well as domestic U.S. traffic.

Figure 10

RECENT TREND—FREIGHT TON-MILES
Master Plan Update
Memphis International Airport



Source: Air Transport Association.

HISTORICAL AIR CARGO DEMAND

Table 25 presents historical air cargo data at the Airport. As shown, from 1997 to 2007 significant growth in air cargo occurred at an annual growth rate of 5.6%, which has solidified the Airport as the busiest cargo airport in the world. Of particular note, this steady increase has been experienced during a volatile period where almost every other major airport gateway has seen periods of significant decline (due to economic recession, security regulations, and shipper's modal indifference).

While the overall air cargo totals have continued to increase since 1997, the mail volumes have declined significantly from a high of over 50,000 tons in 1997 to a low of 4,099 tons in 2007. This trend is not unique to Memphis as most airports in North America have experienced similar declines during this period. The increased use of regional jet aircraft (that generate little to no air cargo capacity) has been a key factor to the decline in mail. However, the most important reason for the reduction in mail activity across the country has actually contributed to an increase in the overall cargo tonnage at Memphis. In late 2001, the United State Postal Service (USPS) entered into a service agreement with FedEx to transport a significant portion of the time-sensitive U.S. mail activity. The large increase in overall Airport cargo tonnage in 2002 is directly attributable to this USPS services agreement, as FedEx reports USPS activity as freight tonnage.

Table 25

HISTORICAL AIR CARGO TONNAGE
Master Plan Update
Memphis International Airport

Calendar year	Freight	Mail	Total	Percent increase
1997	2,190,244	50,560	2,240,804	--%
1998	2,338,496	38,236	2,376,733	6.1
1999	2,386,895	33,914	2,420,809	1.9
2000	2,460,680	36,549	2,497,229	3.2
2001	2,609,508	30,703	2,640,211	5.7
2002	3,386,675	15,224	3,401,899	28.8
2003	3,386,089	12,132	3,398,221	0.0
2004	3,557,044	5,610	3,562,654	4.8
2005	3,600,726	5,948	3,606,674	1.2
2006	3,685,787	14,252	3,700,039	2.6
2007	3,845,246	4,099	3,849,344	4.0
	Average annual increase (decrease)			
1997 - 2007	5.8%	(22.2%)	5.6%	
2002 - 2007	2.6	(23.1)	2.5	

Source: Memphis-Shelby County Airport Authority records, June 2008.

Table 26 provides the leading cargo carriers and associated market shares at the Airport from 2003-2007. As shown, FedEx has dominated the Memphis cargo volumes and continues to control almost 98% of the overall market. Other items of note:

- Northwest has experienced a significant reduction in cargo tonnage due to the increase use of regional jet activity at the Airport. In fact, the airline has experienced a reduction of over 17% in total volumes since 1997 (from over 40,000 tons in 1997 to less than 7,000 tons in 2007).

- The other integrated carriers, namely UPS and to a lesser extent DHL, have experienced solid growth since 2003 due to the expansion of distribution and light manufacturing in the region.

- The freight forwarding community has seen a marked increase in heavy freight demand levels in Memphis contributing to some of the all-cargo airlines including Air Transport International (ATI) as well as other airlines.

Table 26

HISTORICAL AIR CARGO TONNAGE AND MARKET SHARES
Master Plan Update
Memphis International Airport

Airline	Total metric tons of cargo *(a)* 2003	2004	2005	2006	2007	Average annual increase (decrease)	Market share 2003	2004	2005	2006	2007
FedEx	3,314,953	3,480,705	3,524,304	3,614,641	3,779,469	3.3%	97.5%	97.7%	97.7%	97.7%	98.2%
UPS	21,049	24,321	26,745	27,412	26,787	6.2	0.6	0.7	0.7	0.7	0.7
Other airlines	37,409	35,284	33,704	35,810	20,154	(14.3)	1.1	1.0	0.9	1.0	0.5
Air Transport International	10,902	13,173	11,286	10,754	11,337	1.0	0.3	0.4	0.3	0.3	0.3
Northwest Airlines	12,593	7,806	7,087	6,722	6,989	(13.7)	0.4	0.2	0.2	0.2	0.2
DHL	1,315	1,365	3,548	4,702	4,608	36.8	0.0	0.0	0.1	0.1	0.1
Total	3,398,221	3,562,654	3,606,674	3,700,040	3,849,345	3.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Numbers may not add due to rounding.

(a) Includes freight (express and deferred) and mail.

Source: Memphis-Shelby County Airport Authority records, June 2008.

AIRCRAFT OPERATIONS

An aircraft take-off or landing is counted as one aircraft operation. In this report aircraft operations are classified by the type of aircraft performing the operation and include mainline passenger operations, regional passenger operations, air cargo operations, general aviation operations and military operations. The following paragraphs include a discussion of each of these categories of aircraft operations.

Passenger Operations

Passenger aircraft operations are classified herein as either mainline or regional. Mainline passenger operations are defined in this report as commercial passenger operations performed by aircraft operated by the mainline air carriers, including narrowbody and widebody jet aircraft. Regional passenger operations are defined as commercial passenger operations performed by aircraft operated by the regional airlines, including both regional jets and turboprops.

As seen in Table 27 mainline passenger operations have steadily declined since 1987, whereas regional operations have steadily increased over the same period. Specifically, the number of mainline passenger operations has steadily declined from 169,668 in 1987 to 70,342 operations in 2007 at an average annual decrease of 4.3%. Conversely, the number of regional passenger operations has steadily increased from 65,548 in 1987 to 127,406 operations in 2007—an average annual increase of 3.4%. This trend in passenger operations has occurred primarily as a result of Northwest Airlines replacing mainline jets with regional aircraft operated by their regional affiliates.

Over the long term, total passenger operations have decreased from 235,216 in 1987 to 197,748 in 2007 at an annual rate of 0.9%. However, for the period from 1997 to 2007, total passenger operations have increased from 190,836 to 197,748 at a moderate annual rate of 0.4%.

Air Cargo

Air cargo operations are those operations by aircraft transporting only air cargo (see Table 27). These include operations by integrated carriers, like FedEx and UPS, and all-cargo carriers such as Air Transport International. Since 1987, air cargo operations have exhibited robust growth at an annual rate of 4.9%.

Table 27

HISTORICAL AIRCRAFT OPERATIONS
Master Plan Update
Memphis International Airport

	Mainline passenger	Regional passenger	Subtotal	Air cargo	General aviation	Military	Total	Average annual increase (decrease)
1987	169,668	65,548	235,216	51,470	88,413	5,812	380,911	--%
1988	157,088	58,769	215,857	54,706	75,263	7,265	353,091	-7.3
1989	140,676	40,602	181,278	61,008	81,588	6,476	330,350	-6.4
1990	130,750	48,942	179,692	65,494	75,280	6,700	327,166	-1.0
1991	115,342	64,958	180,300	68,776	68,437	6,261	323,774	-1.0
1992	105,176	87,742	192,918	75,762	71,905	5,596	346,181	6.9
1993	101,757	76,680	178,437	75,940	77,335	6,330	338,042	-2.4
1994	102,226	78,352	180,578	82,746	79,537	6,477	349,338	3.3
1995	105,860	80,971	186,831	87,130	80,032	5,853	359,846	3.0
1996	102,028	82,866	184,894	90,026	79,035	5,461	359,416	-0.1
1997	102,452	88,384	190,836	99,566	73,698	4,635	368,735	2.6
1998	100,322	76,682	177,004	103,246	79,068	5,391	364,709	-1.1
1999	103,474	83,076	186,550	103,796	79,483	4,988	374,817	2.8
2000	109,166	106,268	215,434	104,824	63,593	4,561	388,412	3.6
2001	109,456	106,536	215,992	111,464	62,810	4,560	394,826	1.7
2002	96,178	107,140	203,318	135,784	57,674	1,993	398,769	1.0
2003	85,812	132,280	218,092	132,084	50,151	1,931	402,258	0.9
2004	78,524	124,348	202,872	132,440	51,123	1,533	387,968	-3.6
2005	79,454	126,424	205,878	136,258	48,619	1,605	392,360	1.1
2006	69,308	131,862	201,170	135,500	46,566	1,587	384,823	-1.9
2007	70,342	127,406	197,748	133,580	42,128	1,533	374,989	-2.6
1997 - 2007	(3.7%)	3.7%	0.4%	3.0%	(5.4%)	(10.5%)	0.2%	
2002 - 2007	(6.1)	3.5	(0.6)	(0.3)	(6.1)	(5.1)	(1.2)	
1987 - 2007	(4.3)	3.4	(0.9)	4.9	(3.6)	(6.4)	(0.1)	

Note: Totals may not add due to rounding.

Source: Memphis-Shelby County Airport Authority records, June 2008.

The strong growth in air cargo operations at the Airport is a direct result of FedEx's growth in Memphis. In 2001, the United States Postal Service and FedEx entered into an extended service agreement which resulted in FedEx carrying a large portion of mail that was traditionally carried by the passenger airlines. This agreement resulted in a dramatic increase from 111,464 air cargo operations in 2001 to 135,784 operations in 2002.

General Aviation

General aviation (GA) is defined as all civil aircraft operations other than commercial passenger operations, air cargo operations, and military operations. GA activity typically includes business and corporate aircraft operations and the operation of privately owned aircraft for personal or recreational flying. GA aircraft range in size from small single-engine piston powered aircraft, popular with recreational pilots, to large multi-engine jet aircraft capable of transcontinental flights and operated for corporate travel purposes.

GA operations are typically recorded as local or itinerant operations. Local operations are those GA flights that stay within sight of their origin airport and typically include pilot training or recreational flying. Historically, the Airport has recorded few or no GA local operations and this trend is expected to continue over the forecast period. There are a number of GA airports within the Memphis MSA which serve most of this "local operation" demand. The other segment of GA activity, known as itinerant operations, includes activity by aircraft that leave the local airspace of their origin airport and travel to a different destination airport. An itinerant operation typically requires the submittal of a flight plan to the FAA. Business and corporate flights represent the majority of itinerant GA operations at the Airport.

The number of GA operations at the Airport has decreased from 88,413 in 1987 to about 42,128 in 2007. This decline is partly a result of the national decrease in GA itinerant activity over the same period. However, the development of new facilities at other regional GA airports such as General Dewitt Spain Airport, Charles W. Baker Airport, and Millington Regional Jetport has attracted some GA activity from the Airport.

Military

Military aircraft operations at the Airport primarily consist of the operations of the 164th Airlift Wing of the Tennessee Air National Guard (TnANG). Between 1987 and 2007, military aircraft operations at the Airport fluctuated between a high of 7,265 and a low of 1,533. Since 2002, military operations have stabilized, averaging approximately 1,700 per year.

Total Aircraft Operations

As shown in Table 27, total aircraft operations increased an annual rate of 0.2% per year from 1997 to 2007, and decreased at an average rate of 1.2% per year from 2002 to 2007. The decrease in total operations since 2002 was due to (1) a gradual decline in noncommercial aircraft operations (military declining at an average annual rate of 5.1% and GA declining at 6.1%); (2) air cargo operations have declined slightly at a rate of 0.3%; and (3) passenger operations have declined at a rate of 0.6%. These modest declines in commercial activity since 2002 reflect airlines' efforts to serve increased demand for air cargo and travel with fewer operations in an attempt to control operating costs.

Notably, the slight decline in operations since 2002 should not be construed as an indication of demand for either travel or air cargo services in the Memphis service region, as both the number of passengers and air cargo tonnage have grown during the same period (passengers at 0.2% and air cargo tonnage at 2.5%).

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Section 3

KEY FACTORS AFFECTING FUTURE AIRLINE TRAFFIC

There are a large number of factors that will eventually influence the demand for future air service at the Airport. These factors are due to local, national and international influences and are often difficult, if not impossible, to accurately quantify. Discussed below are general summaries of the key factors likely to affect the type and volume of future airline traffic at the Airport. These key factors include:

- Economic and political conditions
- Aviation security concerns
- Airline service and routes
- Availability and price of aviation fuel
- Capacity of the Airport
- Implications of Northwest/Delta merger

ECONOMIC AND POLITICAL CONDITIONS

Historically, airline passenger traffic nationwide has correlated closely with the state of the U.S. economy and levels of real disposable income. Recession in the U.S. economy in 2001 and stagnant economic conditions in 2002 contributed to reduced passenger traffic during those years. Future increases in passenger traffic will depend largely on the ability of the nation to sustain growth in economic output and income.

With the globalization of business and the increased importance of international trade, growth of the U.S. economy has become more closely tied to worldwide economic, political, and social conditions. As a result, international economics, currency exchange rates, trade balances, political relationships, public health concerns, and international hostilities are now important influences on passenger traffic at U.S. airports. Sustained future increases in both domestic and international passenger traffic will depend on stable and peaceful international conditions and global economic growth.

AVIATION SECURITY CONCERNS

Concerns about the safety of airline travel and the effectiveness of security precautions influence passenger travel behavior and the demand for air travel. Anxieties about the safety of flying and the inconveniences and delays associated with security screening procedures lead to both the avoidance of air travel and the switching from air to surface modes for short-haul trips.

Safety concerns in the aftermath of the terrorist attacks in September 2001 were largely responsible for the steep decline in airline travel in 2002. In early 2003, safety concerns were again heightened by the beginning of hostilities in Iraq and the threat of retaliatory terrorist attacks.

Since September 2001, government agencies, airlines, and airport operators have upgraded security measures to guard against attacks and maintain confidence in the safety of airline travel. These measures include strengthened aircraft cockpit doors, changed flight crew procedures, increased presence of armed sky marshals, federalization of airport security functions under the Transportation Security Administration (TSA), and more intensive screening of passengers and baggage.

Historically, airline travel demand has recovered after temporary decreases stemming from terrorist attacks, hijackings, aircraft crashes, and international hostilities. Provided that intensified security precautions serve to maintain confidence in the safety of commercial aviation without imposing unacceptable inconveniences for airline travelers, it can be expected that future demand for airline travel at the Airport will depend primarily on economic, not security, factors.

AIRLINE SERVICE AND ROUTES

The number of origin and destination passengers at the Airport depends on the intrinsic attractiveness of the Memphis region as a business and leisure destination and the propensity of residents to travel.

In recent years, low-cost airlines have increased market share and gained acceptance by passengers. As a spoke market to several airline hubs, the Airport may be impacted by changes to service offerings by hub airlines.

AVAILABILITY AND PRICE OF AVIATION FUEL

Since 2004, the price of aviation fuel has increased dramatically, driven by a multitude of factors including global supply and demand for crude oil, refining capacity and refined product distribution issues, international hostilities, and market price speculation. As a result of these and other influences, the average price of crude oil more than doubled from approximately $31 per barrel in 2003 to over $74 per barrel by 2007. This price escalation has continued at an unprecedented pace with crude oil at more than $140 per barrel in the summer of 2008.

The price of crude oil has a direct impact on the cost of aviation fuel which in turn has a dramatic negative affect on airline profitability. The Air Transport Association (ATA) estimates that every $1.00 increase in the price of crude oil costs the airlines an additional $465 million in operating expense. In 1998, aviation fuel accounted for approximately 10% of airline operating costs—in 2008 it is expected to account for 40% of airline operating costs. The future price of crude oil is unknown and difficult to predict even in the short-term. It is possible that the price of crude oil and its derivative energy products will continue to increase. If this occurs it may result in a significant increase to the cost of air travel as airlines raise ticket prices to cover fuel expense. This will undoubtedly have a negative affect on future air travel demand.

Airlines continue to seek ways to both reduce costs and increase revenues. Many airlines have enacted capacity reductions or announced future service reductions by reducing the number of scheduled seats in particular markets and canceling many poor performing routes. Airlines have also been replacing older less fuel efficient aircraft with newer aircraft. For example, Northwest has been removing DC-9 aircraft from its national fleet and replacing them with newer more fuel efficient Embraer 175 and Canadair CRJ900 regional jets.

The airlines have taken other steps to counteract the rising cost of fuel such as applying fuel surcharges to ticket prices and instituting more restrictive travel policies such as "Saturday night stay" requirements on certain air fares. Through the first two months of 2008 air service demand has shown little dampening effect from rising airfares and reduced capacity. According to the Bureau of Transportation Statistics, U.S. airlines carried 1.2% more domestic passengers and 6.5% more international passengers during the first two months of 2008 than during the same period in 2007, but it is uncertain whether this year over year growth will continue. Most of the mainline carriers have indicated that although summer travel season demand is steady they will be implementing further capacity reductions in the fall in anticipation of decreasing demand. If the economy continues to weaken it is possible that these factors will combine to reduce near-term air travel demand.

CAPACITY OF THE AIRPORT

In addition to any future constraints that may be imposed by the capacity of the national air traffic control and airport systems, future growth in airline traffic at the Airport will depend on the provision of increased capacity at the Airport itself.

The forecast presented in the following paragraphs assumes unconstrained aviation demand, and therefore, it does not reflect any possible capacity constraints of the airfield, airspace, passenger terminal, or cargo facilities.

IMPLICATIONS OF NORTHWEST/DELTA MERGER

A common event running through the history of commercial airline service is airline mergers and acquisitions. In response to competitive pressures, the U.S. airlines have consolidated many times and they continue to do so. For example, in April 2001, American completed an acquisition of failing Trans World Airlines. In September 2005, America West and US Airways completed a merger and in April 2008 Northwest and Delta Air Lines announced their intentions to merge the two airlines. The initial plans indicate the new airline will be named Delta, will be headquartered in Atlanta, GA., and all of the six existing airline hubs (Memphis, Detroit and Minneapolis for Northwest and Atlanta, Cincinnati, Salt Lake City and New York-JFK for Delta) will continue to function in their current manner. In addition, the new Delta will remain part of the SkyTeam alliance that includes Air France-KLM, Alitalia, Korean Air, CSA and others. Such alliances typically involve marketing, code-sharing, and scheduling arrangements to facilitate the transfer of passengers between the airlines.

The outcome of the proposed Northwest-Delta merger is still uncertain as the plan must receive FAA, Department of Transportation and other regulatory approvals in addition to winning approve from both airlines' shareholders. If the merger does occur, the airlines anticipate it to provide a number of important synergies, cost saving opportunities and an increased worldwide route network. The merger has been described from an operational perspective as an "end-to-end" merger in that the two carriers have minimal route overlap. Where Northwest has a strong route network in the north-central, Midwest and south-central U.S., Delta has an established route network on the East Coast, southeastern U.S., and West Coast. When combined the two networks have vastly increased scope. Likewise, from an international perspective, where Northwest has a major hub at Tokyo Narita International Airport (Narita) and unique fifth freedom beyond service rights which allows it to serve other Asian markets from Narita, Delta has a strong route network to Europe and Latin America. Since both Delta and Northwest currently codeshare with SkyTeam members Air France-KLM, Korean Air and others the expanded integration of international routes and service should occur more efficiently.

In addition to the proposed merger Northwest, Delta, Air France-KLM, Alitalia and CSA have received anti-trust immunity to cooperate on international routes. It is uncertain whether or not the proposed Northwest-Delta merger will affect the anti-trust exemption.

On March 30, 2008 an Open Skies air services agreement between the U.S. and the European Union Member States (EU) went into affect. This agreement allowed for the unlimited operation and pricing of flights by any U.S. or EU carrier to or from any airport in the U.S. and EU and beyond traffic rights (provided that there are available arrival and departure slots and airport facilities). The Open Skies agreement does not guarantee access to any airport, but removed the legal and regulatory barriers previously in place. As a result of the Open Skies agreement, new flights are being offered by Northwest from DTW, MSP, and Seattle Tacoma International Airport (SEA) to London's Heathrow International Airport. Previously, access to LHR was restricted to just two U.S. airlines, American Airlines and United Airlines. Over the long term, Open Skies is likely to have a positive affect on air travel at the Airport in that it provides additional opportunities for transatlantic service.

Combined Carrier

According to Delta and Northwest, the combined carrier would be the largest U.S. airline in terms of revenue passenger miles, would be a stronger global competitor, and would create over $1.0 billion in annual operating cost synergies. These assumed benefits would help the combined carrier better compete against growing low-cost carrier competition in the U.S. and against consolidating European carriers and other strong foreign carriers in the Open Skies environment.

A significant factor of the proposed merger is that the combined carrier would have minimal domestic city-pair overlap. The airlines claim that currently only

12 Northwest and Delta nonstop domestic city-pair routes overlap resulting in limited competitive concerns. The combined carrier states that it would continue a focus on small community service with over 140 small community destinations, almost twice the number of the next closest competitor.

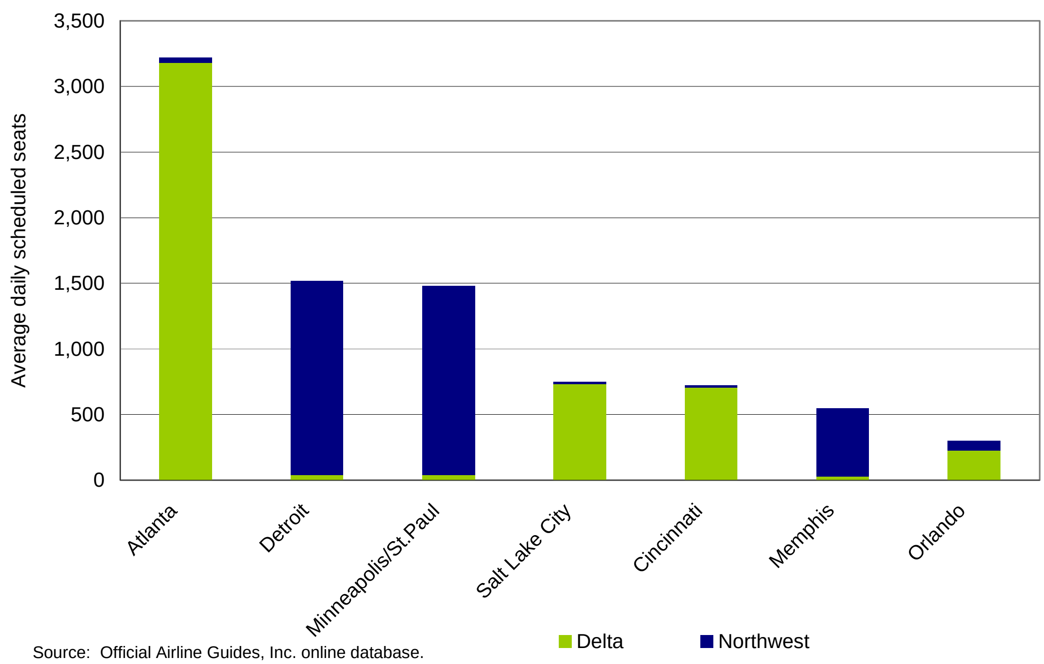
Figure 11 presents the scale of the combined Delta-Northwest connecting hub system in terms of scheduled seats. Atlanta would be the largest hub in the combined system by greater than a 2 to 1 margin over the next largest hubs of Minneapolis/St. Paul and Detroit. Memphis is in the range of the combined carriers' hubs which include Cincinnati, Salt Lake City and Orlando. The combined carrier would have exceptional hub distribution with established connecting operations in the Southeast, Great Lakes, Plains, and Rocky Mountain regions.

Figure 11

NORTHWEST AND DELTA AIR LINES SCHEDULED SEATS AT PRIMARY HUBS – MAY 2008

Master Plan Update

Memphis International Airport



Source: Official Airline Guides, Inc. online database.

Aircraft Fleets

The combination of the Delta and Northwest aircraft fleets will provide potential synergies and advantages to the combined carrier. For example, with the addition of Northwest's fleet, Delta will add to its fleet the Airbus A330 configured with 243 to 298 seats and the Boeing 747-400 configured with 403 seats. Currently, Delta's largest aircraft is the Boeing 767 configured with 285 seats. The addition of these widebody aircraft will provide the combined carrier with greater flexibility to match market demand with the appropriately sized aircraft to maximize potential revenues. Similarly, the addition of the new Boeing 787, currently on order by Northwest with delivery expected in late 2009 or early 2010, will provide the combined airline with the ability to serve markets that would be uneconomical with aircraft in the existing fleet. Table 28 presents the combined fleet of aircraft of the two airlines.

Table 28

NORTHWEST AND DELTA AIR LINES COMBINED FLEET (DECEMBER 2007)
Master Plan Update
Memphis International Airport

	Northwest	Delta	Combined	Firm orders
Narrowbody aircraft				
A319	57	--	57	5
A320	73	--	73	2
B737	--	71	71	50
B757	71	133	204	--
DC9	94	--	94	--
MD88	--	117	117	--
MD90	--	16	16	--
Subtotal	295	337	632	57
Widebody aircraft				
A330	32	--	32	--
B747	29	--	29	--
B767	--	101	101	--
B777	--	8	8	8
B787	--	--	--	18
Subtotal	61	109	170	26
Total mainline fleet	356	446	802	83
Regional aircraft	212	132	344	68
Total aircraft	568	578	1,146	151

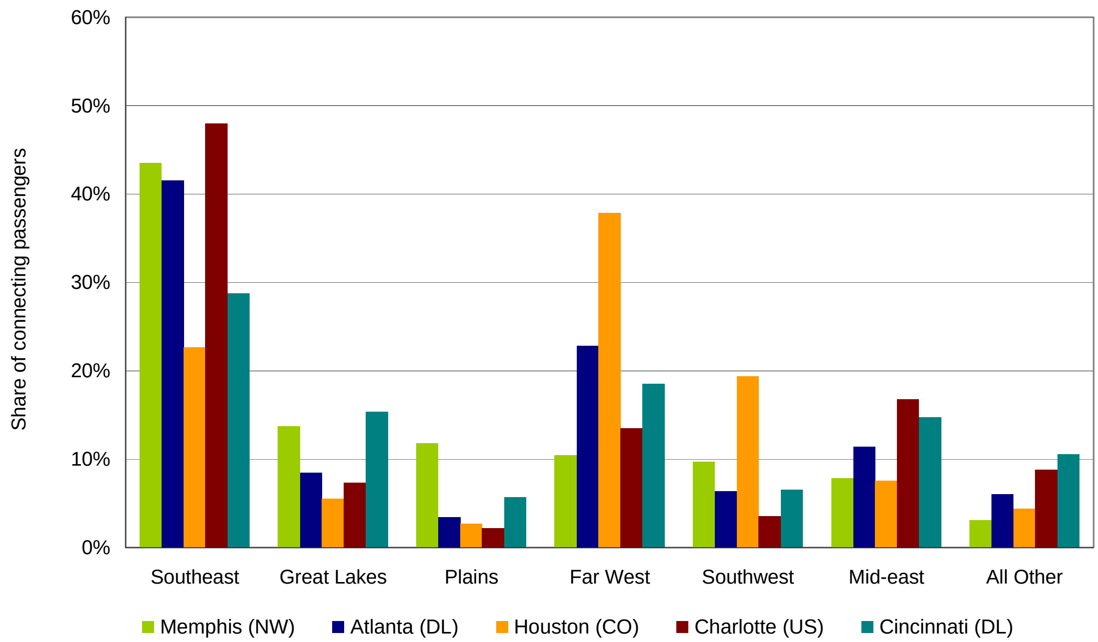
Source: Northwest Airlines and Delta Air Lines Annual Reports, 2007.

Combined Hub Coverage

As presented on Figure 12, the combined Delta-Northwest airline will compete for connecting passenger flows with other major airline connecting hubs such as US Airways hub in Charlotte, Virginia, and Continental's hub in Houston, Texas. The geographic location of Memphis, which is more centrally located than Atlanta may provide an advantage for the combined carrier when competing for connecting traffic flows.

Figure 12

COMPETING HUB CONNECTING FLOWS (2007)
Master Plan Update
Memphis International Airport



Source: U.S. Department of Transportation OD1B database.

Presented on Figure 13 are the locations of the existing Delta and Northwest connecting hubs. Atlanta, which is the nation's largest hub in terms of total passengers, is located within the southeast region together with Memphis. These two airports compete for connecting traffic that originates primarily within the Southeast, Great Lakes and Mid-East regions of the U.S. As a combined carrier, they will have the option of distributing connecting traffic over both Memphis and Atlanta to improve traffic flow efficiencies and maximize revenues.

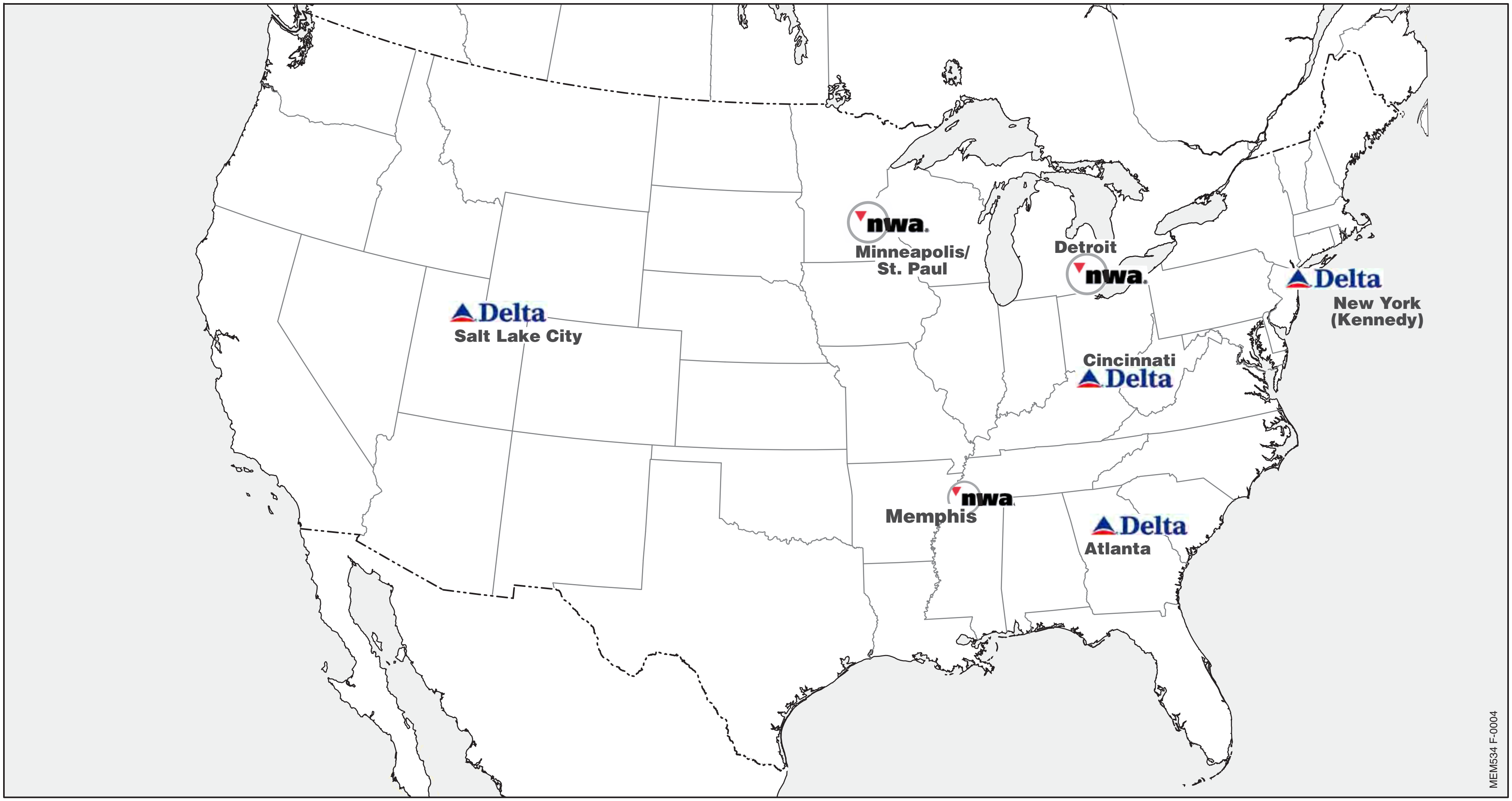


Figure 13

DELTA AND NORTHWEST PRIMARY HUBS

Master Plan Update
Memphis International Airport

December 2009

JACOBS
CONSULTANCY

Section 4

FORECAST AVIATION DEMAND

Forecasts of airline traffic were developed for the two major categories of commercial passenger airline activity, i.e., total enplaned passengers and total aircraft operations. Derivative forecasts were also developed for the significant components of activity within these major categories. For example, within the enplaned passenger category, forecasts were developed for originating and connecting enplanements, domestic and international enplanements, and mainline and regional enplanements. Within the aircraft operations category, forecasts were developed for mainline and regional aircraft operations. The approach, methodology, and key assumptions used in developing the commercial passenger airline activity forecasts are provided below.

ENPLANED PASSENGERS

The enplaned passenger forecasts were prepared using standard industry forecasting techniques to analyze (1) historical patterns of passenger traffic at the Airport, (2) recent or emerging trends at the Airport and in the airline industry, and (3) the outlook for future aviation demand on a local, national and international level. The assumptions, methodology and forecast results were coordinated with Northwest Airlines.

The originating passenger forecast and connecting passenger forecast were developed using different methodologies. Originating passengers are derived from the local demand for aviation service which includes passengers that live or work in the Memphis MSA or those passengers where the Memphis MSA is their destination for business or personal purposes. Accordingly, the projections of originating passengers were developed based on the forecasts of local economic variables and the cost of travel using various techniques such as trend line analysis, linear regression, travel propensity analysis, airline schedule analysis and professional judgment.

The number of connecting passengers routed through a connecting hub airport is largely dependent on scheduling and operational decisions of the "hubbing" airline, and therefore the projections of future connecting passengers were prepared separately from the forecast of originating passengers. The projections of connecting passengers were based on an analysis of long-term and near-term historical trends, significant events which resulted in changes to these trends, recent or emerging industry trends, and discussions with Northwest. The forecast of total enplanements is the sum of the originating and connecting passenger forecasts.

For planning purposes and to account for inherent uncertainty, a range of enplanement forecasts (baseline, low-growth and high-growth) were developed to account for potential levels of future demand under various economic and airline industry conditions. Together, these forecasts represent a reasonable range of potential future enplanement levels. The low-growth scenario represents a level of enplanement activity that may occur under weaker national economic conditions that have a strong negative impact on all airlines and airports, while the high-growth scenario represents a projected level of activity assuming strong economic conditions and a significant expansion of airline service and the addition of some new markets served from the Airport. Key assumptions for each of the three scenarios are described in the following sections.

Baseline Scenario

The baseline enplanement projections were predicated on the following primary assumptions:

1. The population and economy of the Memphis MSA will increase at the rates shown in Tables 2, 3, and 8. Memphis will continue to develop as a transportation and distribution center for the southeastern region and the nation as a whole.

2. The Airport's central geographic location, moderate weather, and relatively low airline operating costs will continue to support it location as an airline connecting hub.

3. Northwest or its merged airline will continue to be a financially viable airline and operate a connecting hub operation at the Airport of a similar size and scope as the current Northwest operation serving both domestic and international destinations from Memphis. The hubbing airline's long-term intent will be to increase its traffic at Memphis.

4. Total passenger volumes are expected to remain flat in 2008 and increase only modestly in 2009 as a result of the weakening U.S. economy and record high fuel prices.

3. By 2010, local passenger demand will begin to increase as the economy improves and Northwest and other airlines will respond by increasing scheduled departures and scheduled seats at Memphis.

4. The Airport will continue functioning as a connecting hub in the national route system of Northwest Airlines (or its merged airline), but its share of connecting passengers will decrease modestly over the forecast horizon from approximately 56% in 2007 to 49% in 2027.

5. Northwest's scheduling decisions determining the level of future connecting passengers will depend partially on the growth of local originating traffic to supplement connecting activity and maintain economically justifiable connecting operations.

6. Historically, the number of connecting passengers has increased from approximately 2.7 million in 1990 to 3.0 million in 2007, at an annual rate of 0.6%. During this period there was significant variability from year to year with connecting activity peaking at 3.8 million enplanements in 2000. Over the forecast period, it is anticipated that the projected growth in originating demand (2.5% annual growth over the forecast period) will generate significant local traffic to support moderate growth in connecting passengers.

7. Demand for international service will continue to increase at an annual rate higher than that for domestic service. It is expected that over the forecast period new transatlantic and transpacific markets will be served form Memphis in addition to increased service to some existing international markets.

8. Northwest combined with its regional affiliates will continue to maintain its existing dominant enplanement market share at the Airport, although this is expected to decrease modestly from approximately 81% in 2007 to 76% in 2027.

9. The other network carriers currently serving the Airport (American Airlines, Continental Airlines, Delta Air Lines, United Airlines and US Airways) will continue to serve the Airport from their respective hub airports, but they will not add a significant amount of new city-pair service.

10. Low fare carriers, such as AirTran, are not expected to have a dramatic impact at the Airport, although their enplanement market share is expected to gradually increase from approximately 4% in 2007 to approximately 10% in 2027.

11. Continued increases in fuel prices will increase airfares and decrease passenger demand in the short term. However, in the long term, airfares are expected to increase at rates consistent with the increase in other goods and services.

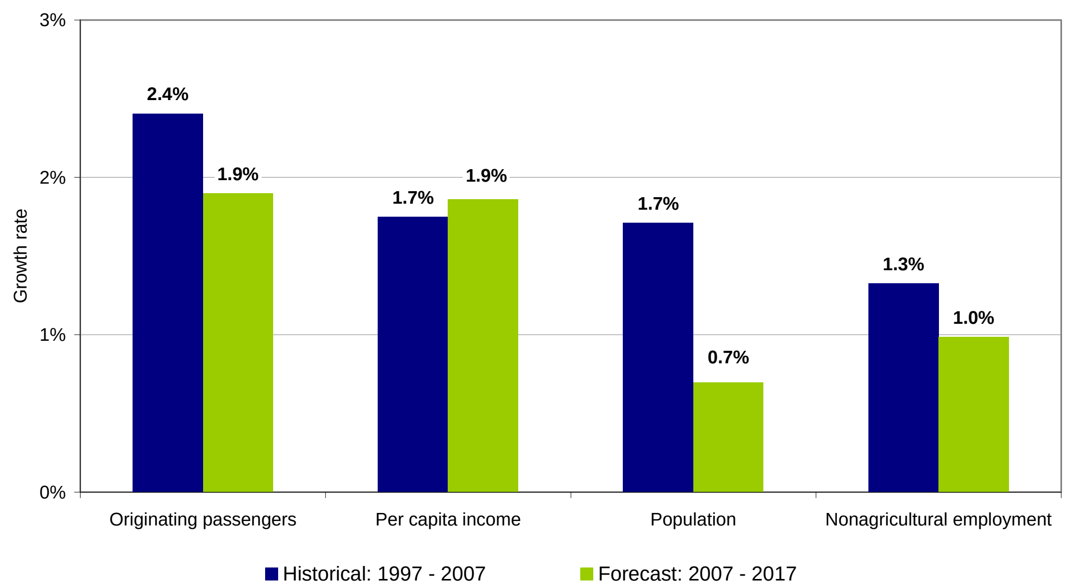
12. No major external events such as acts of terrorism, global economic recession, or major health epidemics will occur during the forecast period.

13. The surrounding connecting hub airports that compete with Memphis will continue to be viable connecting passenger airports.

The baseline forecast projects connecting passenger activity to increase over the forecast period at an annual rate of 1.1% as Northwest or the merged airline continues to operate and develop a connecting hub at the Airport. The increase in the number of originating passengers at the Airport since 1997 has resulted from overall population and economic growth in the Memphis MSA. A comparison of the historical and forecast growth rates for originating passengers, per capita income, population, and employment is provided on Figure 14. As shown, between 1997 and 2007, the number of originating passengers increased an average of 2.4% per year—a higher rate than the average increase of per capita income, population and nonagricultural employment at 1.7%, 1.7%, and 1.3%, respectively. For the period from 2007 to 2017, the forecast projects originating passengers to grow at an annual rate of 1.9% which is greater than those forecast for population (0.7%) and nonagricultural employment (1.0%) and the same as the growth rate for per capita income.

Figure 14

HISTORIC AND FORECAST ORIGINATING PASSENGERS AND ECONOMIC GROWTH
Master Plan Update
Memphis International Airport



Sources: Originating passenger growth rates:1997-2007 based on MSCAA activity records; 2007-2017 based on Jacobs Consultancy forecast; per capita income, population, and nonagricultural employment data sourced in Tables 2, 3, and 8 of this report.

The baseline forecast projects originating passengers to increase from approximately 2.4 million in 2007 to approximately 3.9 million in 2027 at an annual growth rate of 2.5%. The Airport's share of originating passengers is expected to increase from approximately 44% in 2007 to 51% in 2027.

Total enplanements, which equal the sum of originating and connecting passengers, are projected to increase from approximately 5.4 million in 2007 to 7.6 million in 2027. Connecting passengers are expected to continue to account for a significant share of total enplanements and increase at a slower rate than originating passengers. As a result, total enplaned passengers are forecast to increase at an annual rate of 1.8%.

High-Growth Scenario

The high-growth scenario was based on the baseline forecast assumptions described above with the following alternative high-growth assumptions:

1. Faster than forecast population and economic growth as shown in Tables 2, 3, and 8 and assumed in the baseline forecast scenario are expected to contribute to strong local and national economic growth and increased demand for air service at the Airport.

2. An immediate correction of the factors contributing to the current slow economic growth and high fuel price environment will occur, resulting in profitable airline financial performance to support the expansion of additional air service and modernization of aircraft fleets.

3. Strong local and national economic growth and reduced fuel prices will support Northwest service development plans to existing markets and new medium-haul and long-haul markets. New markets served from the Airport would include east- and west-coast cities currently served by Northwest from its hubs at Minneapolis/St. Paul International Airport (MSP) and Detroit Metropolitan Wayne County Airport (DTW), but not currently served from Memphis. Examples of potential new markets include Portland, Oregon, Washington-Dulles, Salt Lake City, and year-round service to San Diego. Expanded service was assumed to Los Angeles, San Francisco, Las Vegas, Ft. Lauderdale, Boston and Fort Meyers.

4. Airlines serving the Airport would increase capacity by approximately 11% to a combination of new and existing markets.

5. As a result of the high growth assumptions mentioned above, the expansion of domestic service will increase connecting traffic feed and support additional nonstop international transatlantic and transpacific service from the Airport.

The high-growth scenario projects total enplanements to grow from 5.4 million in 2007 to 8.3 million in 2027 at an average annual growth rate of 2.2%.

Low-Growth Scenario

The low-growth scenario was based on the baseline forecast assumptions described above with the following alternative low-growth assumptions:

1. Slower than forecast population and economic growth as shown in Tables 2, 3, and 8 and assumed in the baseline forecast scenario are expected to contribute to slow local and national economic growth and reduced demand for air service at the Airport.

2. The factors contributing to the current slow national economic growth and high fuel prices will continue for a period longer than that in the baseline and high-growth scenarios, resulting in unprofitable airline financial results and reduced system-wide airline seating capacity at most U.S. domestic airports.

3. The economic conditions assumed in the low-growth scenario would return to the baseline growth rates for the period 2012 through 2027.

4. All airlines serving the Airport would reduce capacity to their existing markets by approximately 10% to 15% depending on market performance. The poorest performing routes (i.e. those with low load factors or low airfare yields) would be dropped from the flight schedule.

5. Northwest or the merged airline will continue to operate a connecting hub operation at Memphis, but with reduced scheduled seat capacity of approximately 15%.

The low-growth scenario projects total enplanements to grow from 5.4 million in 2007 to 6.6 million in 2027 at an average annual growth rate of 1.1%.

ENPLANED PASSENGER FORECAST SUMMARY

Forecasts of enplaned passengers for each of the scenarios are summarized in Table 29. As shown, the baseline scenario projects the total number of enplaned passengers to grow an average of 1.8% per year between 2007 and 2025. Notably, international enplanements are expected to grow at an annual rate of 6.8% over the forecast period, whereas domestic enplanements are expected to grow at the more modest 1.5%. Likewise, the originating passenger growth rate is higher than the connecting passenger growth rate, at 2.5% versus 1.1%.

Table 29

ENPLANED PASSENGER FORECAST
Master Plan Update
Memphis International Airport

The forecasts presented in this table were prepared using the information and assumptions described in the accompanying text. Inevitably, some of the assumptions used to develop the forecasts will not be realized and unanticipated events and circumstances may occur. Therefore, there are likely to be differences between the forecast and actual results, and those differences may be material.

				Forecast								
	Historical		Estimated *(a)*	Baseline			Low-growth			High-growth		
Enplaned passengers *(b)*	2006	2007 *(c)*	2008	2012	2017	2027	2012	2017	2027	2012	2017	2027
Domestic												
Mainline	2,825	2,874	2,910	3,060	2,933	3,265	2,618	2,503	2,863	3,531	3,417	3,741
Regional	2,326	2,302	2,330	2,580	3,096	3,675	2,183	2,678	3,211	2,735	3,233	3,778
Subtotal	5,151	5,176	5,240	5,640	6,029	6,940	4,801	5,181	6,074	6,266	6,650	7,519
International	169	181	202	310	416	676	264	357	592	344	459	732
Total	5,320	5,357	5,442	5,950	6,445	7,616	5,065	5,538	6,666	6,610	7,109	8,251
Originating	2,267	2,362	2,405	2,691	3,044	3,876	2,291	2,616	3,393	2,989	3,358	4,199
Connecting	3,053	2,995	3,037	3,259	3,401	3,740	2,774	2,922	3,273	3,621	3,751	4,052
Percent connecting	57%	56%	56%	55%	53%	49%	55%	53%	49%	55%	53%	49%
Average annual increase (decrease) *(d)*												
Domestic		0.5%	1.2%	1.7%	1.5%	1.5%	(1.5%)	0.0%	0.8%	3.9%	2.5%	1.9%
International		6.9%	11.7%	11.4%	8.7%	6.8%	7.9%	7.0%	6.1%	13.7%	9.8%	7.2%
Total		0.7%	1.6%	2.1%	1.9%	1.8%	(1.1%)	0.3%	1.1%	4.3%	2.9%	2.2%
Originating						2.5%			1.8%			2..9%
Connecting						1.1%			0.4%			1.5%

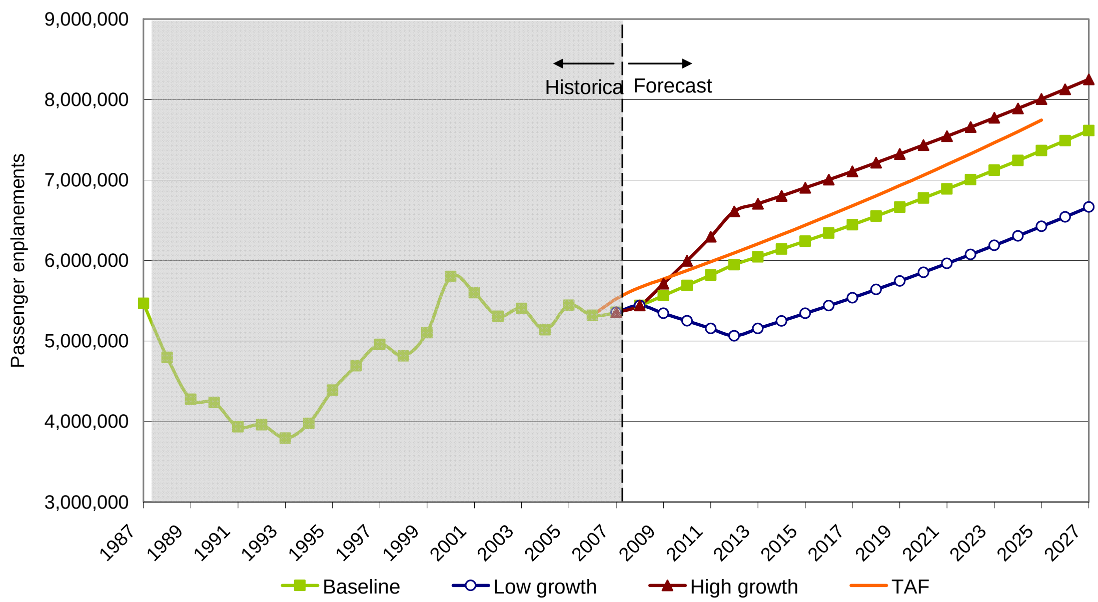
(a) Estimated based on four months of activity (January through April 2008).
(b) All passenger numbers shown in thousands.
(c) Base year for forecast is 2007.
(d) Average annual increases are calculated relative to 2007 activity levels.

Sources: Historical – Memphis-Shelby County Airport Authority records, June 2008.
Estimated and forecast – Jacobs Consultancy, July 2008.

Figure 15 depicts each of the three master plan forecast scenarios and the 2007 FAA Terminal Area Forecast (TAF). As shown, the TAF is a more aggressive projection than the baseline scenario and less aggressive projection than the high-growth scenario. The differences between the TAF and the master plan forecast are discussed in detail in the final section of this report entitled, FAA TAF Forecast Comparison.

Figure 15

ENPLANED PASSENGER FORECAST
Master Plan Update
Memphis International Airport



Sources: Historical—Memphis-Shelby County Airport Authority records, June 2008.
Forecast —FAA Terminal Area Forecast (TAF); Baseline, low growth, high growth forecast—Jacobs Consultancy, June 2008.

In addition, Figure 15 shows that each of the three scenarios differ significantly in the short-term, whereas after 2012, the scenarios are assumed to result in similar growth rates thereafter. Specifically, the growth rate for the TAF for 2007 to 2017 is 1.9%, and the master plan growth rates for the same period range from 2.9% to 0.3%, for the high- and low-growth scenarios, respectively.

AIR CARGO

In developing the Memphis air cargo tonnage forecast, a number of independent cargo forecasts were reviewed to provide benchmark data.

Independent Cargo Industry Forecasts

In addition to the overall industry conditions, a review of independent forecasts prepared by the FAA and the major aircraft manufacturers (Airbus and Boeing) was conducted (see Table 30).

Table 30

INDEPENDENT AIR CARGO GROWTH FORECASTS
Master Plan Update
Memphis International Airport

	Forecast period	Annual growth rate
Airbus	2007-2026	5.8%
Boeing	2006-2026	6.1
FAA	2007-2025	5.3

Note: Growth rates represent worldwide air cargo market projections

Sources: Airbus – 2007 Airbus Global Market Forecast.
Boeing – 2006/2007 World Air Cargo Forecast.
FAA – FAA Aerospace Forecast 2008-2025.

Outlook Summary

Key points regarding the long-term growth outlook for the worldwide air cargo market include:

1. Historically, air trade in terms of both value and tonnage has grown steadily and while air freight tonnage represents slightly over one percent of total international trade tonnage (including all modes of transport), air freight constitutes approximately 40% of world freight value.

2. In the long-term, it is expected that economic growth will be more important than local events in determining levels of cargo activity and demand for airport cargo facilities.

3. The rapidly increasing cost of fuel will impact transportation of worldwide goods. International shippers will be required to decide whether their commodities can endure the time and constant vibration of vessel transportation or absorb the increased cost of air transportation (and its escalating costs due to fuel surcharges). Intercontinental and regional shipping has similar choices, between air and trucking, but the cost of diesel fuel is increasing at a similar pace to jet-A fuel and switching from air to truck transportation is not a simple decision.

4. Segments such as integrated and all-cargo may grow more than the belly cargo segment. In addition, the growth rate in main deck freighter aircraft is expected to increase substantially, especially in the long-haul international market.

Air Cargo Forecasts

Total annual cargo tonnage forecasts for the 2007 through 2027 period for baseline, high-, and low-growth scenarios are provided in Table 31. Because of the disproportionate amount of total airport cargo accommodated by FedEx at Memphis, two distinct forecasts models were developed—a FedEx-specific model and another for all other Airport cargo activity. Hence, the unique market drivers for FedEx were quantified and assessed separately from all other carriers, such as UPS, DHL, and potential international all-cargo flights accommodated at Cargo Central. Forecasts and scenarios were derived after a thorough analysis of the various FedEx operations, a review of data gathered on the other airlines operating at the Airport, and an assessment of key market data affecting the Memphis region. Assumptions associated with the baseline, high-, and low-growth scenarios are as follows:

Baseline Scenario

- **Express**. FedEx continues to experience a slowdown in overnight express traffic. Shippers are becoming more conscious of transportation costs and are moving to more cost effective, but slower modes of transportation.

- **International**. FedEx focuses on the international market over the next several years. The new Boeing 777 freighter aircraft are primarily scheduled to facilitate the company's approach to this market.

- **Other Carriers**. Other integrated carriers (UPS and DHL) continue to expand operations with the growth of the local Memphis economy. It is assumed that each will initiate air feeder service beginning in 2017 to accommodate growing markets within 300 miles of the Airport.

- **Heavy Freight**. The heavy freight and international markets controlled by the freight forwarding and third party logistics providers will develop as a result of additional light manufacturing and distribution in the immediate area. It is assumed that (1) at least one international all-cargo airline will initiate service to the Airport by 2012 to respond to this market segment (serving twice per week initially and expanding to five times per week by 2027); and (2) a second all-cargo freighter airline will begin service by 2027.

Table 31

FORECAST TOTAL AIR CARGO TONNAGE
Master Plan Update
Memphis International Airport

	Historical		Scenario								
			Baseline			Low-growth			High-growth		
	2006	2007	2012	2017	2027	2012	2017	2027	2012	2017	2027
Total cargo *(a)*											
FedEx	3,614,641	3,779,469	4,316,163	4,837,013	5,721,067	4,090,748	4,450,163	4,962,370	4,467,595	5,216,957	6,692,932
Others	80,697	69,875	97,137	118,915	172,384	79,457	90,014	129,002	106,692	147,862	214,737
Total	3,695,338	3,849,344	4,413,300	4,955,928	5,893,451	4,170,205	4,540,177	5,091,372	4,574,287	5,364,819	6,907,669
Average annual increase (decrease) *(b)*											
FedEx	-	4.6%	2.7%	2.5%	2.1%	1.6%	1.6%	1.4%	3.4%	3.3%	2.9%
Other	-	(13.4)	6.8	5.5	4.6	2.6	2.6	3.1	8.8	7.8	5.8
Total	-	4.2%	2.8%	2.6%	2.2%	1.6%	1.7%	1.4%	3.5%	3.4%	3.0%

(a) Includes freight (express and deferred) and mail.
(b) Average annual increases are calculated relative to 2007 activity levels.

Source: Jacobs Consultancy, July 2008.

High-Growth Scenario

- **Express**. The high case scenario contains similar assumptions those of the baseline scenario for the overnight express market, but generally assumes that FedEx's international activity will increase at a faster rate.

- **Heavy Freight**. One international all-cargo airline would initiate operations as soon as 2010 with twice weekly service using Boeing 747 aircraft. This scenario also anticipates this airline's service would grow quickly to five times per week and that another international all-cargo airline would begin service in 2012.

Low-Growth Scenario

- **Express.** This scenario assumes that shipping managers will become more cost-sensitive and reallocate shipments of domestic cargo to surface modes, including both trucks and rail. This slowdown in air cargo will also impact portions of the deferred air cargo market.

- **Other Carriers**. It is assumed that a slowing economy would impact the other integrated carriers. UPS and DHL are currently serving the local market, versus the national sort operation of FedEx, and therefore, their growth trends would be slower in this scenario. Air feeder service is not initiated under this scenario.

- **Heavy Freight**. International all-cargo airline activity does not materialize until 2027. While the surrounding Memphis economy includes increasing amounts of light manufacturing, locally produced and consumed air cargo volumes would be trucked to existing major cargo gateways (e.g. Chicago-O'Hare, Atlanta).

Forecasts contained herein represent unconstrained demand that is not hampered by potential facility limitations. Unconstrained forecasts were used to indicate what type of cargo demand the Airport could expect throughout the 20-year planning horizon.

FedEx Day/Night Activity. FedEx activity at the Airport occurs in two distinct periods that are driven by the nighttime and daytime sort operations at the carrier's Memphis Super Hub facilities. The nighttime sort primarily accommodates the overnight or express product, while the daytime operation is more focused on the USPS mail and FedEx deferred (2nd and 3rd day shipment) volumes. One of the important trends regarding FedEx activity and the entire integrated carrier market is that growth in overnight activity has been relatively flat over the past several years, while growth has been experienced in the deferred product volumes. This trend has been experienced by both FedEx and the broader integrated carrier markets.

Cargo Central. While FedEx represents 98% of the total cargo activity at the Airport, there are other air cargo carriers with an existing presence and/or future market development opportunities. Growth and development of Cargo Central will be the main focus of future Airport cargo capacity outside of FedEx. This is reflected in the forecasts through an understanding of key market drivers, demand patterns, emerging market potential, and key cargo operators.

Based on discussions with planning managers for UPS and DHL, as well as shipping managers at two large international freight forwarding companies, there are residual effects on the overall Memphis cargo market from the large FedEx operation.

- Freight forwarders suggested that there is additional outbound activity in the market (substantiated by the recent trend in FedEx volumes) and that there is more "value-added" activity seen recently, such as computer repair and time-sensitive commodities.

- If more of the local activity can be captured by the more traditional heavy freight market (freight forwarders), there is real potential for the Airport to experience growth in the direct international freighter market. The varying degrees of this market potential are captured within the baseline, high-, and low-growth forecast scenarios.

- Transportation costs are becoming an increasing share of the overall operation costs to manufacturers. While some commodities have the ability to switch modes (i.e., air to ocean) it is unclear how much of the increasing local activity can absorb additional increases in price. The majority of this is currently accommodated by FedEx, whose shipping prices are almost double that of a freight forwarders or other all-cargo carriers.

AIRCRAFT OPERATIONS

A forecast of aircraft operations was developed for mainline passenger, regional passenger, air cargo, GA, and military operations. For passenger operations, baseline, high, and low forecasts were developed that correspond to the respective enplanement forecast scenarios. Likewise, baseline, high, and low forecasts were developed for air cargo and GA operations based on factors unique to each category. The methodology and assumptions underlying each the forecasts of aircraft operations are presented below.

Passenger Operations

The forecast of passenger operations was developed by creating a average day peak month airline schedule for the 2007 baseline year and each of the forecast years: 2012, 2017 and 2027. The projected average day peak month airline schedules were adjusted for the evolution of the aircraft fleet mix, passenger load factors, and city-pair markets to accommodate the corresponding enplanement forecast for each year. The projected airline schedules were then annualized to produce forecasts of mainline and regional passenger operations.

The baseline, high, and low forecasts of enplanements were the primary inputs to the three aircraft operations scenarios. Key assumptions common to the three forecast scenarios included:

1. The passenger aircraft operations forecast is based on the forecast of total enplaned passengers and assumptions regarding the future airline fleet mix, load factors, and city-pair markets.

2. The future airline fleet mix was projected based on recent and emerging airline trends, new aircraft orders for the airlines serving Memphis, and the assumption that the Airport will remain a connecting hub.

3. Average passenger load factors would gradually increase over time, based on recent historical load factors and the airline industry trend towards increasingly efficient aircraft utilization.

4. The average number of enplaned passengers per departure for both regional aircraft and mainline aircraft are anticipated to increase based on an assumed increase in aircraft size (average seats per departure) and load factors.

5. Consistent with historical trends, commuter aircraft operations would represent an increasing share of passenger aircraft operations over the forecast period.

6. Older, less fuel-efficient aircraft, such as the DC-9s operated by Northwest, would be gradually replaced by new aircraft over the forecast period. Some of the DC-9s would be replaced by large regional jets with 76 seats; others would be replaced with new narrowbody aircraft.

The characteristics of the flight schedules which were developed using the aforementioned assumptions are presented in Table 32. Notably, the average seat per departure grows for both the mainline and regional aircraft. In part, this can be explained by the heavier growth in regional aircraft and the modest decline in mainline aircraft. Those mainline aircraft removed from the fleet over time are assumed to be replaced in large part by regional jets with fewer seats than the aircraft they are replacing. However, the new regional jets have more seats than the existing aircraft in the regional class driving the average seat size of the regional category upward. For example, based on discussions with Northwest it was assumed that DC-9s (100 – 125 seats) would be replaced primarily by 76 seat regional jets. In addition, although fewer mainline jets remain in the mix, the average gauge of these aircraft is increasing, (e.g., DC-9s being removed leaving primarily A320s with 148 seats).

Table 32

PASSENGER AIRLINE AIRCRAFT DEPARTURES
Master Plan Update
Memphis International Airport

	Historical	Baseline forecast		
	2007	2012	2017	2027
Average seats per departure				
Mainline	128	134	146	147
Regional	50	53	60	63
Load factor				
Mainline	78%	80%	80%	82%
Regional	77%	78%	79%	81%
Enplaned passengers per departure				
Mainline	100	108	117	120
Regional	38	42	47	51

Source: Jacobs Consultancy, July 2008.

With regard to the load factor progression for both mainline and regional aircraft, the load factors shown in Table 32 represent load factors growing over time to serve additional passenger demand over the forecast period.

As shown in Table 33, passenger aircraft operations in the baseline scenario are forecast to increase from 197,748 in 2007 to 243,100 in 2027 at an annual rate of 1.0%. Mainline passenger operations are projected to decrease from 70,342 in 2007 to 66,200 in 2027, at an annual rate of -0.3%. Continuing the converging historical trends, regional operations are projected to increase from 127,406 in 2007 to 176,900 in 2027, at an annual rate of 1.7%.

The high scenario was based on the high enplanement forecasts and the same approach and methodology as the baseline operations forecast. Under the high scenario aircraft operations are projected to increase from 197,748 in 2007 to 253,200 in 2027 at an annual rate of 1.2%. In contrast to the baseline and low scenarios, this scenario envisions both mainline and regional operations growing at 0.5% and 1.6%, respectively. Mainline operations growing in the high scenario reflect the additional narrowbody aircraft that would be added to the fleet under the realization of the high scenario.

The low growth passenger operations scenario was also based on the low growth enplanement forecasts and the same approach and methodology as the baseline operations forecast. Under the low growth scenario, aircraft operations are projected to increase from 197,748 in 2007 to 209,100 in 2027 at an annual rate of 0.3%.

Table 33

AIRCRAFT OPERATIONS FORECAST

Master Plan Update

Memphis International Airport

The forecasts presented in this table were prepared using the information and assumptions described in the accompanying text. Inevitably, some of the assumptions used to develop the forecasts will not be realized and unanticipated events and circumstances may occur. Therefore, there are likely to be differences between the forecast and actual results, and those differences may be material.

	Historical		Estimated *(a)*	Forecast								
				Baseline			Low-growth			High-growth		
	2006	2007 *(b)*	2008	2012	2017	2027	2012	2017	2027	2012	2017	2027
Passenger operations												
Mainline	69,308	70,342	73,400	66,600	59,400	66,200	56,600	50,900	58,000	78,100	70,200	77,700
Regional/commuter	131,862	127,406	131,000	144,300	155,800	176,900	117,100	133,200	151,100	147,200	157,200	175,500
Subtotal	201,170	197,748	204,000	210,900	215,200	243,100	173,700	184,100	209,100	225,300	227,400	253,200
Air cargo operations												
Air carrier	127,888	127,668	128,400	131,500	134,400	151,800	124,300	122,700	131,000	136,000	144,400	175,100
Feeder	7,612	5,912	5,900	5,900	5,800	6,000	5,600	5,400	5,600	6,000	5,900	6,100
Subtotal	135,500	133,580	134,300	137,400	140,200	157,800	129,900	128,100	136,600	142,000	150,300	181,200
General aviation operations	46,566	42,128	41,500	39,000	43,000	51,000	38,000	35,000	29,000	46,000	49,000	59,000
Military operations	1,587	1,533	1,500	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700
Total operations	384,823	374,989	381,700	389,000	400,100	453,600	343,300	348,900	376,400	415,000	428,400	495,100
Average annual increase												
Passenger operations		(1.7%)	3.4%	1.3%	0.8%	1.0%	(2.6%)	(0.7%)	0.3%	2.6%	1.4%	1.2%
Air cargo operations		(1.4%)	0.5%	0.6%	0.5%	0.8%	(0.6%)	(0.4%)	0.1%	1.2%	1.2%	1.5%
Military operations		(3.4%)	(2.2%)	2.1%	1.0%	0.5%	2.1%	1.0%	0.5%	2.1%	1.0%	0.5%
General aviation operations		(9.5%)	(1.5%)	(1.5%)	0.2%	1.0%	(2.0%)	(1.8%)	(1.8%)	1.8%	1.5%	1.7%
Total operations		(2.6%)	1.8%	0.7%	0.7%	1.0%	(1.8%)	(0.7%)	0.0%	2.0%	1.3%	1.4%

(a) Estimated based on four months of activity (January through April 2008).
(b) Base year for forecast is 2007.
(c) Average annual increases are calculated relative to 2007 activity levels.

Sources: Historical – Memphis-Shelby County Airport Authority records, June 2008.
Estimated and forecast – Jacobs Consultancy, July 2008.

Air Cargo Operations

From Table 33 it is seen that total air cargo aircraft operations in the baseline scenario are forecast to increase from 133,580 in 2007 to 157,800 in 2027 at an annual rate of 0.8%.

The high-growth forecast was based on the high-growth scenario assumptions and the same approach and methodology as the baseline operations forecast. Under the high-growth scenario total air cargo aircraft operations are projected to increase to 181,200 in 2027 at an annual rate of 1.5%.

The low-growth forecast was based on the low-growth scenario assumptions and the same approach and methodology as the baseline operations forecast. Under the low-growth scenario, total air cargo aircraft operations are projected to increase to 136,600 in 2027 at an annual rate of 0.1%.

General Aviation Operations

GA operations at the Airport, which are essentially 100% itinerant operations, have declined from 73,698 operations in 1997 to 42,128 in 2007. After peaking at 79,483 operations in 1999, GA activity has declined each year through 2007 which is consistent with the national trend. GA activity has been declining in part because of the rising costs of aircraft ownership and maintenance, liability issues related to GA aircraft operation, and the increased availability of commercial airline service. In addition, a portion of the decline in the Airport's GA activity was the result of GA activity transferring to other airports, including Charles W. Baker Airport and General DeWitt Spain Airport.

To reflect potential changes in the GA traffic segment, a range of GA operations forecasts were developed and the results are presented in Table 33. These forecasts were based on historical trends for GA activity at the Airport, FAA forecasts for itinerant GA operations, and anticipated GA segment developments.

Key assumptions used in developing the three GA forecast scenarios are described below:

1. The baseline scenario of GA operations is based on a national market share analysis. Historically, the Airport's share of total U.S. GA operations has consistently declined from 1997 to 2007. Likewise, the Airport's absolute number of GA operations has generally followed national trends, although over the last ten years the Airport's activity has been declining faster than the national average.

2. The Airports share of national GA itinerant operations will continue to decline through 2011. Beginning in 2012, itinerant GA operations will begin to increase as a result of new advances in business and corporate aircraft, such as the introduction of very light jets (VLJs) which will result in a

moderate increase in GA activity. The average annual increase for the forecast period for the baseline scenario is 1.0%.

3. The high scenario assumes that GA operations at the Airport would increase at the FAA's projected national growth rate for GA itinerant operations of approximately 1.7% from 2007 through 2027.

4. The low scenario assumes that GA operations would continue to decline as a percentage of total U.S. itinerant GA operations at a rate similar to that recorded between 1997 and 2007, with a resultant average annual decrease of 1.8% from 2007 to 2027.

Military Operations

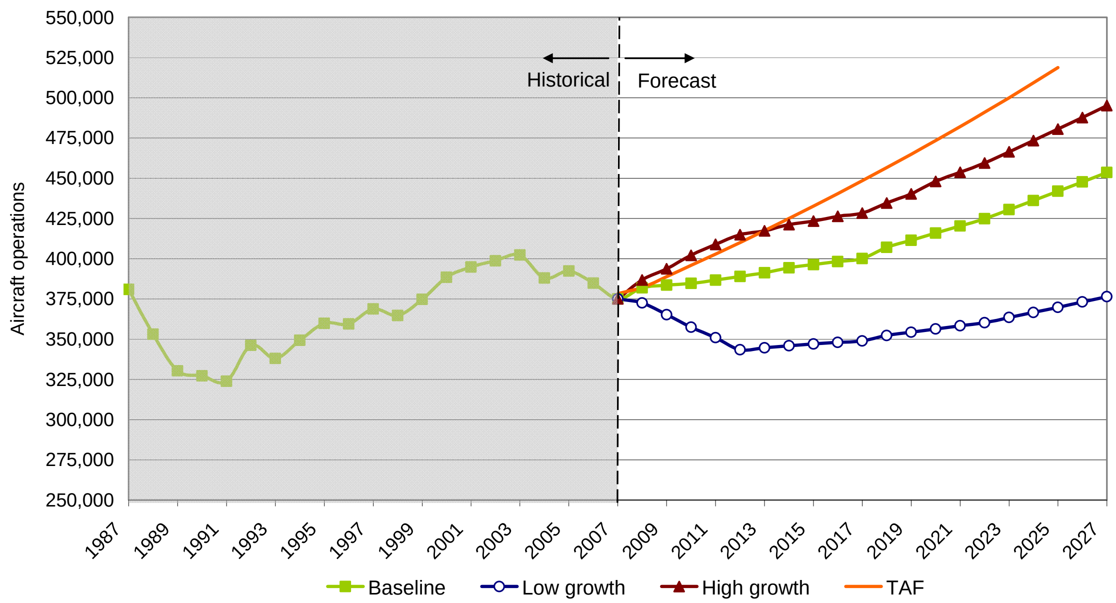
The forecast for military operations assumes that military operations will increase slightly from approximately 1,553 operations in 2007 to 1,700 operations by 2012 and then remain constant at approximately 1,700 operations through 2027. The forecast of 1,700 operations represents the average number of military operations from 2002 through 2007. High and low forecast scenarios for military operations were not developed as the master plan does not envision any need for military facilities planning. Table 33 presents the military operations forecast.

Total Operations

Table 33 and Figure 16 depict aircraft operations for each of the three scenarios for comparative purposes. The baseline scenario projects total aircraft operations to increase from 374,989 in 2007 to 453,600 in 2027 with an average annual increase of 1.0%. Total aircraft operations are forecast to remain relatively flat increasing modestly from their present level to 376,400 in the low growth scenario while they would increase to 495,100 in the high growth scenario with average annual growth rates of 0.0% (slight growth) and 1.4%, respectively.

Figure 16

AIRCRAFT OPERATIONS FORECAST
Master Plan Update
Memphis International Airport



Sources: Historical—Memphis-Shelby County Airport Authority records, June 2008.
Forecast —FAA Terminal Area Forecast (TAF); Baseline, low growth, high growth forecast—Jacobs Consultancy, June 2008.

Figure 16 depicts each of the three master plan forecast scenarios and the 2007 FAA Terminal Area Forecast (TAF). As shown, the TAF is a more aggressive projection than the high growth scenario. The differences between the TAF and the master plan forecast are discussed in detail in the final section of this report entitled, Forecast Comparison.

In addition, Figure 16 shows that each of the three scenarios differ significantly in the short-term, whereas after 2012, the scenarios are assumed to have played out and the growth rates thereafter are similar. Specifically, each of the scenarios increase at a moderate rate between 2012 and 2017, and each grow more aggressively after 2017.

Aircraft Fleet Mix

A fleet mix forecast was developed which presents the anticipated fleet mix by aircraft operations category and the estimated percentage of total future operations anticipated by each aircraft type.

The fleet mix forecast was developed for the baseline operations forecast for passenger, air cargo, GA, and military aircraft. For 2007, actual fleet data was used to estimate the percentages of the various aircraft operating during the year. This base year fleet mix was then adjusted over the forecast period to account for projected changes to the fleet as a result of aircraft retirements, aircraft orders, airline announcements regarding fleet changes, general industry trends, and professional judgment. Given the predominance of Northwest and FedEx in terms of aircraft operations at the Airport, input from both airlines was used to refine their fleet mix in accordance with their planned evolution.

Key assumptions used in developing the forecast fleet mix are provided below.

1. The baseline passenger aircraft fleet mix was derived from the Official Airline Guides, Inc. passenger flight schedule for the selected design day in May 2007.

2. The Airport will continue to serve as a connecting hub airport, and therefore it will continue to have a significant percentage of regional aircraft operations to feed mainline aircraft operations.

3. Northwest will gradually phase out operations of DC-9 aircraft and replace them with large (76-seat) regional jets.

4. Operations by existing 50-seat regional jet aircraft (or future equivalently sized regional jets) are expected to decline moderately over the forecast horizon. It is possible that under certain future conditions the airlines will expedite the replacement of the existing 50-seat aircraft. The likely replacement for the 50-seat regional jets in Memphis would be 70- to 76-seat regional jets. Some transitions to the larger regional jets are occurring today.

5. FedEx will gradually replace its existing Boeing 727 aircraft with Boeing 757 aircraft in accordance with their 2007 Annual Report. FedEx will gradually introduce Boeing 777 aircraft to serve long-haul and international destinations. The DC-10s in the fleet mix today will be retired over the next few years and be completely retired by 2012.

6. The GA aircraft fleet will continue to evolve toward more sophisticated business/corporate jets while operations from piston and multi-engine turboprop aircraft will decrease in accordance with both local and national trends in GA.

7. The military operations will be performed by TnANG primarily with either the C5-A Galaxy or C-17 Globemaster III aircraft.

Table 34 presents the historical and forecast fleet mix for 2007 and the forecast horizon years.

Table 34

AIRCRAFT FLEET MIX FORECAST
Master Plan Update
Memphis International Airport

The forecasts presented in this table were prepared using the information and assumptions described in the accompanying text. Inevitably, some of the assumptions used to develop the forecasts will not be realized and unanticipated events and circumstances may occur. Therefore, there are likely to be differences between the forecast and actual results, and those differences may be material.

	2007	2012	2017	2027
Passenger aircraft				
Mainline aircraft				
Widebody				
A332	0.4%	0.7%	0.7%	0.3%
B787	0.0%	0.3%	0.3%	0.9%
Subtotal	0.4%	1.0%	1.0%	1.2%
Narrowbody				
A319	5.3%	5.1%	5.0%	4.4%
A320	8.5%	7.8%	8.0%	7.1%
B717	2.5%	2.7%	2.3%	1.5%
B737	0.0%	0.0%	7.0%	13.1%
B757	1.8%	1.7%	2.0%	0.0%
DC-9	15.9%	10.6%	0.0%	0.0%
MD-80	2.9%	2.7%	2.7%	0.0%
Subtotal	36.7%	30.7%	26.9%	26.1%
Regional aircraft				
CRJ-200	40.2%	36.8%	31.2%	30.9%
CRJ-700	2.8%	3.7%	7.0%	8.0%
CRJ-900	2.6%	8.3%	15.9%	18.4%
E70	0.4%	0.3%	0.7%	0.9%
E75	0.0%	3.4%	7.8%	11.0%
ER3	0.4%	0.3%	0.0%	0.0%
ERJ	6.4%	6.1%	6.0%	3.6%
SF3	10.2%	9.2%	3.6%	0.0%
Subtotal	63.0%	68.3%	72.1%	72.8%
Total passenger aircraft	100.0%	100.0%	100.0%	100.0%
Air cargo aircraft				
Widebody				
A306	20.4%	18.8%	18.0%	17.0%
A310	15.8%	14.5%	13.9%	13.1%
B747	0.4%	0.7%	1.4%	1.6%
B767	0.0%	0.7%	1.4%	2.2%
B777	0.0%	3.9%	5.4%	6.7%
DC10	8.1%	6.2%	5.8%	0.0%
MD10	16.6%	16.3%	15.6%	20.2%
MD11	8.3%	10.8%	11.4%	10.7%
Subtotal	69.6%	72.0%	72.8%	71.5%
Narrowbody				
B727	25.8%	12.6%	0.0%	0.0%
B757	0.4%	11.5%	23.1%	24.3%
DC8	0.4%	0.0%	0.0%	0.0%
DC9	0.4%	0.0%	0.0%	0.0%
Subtotal	27.0%	24.1%	23.1%	24.3%
Turboprops/piston	3.5%	3.9%	4.1%	4.2%
Total air cargo aircraft	100.0%	100.0%	100.0%	100.0%
General aviation aircraft				
Piston	25%	25%	20%	15%
Turboprop	20%	15%	10%	10%
Corporate jet – heavy	5%	7%	10%	12%
Corporate jet – light	50%	53%	60%	63%
Total	100%	100%	100%	100%
Military aircraft				
C5A/C17	100%	100%	100%	100%

Note: Totals may not add due to rounding.

Sources: Historical – Memphis-Shelby County Airport Authority records and Official Airline Guides, Inc. online database. Forecast – Jacobs Consultancy, July 2008.

PEAK PERIOD DEMAND FORECAST

The forecasts of enplaned passengers and aircraft operations are used in master plans to determine future facility requirements. Before the annual forecasts of enplanements and operations can be applied in facility planning, they must be converted into design metrics known as "peak period" activity. These metrics typically include average day peak month (ADPM) activity and peak hour activity.

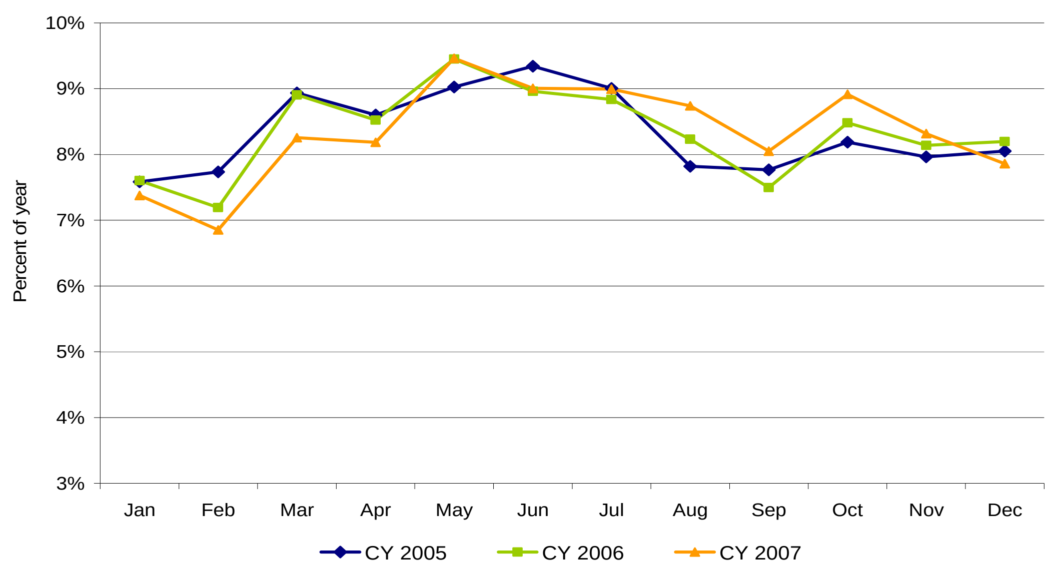
The ADPM was estimated independently for passenger enplanements and total aircraft operations. Peak hour enplanements and peak hour aircraft operations were calculated from the estimates of the future ADPM.

Enplaned Passengers

The first step in determining peak period enplanements is to identify the peak month of enplanement activity in the baseline year 2007. Figure 17 shows the monthly distribution of enplaned passengers for the period from January 2005 to December 2007. The number of monthly enplaned passengers ranged between

Figure 17

ENPLANED PASSENGERS – PERCENT OF YEAR
Master Plan Update
Memphis International Airport



Sources: Memphis-Shelby County Airport Authority records, June 2008.

about 360,000 and 510,000 over the period, with the peak month occurring in May the last two years with just over 500,000 enplaned passengers. Figure 17 data also shows the peak month can be expected to represent approximately 9.5% of the year as it did for both calendar years 2006 and 2007.

Upon establishing May as the peak month for passenger enplanements, the daily scheduled seats for each of the days in May 2007 were pulled to determine the average day of the peak month. The average day of the peak month is a theoretical metric estimated by dividing the month's total scheduled seats by 31. Upon determining the number of scheduled seats that the ADPM schedule should represent, an actual weekday schedule with a comparable number of scheduled seats was compiled. The average day enplanements were then allocated on an hourly basis according to the representative flight schedule to determine the peak hour for enplanements.

Peak period projections for the forecast horizon years 2012, 2017 and 2027 were developed based on the 2007 baseline analysis, and the respective annual enplanement forecasts. Table 35 outlines the peaking characteristics for both enplaned passengers and total aircraft operations.

Table 35

PEAK PERIOD ACTIVITY – BASELINE SCENARIO
Master Plan Update
Memphis International Airport

	Estimated	Forecast		
	2007	2012	2017	2027
Enplaned passengers				
Annual	5,356,614	5,950,000	6,445,000	7,616,000
Peak month	507,864	564,123	611,055	722,078
Percent of annual	9.48%	9.48%	9.48%	9.48%
ADPM	16,383	18,499	20,036	23,694
Percent of annual	0.31%	0.31%	0.31%	0.31%
Peak hour	3,309	3,410	3,497	3,547
Aircraft Operations				
Annual	374,989	388,959	400,124	453,656
Peak month	32,925	34,152	35,132	39,832
Percent of annual	8.78%	8.78%	8.78%	8.78%
ADPM	1,062	1,102	1,133	1,285
Percent of annual	0.28%	0.28%	0.28%	0.28%

Sources: Historical – Memphis-Shelby County Airport Authority records, June 2008.
Forecast – Jacobs Consultancy, July 2008.

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Section 5

FORECAST COMPARISON

A comparison of the master plan forecast to the FAA's 2007 Terminal Area Forecast (TAF) is presented in Tables 36 and 37. The format of Tables 36 and 37 is based on the templates provided by the FAA for the comparison of airport planning forecasts and the FAA TAF.* As required, the results are presented for the base year of 2007 and forecast horizons years which are equal to the base year, plus 1, 5, 10 and 15 years (2008, 2012, 2017, and 2022). A comparison for 20 years (2027) is also provided. A direct comparison of the master plan forecast to the TAF required the conversion of the master plan's aviation demand categories, which are based on the Airport's record keeping system, to the TAF format. This required converting passenger enplanements and aircraft operations into the FAA's categories: (1) air carrier and (2) commuter for enplanements; (1) air carrier and (2) commuter/air taxi for operations.

A number of minor differences exist between the time horizons of the master plan forecast and the TAF. First, the master plan forecast was prepared on a calendar year basis while the TAF was prepared on a federal fiscal year basis (ending September 30). Also, the base year for the master plan forecast is 2007 (based on actual 2007 data); whereas the TAF base year was fiscal year 2006 with the 2007 data being an estimate. Finally, the TAF projects enplanements through 2025, whereas the master plan projects through 2027; therefore, Jacobs Consultancy extrapolated 2027 projections for the TAF using the TAF growth rate for the period 2007 - 2025.

FAA categorizes an enplanement as an air carrier enplanement if the passenger traveled on an aircraft with 60 seats or more, whereas the master plan forecast projected enplanements in terms of mainline and regional categories. Mainline passengers defined as those traveling on jets operated by mainline carriers (e.g., Northwest); regional passengers defined as those traveling on regional jets or turboprops operated by the regional airlines (e.g., Mesaba, Pinnacle). Because some regional jets have more than 60 seats, a direct comparison of the master plan's mainline enplanements cannot be made to FAA's air carrier enplanements. Therefore, the master plan forecast of enplanements was converted into FAA's categories to enable a direct comparison. Likewise, the aircraft operations projected by the master plan were reconciled using FAA's categories. The results of this reconciliation are presented in Table 36.

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*U.S. Department of Transportation, Federal Aviation Administration., Forecasting Aviation Activity by Airport, July 2001, and Revision to Guidance on Review and Approval of Aviation Forecasts., Memorandum from Director of Airport Planning and Programming, APP-1, December 23, 2004, http://www.faa.gov.

Table 36

MASTER PLAN BASELINE FORECAST BY FAA CATEGORIES
Master Plan Update
Memphis International Airport

		Forecast *(a)*					Average annual increase (decrease)				
	Base year 2007	2008	2012	2017	2022	2027	2007 - 2008	2007 - 2012	2007 - 2017	2007 - 2022	2007 - 2027
Passenger enplanements *(b)*											
Air carrier	3,528,567	3,619,000	4,102,600	4,915,600	5,480,000	6,099,600	2.6%	3.1%	3.4%	3.0%	2.8%
Commuter	1,828,047	1,823,000	1,847,400	1,529,400	1,524,000	1,516,400	-0.3%	0.2%	-1.8%	-1.2%	-0.9%
Total	5,356,614	5,442,000	5,950,000	6,445,000	7,004,000	7,616,000	1.6%	2.1%	1.9%	1.7%	1.8%
Aircraft operations *(c)*											
Air carrier	212,417	216,000	231,700	261,500	284,500	311,100	1.7%	1.8%	2.1%	1.9%	1.9%
Commuter/air taxi	118,911	122,700	116,600	93,900	91,900	89,800	3.2%	-0.4%	-2.3%	-1.9%	-1.4%
Total	331,328	338,700	348,300	355,400	376,400	400,900	2.2%	1.0%	0.7%	0.7%	1.0%
General aviation											
Itinerant	42,128	41,500	39,000	43,000	46,800	51,000	-1.5%	-1.5%	0.2%	0.8%	1.0%
Local	-	-	-	-	-	-	-	-	-	-	-
Total	42,128	41,500	39,000	43,000	46,800	51,000	-1.5%	-1.5%	0.2%	0.8%	1.0%
Military	1,533	1,500	1,700	1,700	1,700	1,700	-2.2%	2.1%	1.0%	0.8%	0.5%
Total aircraft operations	374,989	381,700	389,000	400,100	424,900	453,600	1.8%	0.7%	0.7%	0.7%	1.0%
Based aircraft	107	106	98	91	85	88	-0.9%	-1.7%	-1.6%	-1.5%	-1.0%

Note: Totals may not add due to rounding.

(a) Master plan forecast based on calendar year.
(b) Master plan enplanements presented here shown per FAA categories converted from mainline and regional totals.
(c) Master plan operations presented here shown per FAA categories converted from mainline and regional totals.

Sources: Historical – Memphis-Shelby County Airport Authority records, June 2008.
Forecast – Jacobs Consultancy, July 2008.

Table 37 presents the master plan baseline forecast side by side with the 2007 TAF for comparison. Notably, the enplanements forecasts are very similar, differing by only 4.4% in the forecast horizon year 2022 with the master plan forecast being the more conservative of the two. Specifically, the master plan projects just over 7.0 million enplanements in 2022, whereas the TAF projects about 7.3 million for the same period. The growth rates for enplanements for each of the periods examined are also similar.

However, the two forecasts differ in terms of aircraft operations, when comparing either commercial operations or total operations. Overall, the master plan forecast of aircraft operations is more conservative than those projected by the FAA. For total operations, the TAF projects about 5.1% more than the master plan looking ahead five years, and the TAF projects about 13.5% more than the master plan looking out ten years. Much of the difference between the two forecasts of total operations can be explained by the variance between the commercial operations—7.5% for 2012 and 17.1% in 2017. The variance can be explained by the following:

- The master plan assumes the trend toward serving passenger demand with regional jets in lieu of mainline jets will continue; however, newer regional jets and those on order have greater seating capacity than the predecessor aircraft allowing more passengers to be served with less operations;

- Load factors are expected to increase over time as airlines attempt to serve demand with fewer operations.

While these differences are notable, the FAA considers forecasts that differ by less than 10% in the five year period and 15% in the ten year period as consistent. *Therefore, the two forecasts can be considered consistent and acceptable for planning purposes.*

FORECAST SUMMARY

Table 38 presents a comprehensive summary of the aviation demand forecast for each of the three scenarios. The forecast of passenger enplanements and aircraft operations for each category are included.

Table 37

COMPARISON OF MASTER PLAN BASELINE FORECAST AND FAA TAF
Master Plan Update
Memphis International Airport

	Forecast Year *(a)*	MEM Master Plan Update *(b)*	2007 FAA TAF *(c)*	% Variance MEM MPU vs. 2007 TAF
Passenger enplanements				
Base year	2007	5,356,614	5,524,282	-3.0%
Base year + 1 year	2008	5,442,000	5,666,403	-4.0%
Base year + 5 years	2012	5,950,000	6,095,575	-2.4%
Base year + 10 years	2017	6,445,000	6,681,064	-3.5%
Base year + 15 years	2022	7,004,000	7,326,853	-4.4%
Base year + 20 years	2027	7,616,000	8,042,650	-5.3%
Annual compound growth rates				
2007-2012		2.1%	2.0%	
2008-2012		2.3%	1.8%	
2012-2017		1.6%	1.9%	
2017-2027		3.4%	3.8%	
Commercial operations *(d)*				
Base year	2007	331,328	346,040	-4.3%
Base year + 1 year	2008	338,700	349,669	-3.1%
Base year + 5 years	2012	348,300	376,437	-7.5%
Base year + 10 years	2017	355,400	413,210	-14.0%
Base year + 15 years	2022	376,400	454,071	-17.1%
Base year + 20 years	2027	400,900	498,993	-19.7%
Annual compound growth rates				
2007-2012		1.0%	1.7%	
2008-2012		0.7%	1.9%	
2012-2017		0.4%	1.9%	
2017-2027		2.4%	3.8%	
Total operations *(e)*				
Base year	2007	374,989	378,324	-0.9%
Base year + 1 year	2008	381,700	382,106	-0.1%
Base year + 5 years	2012	389,000	410,093	-5.1%
Base year + 10 years	2017	400,100	448,462	-10.8%
Base year + 15 years	2022	424,900	490,999	-13.5%
Base year + 20 years	2027	453,600	537,240	-15.6%
Annual compound growth rates				
2007-2012		0.7%	1.6%	
2008-2012		0.5%	1.8%	
2012-2017		0.6%	1.8%	
2017-2027		2.5%	3.7%	

(a) The Master Plan Update forecast was prepared on a calendar year basis and the FAA TAF was prepared on a federal fiscal year ending September 30.
(b) Memphis Master Plan Update figures for 2007 are based historical results.
(c) TAF projections for 2027 estimated by Jacobs Consultancy using 2007-2025 TAF growth rates.
(d) Commercial operations include operations by passenger airlines and all-cargo airlines.
(e) Total operations include commercial operations plus operations by air taxi, general aviation and military aircraft.

Sources: Terminal Area Forecast, FAA, December 2007.
Memphis Master Plan Update forecast, Jacobs Consultancy, July 2008.

Table 38

FORECAST SUMMARY
Master Plan Update
Memphis International Airport

The forecasts presented in this table were prepared using the information and assumptions described in the accompanying text. Inevitably, some of the assumptions used to develop the forecasts will not be realized and unanticipated events and circumstances may occur. Therefore, there are likely to be differences between the forecast and actual results, and those differences may be material.

	Historical		Estimated *(a)*	Forecast: Baseline			Average annual increase (decrease)	Forecast: Low-growth			Average annual increase (decrease)	Forecast: High-growth			Average annual increase (decrease)
	2006	2007 *(b)*	2008	2012	2017	2027	2007 - 2027	2012	2017	2027	2007 - 2027	2012	2017	2027	2007 - 2027
Enplaned passengers *(c)*															
Domestic															
Mainline	2,825	2,874	2,910	3,060	2,933	3,265	0.6%	2,618	2,503	2,863	0.0%	3,531	3,417	3,741	1.3%
Regional	2,326	2,302	2,330	2,580	3,096	3,675	2.4%	2,183	2,678	3,211	1.7%	2,735	3,233	3,778	2.5%
Subtotal	5,151	5,176	5,240	5,640	6,029	6,940	1.5%	4,801	5,181	6,074	0.8%	6,266	6,650	7,519	1.9%
International	169	181	202	310	416	676	6.8%	264	357	592	6.1%	344	459	732	7.2%
Total	**5,320**	**5,357**	**5,442**	**5,950**	**6,445**	**7,616**	**1.8%**	**5,065**	**5,538**	**6,666**	**1.1%**	**6,610**	**7,109**	**8,251**	**2.2%**
Originating	2,267	2,362	2,405	2,691	3,044	3,876	2.5%	2,291	2,616	3,393	1.8%	2,989	3,358	4,199	2.9%
Connecting	3,053	2,995	3,037	3,259	3,401	3,740	1.1%	2,774	2,922	3,273	0.4%	3,621	3,751	4,052	1.5%
Percent connecting	57%	56%	56%	55%	53%	49%		55%	53%	49%		55%	53%	49%	
Aircraft operations															
Passenger aircraft															
Mainline	69,308	70,342	73,400	66,600	59,400	66,200	(0.3%)	56,600	50,900	58,000	(1.0%)	78,100	70,200	77,700	0.5%
Regional/commuter	131,862	127,406	131,000	144,300	155,800	176,900	1.7%	117,100	133,200	151,100	0.9%	147,200	157,200	175,500	1.6%
Subtotal	201,170	197,748	204,000	210,900	215,200	243,100	1.0%	173,700	184,100	209,100	0.3%	225,300	227,400	253,200	1.2%
Air cargo aircraft															
Air carrier	127,888	127,668	128,400	131,500	134,400	151,800	0.9%	124,300	122,700	131,000	0.1%	136,000	144,400	175,100	1.6%
Feeder	7,612	5,912	5,900	5,900	5,800	6,000	0.1%	5,600	5,400	5,600	(0.3%)	6,000	5,900	6,100	0.2%
Subtotal	135,500	133,580	134,300	137,400	140,200	157,800	0.8%	129,900	128,100	136,600	0.1%	142,000	150,300	181,200	1.5%
General aviation aircraft	46,566	42,128	41,500	39,000	43,000	51,000	1.0%	38,000	35,000	29,000	(1.8%)	46,000	49,000	59,000	1.7%
Military aircraft	1,587	1,533	1,500	1,700	1,700	1,700	0.5%	1,700	1,700	1,700	0.5%	1,700	1,700	1,700	0.5%
Total aircraft operations	**384,823**	**374,989**	**381,700**	**389,000**	**400,100**	**453,600**	**1.0%**	**343,300**	**348,900**	**376,400**	**0.0%**	**415,000**	**428,400**	**495,100**	**1.4%**

Note: Numbers may not add due to rounding.

(a) Estimated based on four months of activity (January through April 2008).
(b) Base year for forecast is 2007.
(c) Enplaned passengers shown in thousands.

Sources:Historical – Memphis-Shelby County Airport Authority records, June 2008.
Estimated and forecast – Jacobs Consultancy, July 2008.

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FACILITY REQUIREMENTS
MASTER PLAN UPDATE
Memphis International Airport

Prepared for

Memphis-Shelby County Airport Authority
Memphis, Tennessee

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Technical Memorandum–A

INTRODUCTION

This Working Paper summarizes facilities, land areas, and policies required to accommodate aviation demand throughout the 20-year forecast period. Facility requirements were developed for the airfield, passenger terminal complex, ground access, air cargo, general aviation, and airline and airport support facilities based on assessments of existing capacity and future demand for major aviation-related facilities. This Working Paper is a compilation of six Technical Memoranda, as follows:

A – Introduction
B – Airfield
C – Passenger Terminal
D – Ground Transportation
E – Air Cargo, General Aviation, and Military
F – Aviation Support

PLANNING ACTIVITY LEVELS

Recognizing uncertainties associated with long-range aviation demand forecasting, three planning activity levels (PALs) were identified to represent future levels of activity at which key airside and landside improvements would be necessary. Because activity levels could deviate from the forecasts for any number of reasons, the use of PAL "triggers" allows for facilities planning that is realistically tied to future activity levels as they occur, rather than arbitrary milestone years.

For this Master Plan Update, PALs were chosen to coincide with the *Baseline* growth forecast to ensure facilities are available just prior to when they would be needed. PAL 1, PAL 2, and PAL 3 correspond to baseline aviation activity for 2012, 2017, and 2027, respectively. Aviation activity associated with each PAL is summarized in Table A-1.

FUTURE FLIGHT SCHEDULES

Detailed aircraft flight schedules provide a planning-level synopsis of aviation activity (peak periods, time-of-day, departures and arrivals, fleet mix, etc.) that is used to support analytical and simulation modeling efforts. Flight schedules were developed for this Master Plan Update in order to generate a number of the facility requirements contained in this Working Paper. A detailed flight schedule representing Airport activity in the base year (2007) was developed using existing patterns of aviation activity and operational assumptions developed for the Master Plan Update. Future flight schedules for each PAL were developed from the base year flight schedule by applying growth rate factors based on forecast assumptions.

Table A-1

SUMMARY OF FORECAST AVIATION DEMAND
Master Plan Update
Memphis International Airport

	Historical		Baseline forecast		
	2006	2007	PAL 1 (2012)	PAL 2 (2017)	PAL 3 (2027)
Enplaned passengers					
Local	2,267,000	2,362,000	2,691,000	3,044,000	3,876,000
Connecting	3,053,000	2,995,000	3,259,000	3,401,000	3,740,000
Total	5,320,000	5,357,000	5,950,000	6,445,000	7,616,000
Cargo tonnage					
FedEx	3,614,641	3,779,469	4,316,000	4,837,000	5,721,000
Other	80,697	69,875	97,000	119,000	172,000
Total	3,695,338	3,849,344	4,413,000	4,956,000	5,893,000
Aircraft operations					
Passenger	201,170	197,748	210,900	215,200	243,100
Air cargo	135,500	133,580	137,400	140,200	157,800
General aviation	46,566	42,128	39,000	43,000	51,000
Military	1,587	1,533	1,700	1,700	1,700
Total	384,823	374,989	389,000	400,100	453,600

Sources: Historical – Memphis-Shelby County Airport Authority records.
Forecast – Jacobs Consultancy, July 2008.

Passenger airline activity included in the flight schedules was developed based on projected average day peak month (ADPM) passenger activity, which has historically occurred during the month of May. Air cargo activity was developed for the ADPM for cargo activity, which has historically occurred during the month of December. Future flight schedules also include average annual day general aviation and military activity. Simulation modeling used to develop airfield requirements used the overall "design day" flight schedule, which includes ADPM activity for both passenger airline and air cargo market segments. Modeling for the passenger terminal used only the passenger airline portions of the "design day" schedules. Table A-2 summarizes "design day" activity for the baseline, PAL 2, and PAL 3 activity levels.

Table A-2

SUMMARY OF DESIGN DAY AIRCRAFT OPERATIONS
Master Plan Update
Memphis International Airport

Operator type	Arrivals Baseline (2007)	Arrivals PAL 2 (2017)	Arrivals PAL 3 (2027)	Departures Baseline (2007)	Departures PAL 2 (2017)	Departures PAL 3 (2027)
Daytime						
Passenger	268	285	319	284	302	336
Air cargo	106	121	132	112	133	146
General aviation	51	51	62	49	49	61
Military	3	3	3	3	3	3
Total	428	460	516	448	487	546
Nighttime						
Passenger	15	16	20	0	0	4
Air cargo	153	174	181	148	164	168
General aviation	5	5	6	7	7	7
Military	--	--	--	--	--	--
Total	173	195	207	155	171	179
Total (day and night)						
Passenger	283	301	339	283	301	339
Air cargo	259	295	313	259	295	313
General aviation	56	56	68	56	56	68
Military	3	3	3	3	3	3
Grand total	601	655	723	601	655	723

Notes: Design day schedules were not developed for PAL 1.
Columns may not add due to rounding.

Source: Jacobs Consultancy, based on Computer Airport Simulation Technology (CAST) modeling, analytical methods, and professional judgment, July 2008.

At PAL 3, it is projected that there will be 723 arrivals and departures per design day, totaling 1,446 operations. Of those, 678 will be passenger airline and 626 air cargo related operations. General aviation and military operations are expected to account for the remaining 142 daily operations.

SUMMARY OF REQUIREMENTS

A summary of Airport facility requirements for baseline (2007) and future PALs 1, 2, and 3 organized according to functional areas are provided in Table A-3. As shown, many Airport facilities provide sufficient capacity to accommodate demand forecast throughout the planning period. However, a number of facilities will need to be

Table A-3

SUMMARY OF FACILITY REQUIREMENTS
Master Plan Update
Memphis International Airport

	Existing	Estimated requirement Baseline (2007)	PAL 1 (2012)	PAL 2 (2017)	PAL 3 (2027)
Airfield					
Average annual delay (min/op)					
Overall	2.4	6	6	6	6
Instrument meteorological conditions	5.5	10	10	10	10
Design aircraft					
Wingspan	B-747-400	B-747-400	B-747-400	B-747-400	B-747-400
Length	B-747-400	B-747-400	B-747-400	B-747-400	B-747-400
Wheelbase	B-747-400	B-747-400	B-777-F	B-777-F	B-777-F
Gross weight	B-747-400	B-747-400	B-747-400	B-747-400	B-747-400
Runway length (feet)					
Primary departure runway	11,100	11,100	11,100	11,100	11,100
Other runways	9,320 *(b)*	9,000	9,000	9,000	9,000
Instrument approach capability					
Calm wind runways (Rwy 18s)	CAT IIIc	CAT IIIc	CAT IIIc	CAT IIIc	CAT IIIc
Other runways	CAT I	CAT I	CAT I	CAT I	CAT I
Passenger Terminal					
Gates/aircraft parking					
Preferential use scenario	86	86	87	92	103
Common use scenario	86	81	81	87	94
Passenger holdrooms (sq ft)					
Preferential use scenario	131,270	130,400	130,850	138,200	153,000
Common use scenario	131,270	130,400	130,850	128,600	141,500
Ticketing and check-in					
Curbside (positions)	15	15	15	15	15
Agent counters (positions)	29	26	27	29	33
Self service kiosks (units)	62	26	28	33	34
Queuing area (sq ft)	6,690	3,800	4,400	5,100	6,000
Passenger security screening					
Checkpoints (lanes)	10	8	8	9	11
Queuing area (sq ft)	3,600	3,300	3,400	3,750	4,100
Baggage handling					
Baggage security screening (units) *(b)*	6	4	4	4	4
Outbound baggage make-up *(c)*	168	115	115	122	136
Inbound baggage feeds (ln ft)	595	180	200	210	245
Baggage claim device frontage (ln ft)	990	540	580	615	740
Baggage claim area (sq ft)	13,420	8,500	9,100	9,500	11,500
FIS / International arrivals facility					
Gates/aircraft parking	3	3	3	3	4
Processing booths (positions)	5	4	4	4	5
Queuing area (sq ft)	2,900	2,300	2,300	2,300	2,900
Baggage claim frontage (ln ft)	190	200	200	200	300

Table A-3 (page 2 of 2)
SUMMARY OF FACILITY REQUIREMENTS
Master Plan Update
Memphis International Airport

		Estimated requirement			
	Existing	Baseline (2007)	PAL 1 (2012)	PAL 2 (2017)	PAL 3 (2027)
Ground Transportation					
Parking *(c)*					
Short-term (stalls)	870	900	1,000	1,100	1,450
Long-term (stalls)	6,880	3,200	4,000	4,800	6,700
Employee (stalls)	2,650	1,700	1,850	1,950	2,250
Upper (departures) curbside *(d)*					
Curbside frontage (ln ft)	825	375	425	475	575
Number of lanes	3	3	3	4	4
Ground (arrival) curbside					
Private vehicle—frontage (ln ft)	810	400	450	475	600
Private vehicle—number of lanes	3	3	3	4	4
Commercial vehicle—frontage (ln ft)	1,695	1,190	1,300	1,430	1,580
Commercial vehicle—number of lanes *(e)*	4	4	4	4	4
Rental car ready/return (stalls)	--	1,000	1,200	1,400	1,700
Rental car land area (acres)	25	37	40	46	57
Air Cargo *(f)*					
Processing/warehouse space (sq ft)	336,000	336,000	570,000	600,000	815,000
Aircraft parking apron (sq ft)	1,050,000	1,050,000	1,050,000	1,150,000	1,250,000
General Aviation					
Apron area (sq ft)	1,170,000	1,170,000	1,182,000	1,520,000	1,931,000
Hangar space (sq ft)	200,000	226,000	228,000	294,000	373,000
Total site (acres)	30	30	30	30	30
Airline and Airport Support					
Aircraft rescue and fire fighting (index)	D	D	D	D	D
Airport traffic control tower (level)	ATC12	ATC12	ATC12	ATC12	ATC12
Airport administration offices (sq ft)	128,000	128,000	128,000	128,000	128,000
Airport/airfield maintenance (sq ft)	80,000	80,000	80,000	80,000	80,000
Glycol storage (gal)	40,000	40,000	40,000	40,000	40,000
Fuel storage *(g)*					
5-day supply gross storage (gal)	--	1,415,000	1,507,000	1,545,000	1,750,000
Land area (acres)	--	1.4	1.5	1.5	1.7
Disaster staging center	--	--	20-30	20-30	20-30

(a) Assumes special provisions are in place for handling ARC D-VI aircraft.
(b) Assumes planned in-line EDS in place.
(c) Does not include demand currently accommodated in off-Airport facilities.
(d) Includes demand for inner and outer curbsides.
(e) Assumes two roadways with two lanes on each.
(f) Exclusive of FedEx and USPS facilities.
(g) Exclusive of general aviation storage; passenger terminal requirements only.

Source: Jacobs Consultancy, September 2008.

modified or expanded to accommodate future activity; improve Airport operational capabilities or levels of service; and/or satisfy evolving airfield and building design standards.

Notable requirements over the course of the forecast period include:

- **Airfield** – The existing airfield layout will provide sufficient capacity to accommodate baseline forecast aviation activity through 2027. As activity levels grow, aircraft delays will increase slightly in visual meteorological conditions (VMC) and moderately in instrument meteorological conditions (IMC). These delays, however, do not increase to levels that justify construction of new runways or relocation of runways, until very late in the planning period, if at all. Observation of airfield simulation models indicates that targeted taxiway improvements including new angled exit taxiways to serve Runway 36L, a southside crossfield taxiway, and additional or expanded runway-end holding pads have the potential to improve both operational efficiency and air traffic controllers' ability to dynamically manage departure queues.

  Existing air traffic control facilities*, navigational aids, and visual aids at the Airport are sufficient to effectively support airfield and airspace operations at the Airport through the end of the planning period. However, it would be prudent to identify sites and potential implementation phasing for selected new generation navaids and visual aids. Analyses of wind and weather data for the Airport do not indicate a need to upgrade the Category I instrument landing systems (ILSs) that serve Runways 9, 27, 18L, 18C, and 18R to Category II or higher.

- **Airspace** – The Airport is currently well served by its existing airspace, which is not significantly impacted by the presence of other major airports in the region. Air traffic controllers in the Memphis TRACON have significant flexibility in their use of this airspace, and current air traffic control procedures do not causing significant delays to arrival or departure operations.

- **Passenger Terminal** – The existing passenger terminal footprint is adequate to serve the projected needs of the Airport throughout the planning period. Future requirements are focused on targeted improvements to specific functional elements that are likely to experience congestion, including: expanding aircraft gates and passenger holdrooms; improving passenger and checked-baggage security screening facilities; and enlarging the FIS to better meet existing and future peak-period passenger demands. Future

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*These existing facilities include the new Airport Traffic Control Tower and associated installation of an Aircraft Surface Detection Equipment (ASDE-X) system, which will be commissioned in 2011.

terminal projects should also consider improving pedestrian circulation in congested areas, in particular within the Terminal B ticketing lobby and concourse. Additionally, it is anticipated that multiple projects to rehabilitate, expand, and upgrade the terminal buildings mechanical, electrical, and plumbing infrastructure will be required throughout the planning period.

- **Ground Transportation** – In addition to the planned near-term improvements to ground transportation facilities, the Airport will require additional public parking capacity to meet projected PAL 3 demands. Additional lanes will be required on the upper (departures) level and ground (arrivals) level curbsides to increase capacity for private vehicles. The Airport should also pursue development of a consolidated rental car facility to both expand/replace existing facilities and improve customer level of service. The Airport should continue to advocate for implementation of regional transportation projects that will improve access to on-Airport facilities, including: upgrades to the Plough Boulevard/ Interstate 240 interchange, capacity expansion along Democrat and Tchulahoma Roads, and intersection improvements at Winchester Road/Airways Boulevard.

- **Air Cargo** – Additional processing/warehouse space and aircraft parking apron will be required during the planning period. In addition, modification to facilities or access roadways may be identified during the alternatives analyses phase of the Master Plan.

- **General Aviation** – Forecast general aviation demand will not necessitate an increase in total land area reserved for general aviation, although additional apron areas and hangar capacity are needed to accommodate projected increases in high-end general aviation aircraft.

- **Aviation Support** – Existing aviation support facilities is sufficient to accommodate forecast demand throughout the planning period. However, incremental increases in fuel storage facilities are necessitated by PAL 2.

Additional facility requirements and more robust discussions of assumptions and findings are provided in each of the ensuing technical memoranda.

Technical Memorandum–B

AIRFIELD AND AIRSPACE

The assessment of airfield and airspace facility requirements consisted of the following five tasks:

- Fast-time simulation of the existing airspace and airfield system that serves the Airport to determine if aviation activity levels forecast for the Master Plan Update planning horizon (i.e., through 2027) would exceed the capacity of this system.

- Assessment of the need for new or modified airfield facilities to meet airport design standards or eliminate existing modifications to design standards (MOSs).

- Evaluation of the potential impacts of technology, airline fleet mix changes (e.g., the expanding use of regional jet aircraft and low-fare carriers) and other industry trends on the need for new or modified airfield facilities.

- Evaluation of Terminal Instrument Procedures (TERPS) and Federal Aviation Regulations (FAR) Part 77 obstacle clearance surfaces and identification of existing objects that penetrate these surfaces.

- Evaluation of the need and timing for additional or enhanced navigational aids, marking, and lighting.

The first of these five subtasks was the primary focus of the work effort. In this subtask, the Total Airspace and Airport Modeller (TAAM)—a fast-time airfield and airspace simulation model—was used to assess the performance of the existing airfield and airspace system at the Airport at the 2007, 2017 (PAL 2), and 2027 (PAL 3) forecast activity levels. The results of the simulation analyses, coupled with expert judgment and prior operational analyses conducted by the FAA and FedEx, were used to establish the activity levels at which the existing airfield and airspace systems would be expected to reach capacity. This simulation modeling effort was undertaken in coordination with the Authority, the FAA Air Traffic Organization (i.e., Memphis Tower and TRACON), and FedEx.

AIRFIELD/AIRSPACE SIMULATION ANALYSIS

TAAM was used to evaluate whether existing airfield and airspace facilities and air traffic procedures would provide sufficient capacity to accommodate forecast aviation activity levels through 2027, the Master Plan Update planning horizon. In this subtask, TAAM simulation "experiments" were developed for both visual meteorological conditions (VMC) and instrument meteorological conditions (IMC) at 2007, PAL 2, and PAL 3 aviation activity levels. Separate sets of experiments were prepared to reflect north flow and south flow operating configurations during daytime hours (i.e., 5:00 a.m. to 10:00 p.m.). Additional sets of experiments were developed to reflect FedEx's nighttime operations, in which arrivals land to the north and departures depart to the south.

The simulation experiments developed for the Master Plan Update were focused primarily on the runway, taxiway, and aircraft parking aprons at the Airport and the airspace controlled by the Memphis Terminal Radar Approach Control Facility (TRACON). Aircraft parking positions were simulated in detail, particularly those surrounding the Airport's passenger terminal complex. With the concurrence of the Authority and FedEx, FedEx's cargo complex north of Runway 9-27 was not simulated in detail. Although individual aircraft parking positions were simulated within this area, active management of aircraft pushbacks, parking position assignments and taxilane routes was not modeled.

These simulation experiments provided operational data regarding aircraft delays on the ground and in the air as well as data regarding unimpeded aircraft taxiing times between the Airport's four runways and aircraft parking aprons. The TAAM results also facilitated estimation of the number of FedEx arrivals that were unable to park in time to "make" FedEx's evening and afternoon sorts.

TAAM Description

TAAM is a fast-time airfield and airspace simulation model produced by Jeppesen Optimization Solutions. TAAM models the movement of individual aircraft operations through the airspace and on the ground in accordance with user-specified air traffic control and ground control rules and aircraft manufacturer-specified aircraft performance characteristics.

TAAM was selected for use in the Master Plan Update for the following reasons:

1. TAAM provides a superior visual modeling environment that is easily understood by key stakeholders. The model enables the user to program in flexible taxiway, runway, and gate usage rules, which permit realistic modeling of aircraft ground movements.

2. TAAM has already been used extensively by key Airport tenant, FedEx, which provided a set of initial TAAM input files that were adapted for use in the Master Plan Update airfield modeling effort.

3. TAAM produces performance metrics that are well suited to the assessment of airfield facility requirements, including the following: (1) Taxiing delays, which would include any delays incurred while taxiing and in the lineup queue; (2) overall delays, which would represent excess travel times associated with the presence of other aircraft in the simulations; (3) unimpeded aircraft taxiing times, measured as unimpeded OUT to OFF times for departures and unimpeded ON to IN times for arrivals; and (4) the number

of FedEx arrivals that arrive too late to be included in FedEx's night and afternoon sorts.

TAAM Version 2.6.1, Release 8, was used in this analysis.

Runway Use Configurations

As described in "Technical Memorandum B, Airfield and Airspace" in the *Inventory Working Paper, Master Plan Update, Memphis International Airport* (the Inventory Working Paper), published by Jacobs Consultancy in November 2009, there are two principal runway use configurations that are used during daytime hours—north flow and south flow. North flow runway use involves use of Runways 36L, 36C, 36R, and 27 (crosswind permitting).* South flow runway use involves use of Runways 18R, 18C, 18L, and 27 (crosswind permitting). In accordance with current operating procedures, north flow was assumed to be the preferred runway use configuration during daytime hours, meaning that it is used when winds are calm (e.g., less than 5 knots).

During most of the day, arrivals use the "outboard" runways—Runways 36L and 36R in north flow and Runways 18R and 18L in south flow while departures use the center and west side runways—Runways 36C and 36L in north flow and Runways 18C and 18R in south flow. Runway 27 is used by arrivals during periods of peak arrival flow to enhance airport arrival runway capacity. During the afternoon FedEx departure "launch", which occurs between 2:00 p.m. and 5:00 p.m., these runway use patterns are modified, with departures using the outboard runways and arrivals using the center runway. This modification provides more straightforward taxiing routes and enhanced departure sequencing capabilities for FedEx departures.

During nighttime hours—when FedEx is the predominant aircraft operator—the Airport typically operates in north flow during the "recovery" of FedEx arrivals, which takes place between 10:30 p.m. and 12:30 a.m., and then is switched to south flow during the "launch" of FedEx departures, which takes place between 2:00 a.m. and 5:30 a.m. During the recovery, Runways 36L, 36R, and 27 (crosswind permitting) are used by arrivals, whereas Runway 36C is used by departures. During the launch, Runways 18L, 18R, and 27 (crosswind permitting) are used by departures, whereas Runway 18C is used by arrivals.

Diagrams of these runway use configurations were shown on Figures B-2 and B-3 of the *Airport Inventory*.

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*Wind permitting, Runway 9 can also be used in north and south flow conditions to reduce aircraft airborne travel time for arrivals from the west. Use of Runway 9 was not modeled using TAAM and is not considered herein.

Weather and Wind Analysis

An analysis of Airways Hourly Surface Observations (TD-3280) data from the National Climatic Data Center (NCDC) was conducted to assess the annual percent occurrence of weather conditions and runway use configurations. The results of this analysis were used to (1) determine the final TAAM experimental design and (2) develop occurrence data for use in annualization of simulation results.

Weather conditions—namely cloud ceiling and visibility—determine the ATC procedures that can be used at an airport, which in turn affect runway capacity and aircraft delay. Cloud ceiling and visibility levels that govern changes in ATC procedures at the Airport were identified during conversations with representatives from the Authority, the FAA Memphis Airport Traffic Control Tower/Terminal Approach Control Facility (MEM Tower/TRACON) and FedEx.

Based on these discussions, two weather conditions were modeled:

- VMC, which was defined to occur when the cloud ceiling at the Airport is at least 1,000 feet *and* the visibility at the Airport is at least 3 miles.

- IMC, which was defined to occur when the cloud ceiling at the Airport is less than 1,000 feet *or* the visibility at the Airport is less than 3 miles.

The percentage occurrence of these two weather conditions was estimated using airways surface observation data (TD-3280) obtained from the National Climatic Data Center (NCDC) for a ten-year period beginning on January 1, 1998, and ending on December 31, 2007. These data indicated that VMC occurs approximately 94% of the time, whereas IMC occurs approximately 6% of the time.

The same weather data from the NCDC were used to estimate the percent occurrence of north flow and south flow operating configurations. Table B-1 shows the results of this analysis for VMC, IMC, and overall.*

TAAM Experimental Design

The results of the aforementioned wind and weather analysis were used to develop an experimental design for the simulation effort. This experimental design specified the characteristics of the individual TAAM simulation runs—or "experiments"—that were conducted in the analysis. Table B-2 outlines the characteristics of the eighteen simulation experiments that were performed for this analysis.

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*This analysis excludes wind conditions in which only Runways 9 or 27 can be used, which occur less than 0.5% of the time.

Table B-1

RUNWAY USE CONFIGURATION PERCENT OCCURRENCE
Master Plan Update
Memphis International Airport

Runway use configuration	VMC (94% occurrence)	IMC (6% occurrence)	Overall
North flow *(c)*	81.5%	83.0%	81.6%
South flow	18.5	17.0	18.4

(a) VMC (Visual Meteorological Conditions) defined as a cloud ceiling of at least 1,000 feet and visibility of at least 3 miles.
(b) IMC (Instrument Meteorological Conditions) defined as a cloud ceiling less than 1,000 feet or visibility less than 3 miles.
(c) Presumes that north flow is the preferred runway use configuration during daytime hours and is used when tailwinds are less than 5 knots.

Source: Jacobs Consultancy, based on Surface Airways Hourly Data (TD-3280), January 1, 1998, through December 31, 2007, from the National Climatic Data Center.

Table B-2

TAAM EXPERIMENTAL DESIGN
Master Plan Update
Memphis International Airport

Experiment	Runway use configuration	Weather	Percent occurrence	Flow (arrivals | departures)	Activity level
1	South flow, daytime	VMC *(a)*	17.4%	Arrival priority: 18L, 18R, 27 | 18C, 18R Departure priority: 18C | 18L, 18R, 27	2007
2					2017
3					2027
4		IMC *(b)*	1.1%	Arrival priority: 18L, 18R | 18C, 18R Departure priority: 18C | 18L, 18R	2007
5					2017
6					2027
7	North flow, daytime	VMC *(a)*	76.4%	Arrival priority: 36L, 36R, 27 | 36C, 36L Departure priority: 36C | 36L, 36R	2007
8					2017
9					2027
10		IMC *(b)*	5.1%	Arrival priority: 36L, 36R | 36C, 36L Departure priority: 36C | 36L, 36R, 27	2007
11					2017
12					2027
13	Nighttime	VMC *(a)*	93.8%	Arrival priority: 36L, 36R, 27 | 36C, 36L Departure priority: 18C | 18L, 18R, 27	2007
14					2017
15					2027
16		IMC *(b)*	6.2%	Arrival priority: 36L, 36R | 36C, 36R Departure priority: 18C | 18L, 18R, 27	2007
17					2017
18					2027

(a) VMC (Visual Meteorological Conditions) defined as a cloud ceiling of at least 1,000 feet and visibility of at least 3 miles.
(b) IMC (Instrument Meteorological Conditions) defined as a cloud ceiling less than 1,000 feet or visibility less than 3 miles.

Source: Jacobs Consultancy, September 2008.

Flight Schedule Development

Aircraft flight schedules for the 2007, 2017 (PAL 2), and 2027 (PAL 3) were developed using the annual activity forecasts developed for the Master Plan Update. The flight schedules used in the simulation effort represent a hypothetical "design day" in which passenger and cargo flight schedules were selected to represent average day, peak month conditions for each of these two types of activity.

General aviation and military flight schedules were developed using monthly activity statistics from the FAA's Air Traffic Activity Data System (ATADS) for May 2007, coupled with temporal and fleet mix data extracted from flight progress strips from February 2008, which were obtained from the Memphis Tower. General aviation and military flight schedules for 2017 and 2027 were developed via a process known as "cloning" in which individual flight records from the 2007 schedule were replicated as needed to reach desired activity levels. Table A-2 summarizes the design day demand levels that were simulated.

Commercial passenger and cargo arrivals in the flight schedules were "linked" to subsequent departing flights to facilitate modeling of terminal gate occupancy and pushback operations. The linked schedules also ensured that departure operations would not be able to take place until the "linked" arrival had landed at the Airport and unloaded, resulting in more realistic evaluation of aircraft delays.

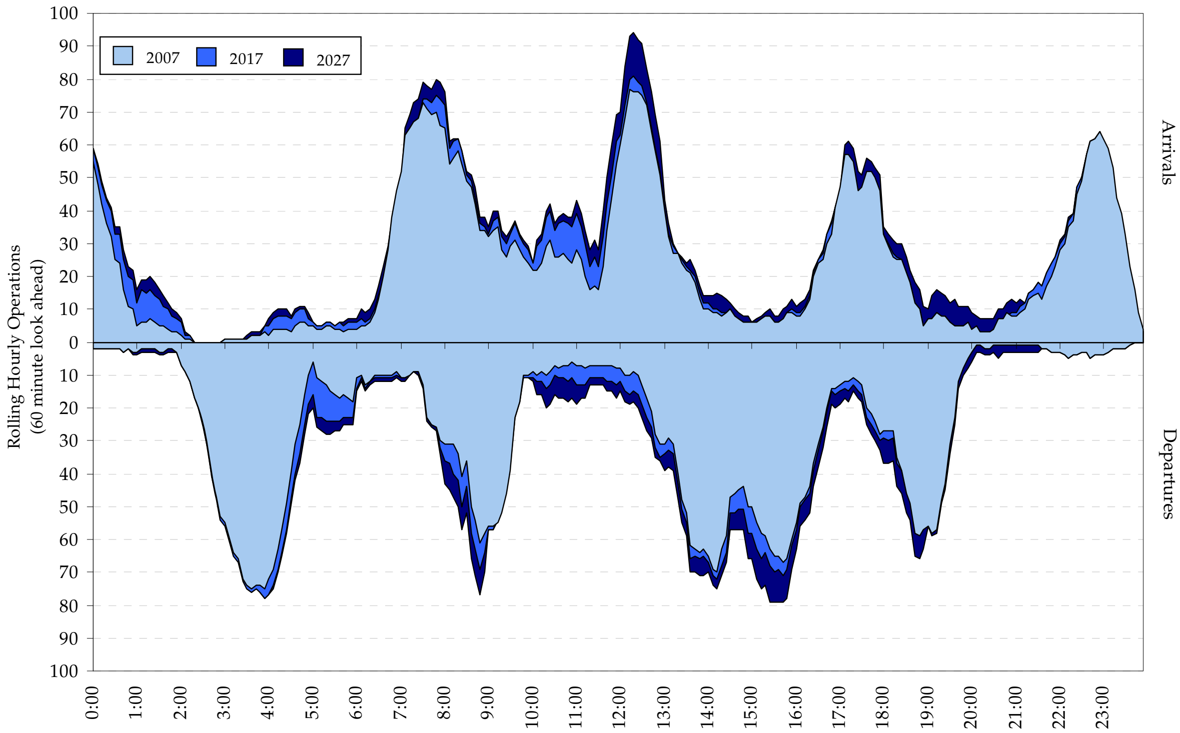
Figure B-1 shows the temporal distribution of the 2007, 2017, and 2027 flight schedules. This figure shows the number of operations scheduled in the next 60 minutes, sampled every 6 minutes. Arrivals are shown on the positive x-axis and departures are shown on the negative x-axis. The figure clearly shows the three commercial passenger arrival and departure banks, which occur in the morning between 7:00 a.m. and 9:30 a.m., midday between 12:00 p.m. and 2:30 p.m., and in the evening between 5:00 p.m. and 7:30 p.m. The figure also shows FedEx's daytime and nighttime recoveries and launches, although the daytime recovery—which occurs between 8:00 a.m. and 12:00 p.m.—overlaps somewhat with the morning passenger bank.

The aircraft fleet mixes in the 2017 and 2027 flight schedules were modified to reflect forecast aircraft retirements, purchases, and acquisitions. Most notable among these is FedEx's planned retirement its B-727-200F aircraft and concurrent purchase of B-757-200F aircraft between 2007 and 2017. Other key fleet mix changes include FedEx's acquisition of B-777-F aircraft and Northwest Airlines regional affiliates' upgauging of 50-seat regional jets (e.g., CRJ-200, EMB-140) to larger 70- to 90-seat models (e.g., CRJ-900, EMB-175).

Table B-3 shows how these changes affected the aircraft fleet mixes in the simulated flight schedules. The fleet mix categories shown in the table reflect categories used by air traffic control when determining the required in-trail separations between aircraft in the airspace. Definitions of these categories are provided in the table.

Figure B-1

DESIGN DAY ACTIVITY – TAAM SIMULATION ANALYSIS
Master Plan Update
Memphis International Airport



Source: Jacobs Consultancy, September 2008.

Table B-3

AIRCRAFT FLEET MIX ASSUMPTIONS
Master Plan Update
Memphis International Airport

Aircraft class *(a)*	Baseline (2007)	PAL 2 (2017)	PAL 3 (2027)
Small	9%	8%	8%
Large	59	47	49
B757	1	11	10
Heavy	31	34	32

(a) Aircraft classes are defined as follows:
Small: Aircraft weighing 41,000 pounds or less, except for the Saab 340.
Large: Aircraft weighing more than 41,000 pounds, but no more than 255,000 pounds, and the Saab 340.
B757: Boeing 757 aircraft.
Heavy: Heavy jet aircraft weighing more than 255,000 pounds.

Source: Jacobs Consultancy, September 2008.

Airfield Layout

For the 2007 simulation experiments, the Airport's existing airfield layout was assumed. As shown, this layout consists of four runways—parallel Runways 18L-36R, 18C-36C, and 18R-36L and crosswind Runway 9-27, together with supporting exit, parallel, and crossfield taxiways. The *Airport Inventory* describes the physical characteristics of these runways and taxiways in greater detail.

The simulated airfield layouts included aircraft parking aprons for the passenger terminal complex, FedEx, UPS, other cargo operators, fixed base operators, and the Tennessee Air National Guard (TnANG). In all simulation experiments, cargo operators other than FedEx and UPS were assumed to park at the newly-constructed Cargo Central apron on the east side of the Airport. Similarly, in all simulation experiments, TnANG operations were assumed to use the newly constructed TnANG facility at the southeast corner of Airport.

For the 2017 and 2027 simulation experiments, the Airport's airfield layout was modified slightly from what is currently in place. First, aircraft parking positions at the north and south ends of Concourse A were realigned to accommodate increasing numbers of larger regional jet aircraft. Second, a series of changes to the Airport's taxiway system that will be made during the reconstruction of Runway 9-27 (currently scheduled to occur in 2009) were implemented. These changes include (1) the relocation/realignment of Taxiway B at a right angle to Runway 9-27 approximately 500 feet west of its current location and (2) demolition of Taxiway V3.

Airspace Structure and Flight Procedures

The airspace structure and flight procedures assumed in TAAM were developed from currently published Standard Instrument Arrival Routes (STARs) and Standard Instrument Departure Procedures (SIDs) and information contained in the MEM Tower Order 7110.65E, *Memphis ATC Tower Air Traffic Control*, dated September 1, 2007.

Airspace Structure. In all experiments, arriving flights were assigned to one of four arrival "corner posts" located to the northwest (Gilmore VOR/DME), northeast (WLDER intersection), southeast (Holly Springs VORTAC), and southwest (Marvell VOR/DME). Arrivals were assigned to these corner posts on the basis of their origin airports. STARS were defined between these corner posts and runway ends at the Airport in accordance with actual air traffic procedures and radar data observed from the MEM TRACON.

Departing flights were assigned to one of ten departure transition areas (DTAs), which are located between arrival corner posts to the north, east, south, and west of the Airport. The MARKS, CUBA, UNION and BRADEN DTAs are located to the north of the Airport, between the Gilmore and WLDER arrival corner posts. The FISHERVILLE and MOSCOW DTAs are located to the east of the Airport, between the WLDER and Holly Springs arrival corner posts. The WYATTE and

COLDWATER DTAs are located to the south of the Airport, between the Holly Springs and Marvell corner posts. Finally, the EARLE and TWIST DTAs are located to the west of the Airport, between the Marvell and Gilmore corner posts. Similar to arrivals, departures were assigned to DTAs on the basis of the locations of their destination cities.

Air Traffic Control Rules. With respect to air traffic control rules, separation requirements specified in FAA Order JO7110.65S, *Air Traffic Control*, were applied, including wake turbulence separation requirements. Minimum separations specified in FAA Order JO7110.65S were "buffered" to account for typical variations in these separations as well as air traffic controllers' need to separate aircraft by distances that are somewhat higher than absolute minimums in order to avoid separation violations. As noted in the following subsection, these buffered separations were validated by comparing runway throughput rates actually achieved during peak operating periods with simulated throughput rates.

Airspeeds restrictions for arriving flights were specified in TAAM to reflect the real restrictions that are utilized by air traffic controllers. In particular, arrivals were limited to airspeeds no greater than 250 knots within MEM TRACON airspace. On final approach, arrival speeds were reduced to 170 knots.

VMC Runway Dependencies. In VMC conditions, operational dependencies among runways were minimal. Arrivals using Runways 18L/18C and 18R and 36R/36C and 36L were considered independent of one another. Likewise, departures using these runways were considered independent, provided their departure courses diverged by at least 15 degrees after takeoff.

Arrivals using Runway 27 and any of the Runway 36s were also considered independent. Arrivals using one of MEM closely-spaced parallel runways (Runway 18L-36R and Runway 18C-36C) were also considered independent.

In south flow, arrivals to Runways 18L/18C were dependent on arrivals to Runway 27, and vice versa. To manage these dependencies, it was assumed that air traffic controllers would continue to use dependent converging approach procedures facilitated by use of the converging runway display aid (CRDA). With these procedures, air traffic controllers from the MEM TRACON "stagger" approaches to Runways 18L/18C with arrivals to Runway 27 at a distance of between 2 and 2.5 nautical miles.

This stagger, which is accomplished with CRDA equipment that "ghosts" a pseudo-image of the converging approach on the other runway's final approach course, enables air traffic controllers to safely sequence arrivals through the virtual intersection between the two runway's approach courses. In TAAM, a stagger distance of 2.5 nautical miles was applied to the dependent converging approach procedure because this separation enabled reliable and repeatable arrivals to the intersecting runways.

IMC Runway Dependencies. In IMC, operations from the closely-spaced parallel runway pair (Runway 18L-36R and Runway 18C-36C) were considered completely dependent upon one another. This meant that arrivals to one of the two closely spaced runways would "capture" the other runway at a distance of 2 nautical miles from the other runway's end, preventing departures from taking off until the arrival had landed. Capture distances for same runway operations were increased to this level as well. Consistent with current procedures, dependencies between missed approach and approach procedures were assumed to preclude use of dependent converging approach procedures in IMC.

Simulation Validation

Simulation validation was accomplished in two ways: (1) comparison of simulated maximum runway throughput rates to actual runway throughput rates and (2) via visual validation with MEM Tower staff.

Validation of runway throughput rates was accomplished by first creating a series of validation flight schedules in which the levels of hourly arrival and departure demand far exceeded the anticipated capacity of the simulated runway system. These validation schedules were then run in TAAM and the resulting runway throughput rates were compared to actual runway throughput rates reported in the FAA's Aviation System Performance Metrics database. These comparisons were performed for each of the runway use configurations and weather conditions that were simulated. Using these comparisons, the in-trail separation buffers were adjusted in tenth of nautical mile increments until reasonable agreement (i.e., ± 3 operations) was found between simulated and actual runway throughputs.

In addition, draft final versions of the TAAM simulation experiments prepared for the Master Plan Update were validated by a designated representative from the MEM Tower/TRACON. Comments received from this representative—which primarily dealt with taxing procedures and restrictions—were incorporated into final versions of the TAAM models.

Simulation Results

For purposes of the estimating airfield facilities requirements, the primary performance metric used was average design day delay. This metric was computed by first multiplying the delay estimates from individual TAAM simulation experiments by the estimated percent occurrence of their runway use configurations and weather conditions. The resulting delay "contributions" from each simulation experiment were then summed and divided by their simulated daily activity level to produce an average design day delay estimate, measured in minutes per aircraft operation.

The thus computed delay estimates reflected the design day activity levels, which as stated previously, represent a combination of average day, peak month passenger activity (i.e., May) and average day, peak month cargo activity (i.e., December, prior to Christmas). As such they are higher than average annual delay estimates, which would reflect average annual day activity, rather than design day activity.

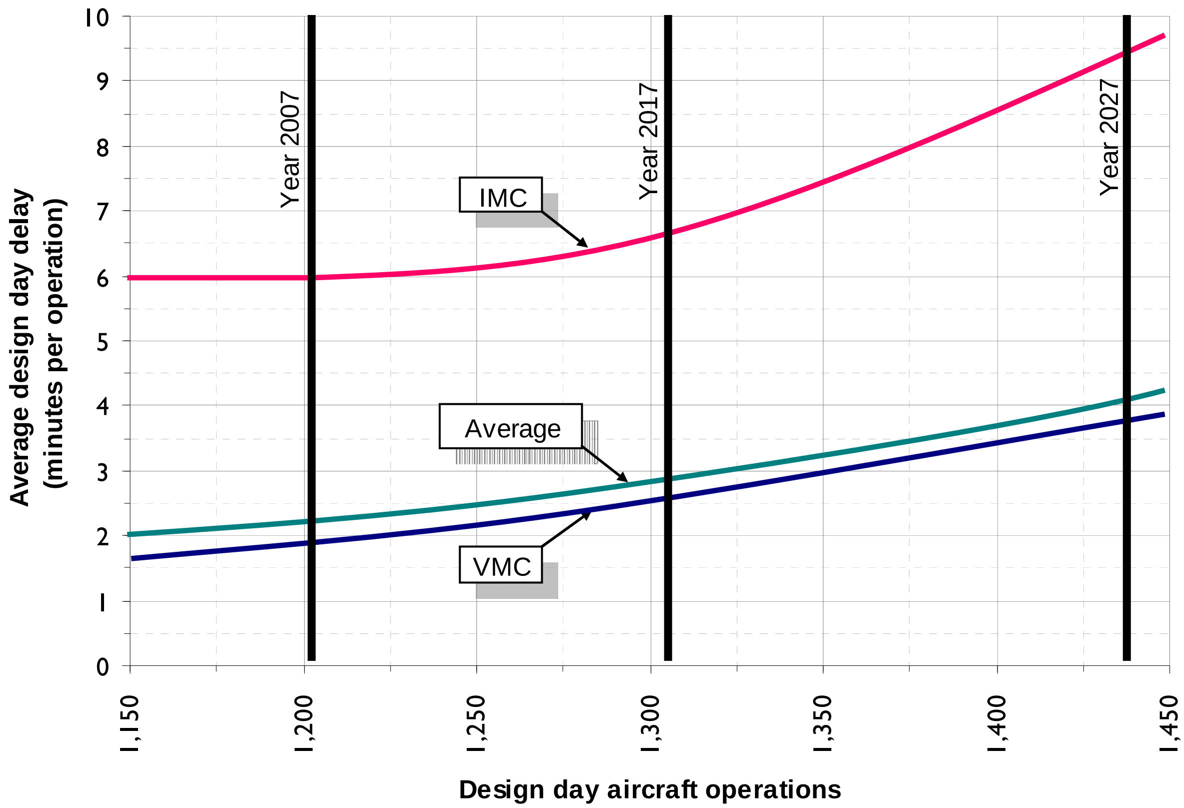
Figure B-2 shows the average design day delay estimates for the three activity levels that were simulated for VMC, IMC, and overall. The experiment-by-experiment results that were used to generate the average design day estimates shown in the figure are presented in Table B-4.

Figure B-2

DESIGN DAY ACTIVITY – TAAM SIMULATION ANALYSIS

Master Plan Update

Memphis International Airport



Source: Jacobs Consultancy, September 2008.

As shown on the figure, the average design day delay is expected to grow, albeit slowly, as activity increases from approximately 1,200 design day operations in 2007 to approximately 1,430 design day operations in 2027 (PAL 3).

Table B-4

TAAM RESULTS SUMMARY
Master Plan Update
Memphis International Airport

Exp.	Runway use configuration	Weather	Percent occr.	Flow (arrivals ǀ departures)	Activity level	Demand (ops)	Delays (minutes/operation) Average	Departure	Arrival
1	South flow, daytime	VMC *(a)*	17.4%	Arrival priority: 18L, 18R, 27 ǀ 18C, 18R Departure priorty: 18C ǀ 18L, 18R, 27	2007	876	3.06	2.73	3.41
2					2017	947	3.06	2.73	3.41
3					2027	1,062	4.16	4.14	4.18
4		IMC *(b)*	1.1%	Arrival priority: 18L, 18R ǀ 18C, 18R Departure priorty: 18C ǀ 18L, 18R	2007	876	6.90	3.26	10.69
5					2017	947	7.08	3.26	10.89
6					2027	1,062	9.37	5.31	13.65
7	North flow, daytime	VMC *(a)*	76.4%	Arrival priority: 36L, 36R, 27 ǀ 36C, 36L Departure priorty: 36C ǀ 36L, 36R	2007	876	1.80	2.09	1.50
8					2017	947	2.17	2.27	2.07
9					2027	1,062	3.89	4.98	2.74
10		IMC *(b)*	5.1%	Arrival priority: 36L, 36R ǀ 36C, 36L Departure priorty: 36C ǀ 36L, 36R, 27	2007	876	6.10	3.06	9.27
11					2017	947	6.18	3.08	9.45
12					2027	1,062	10.04	8.25	11.93
13	Nighttime	VMC *(a)*	93.8%	Arrival priority: 36L, 36R, 27 ǀ 36C, 36L Departure priorty: 18C ǀ 18L, 18R, 27	2007	328	1.79	2.60	1.07
14					2017	366	3.18	4.48	2.04
15					2027	386	3.25	4.82	1.89
16		IMC *(b)*	6.2%	Arrival priority: 36L, 36R ǀ 36C, 36L Departure priorty: 18C ǀ 18L, 18R, 27	2007	328	5.22	2.82	7.35
17					2017	366	7.55	4.10	10.61
18					2027	386	8.10	5.59	10.61

(a) VMC (Visual Meteorological Conditions) defined as a cloud ceiling of at least 1,000 feet and visibility of at least 3 miles.
(b) IMC (Instrument Meteorological Conditions) defined as a cloud ceiling less than 1,000 feet or visibility less than 3 miles.

Source: Jacobs Consultancy, September 2008.

The estimated average design day delays associated with the existing airfield are modest in comparison with current delay levels experienced at other large airports in the United States. Moreover, these delays fall below industry accepted thresholds for major capacity enhancement projects in the United States. The FAA has generally recognized that rapid growth in airport delays caused by airfield capacity constraints occur when average annual airport delays reach between four and six minutes per operation.* As noted above, TAAM simulation results indicate that delays during design days where the activity levels are higher than average would just reach four minutes per operation at the end of the planning period.

Conclusions

The results of the simulation analyses indicate that there will be sufficient airfield capacity to accommodate forecast aviation demand through at least PAL 3/2027. As stated above, design day delays at the Airport will remain very moderate, averaging four minutes per aircraft operation or less, though PAL 3 without additional or relocated runways.

Although the results do not suggest that major airfield enhancements are needed during the planning period, several opportunities for targeted airfield enhancements were observed during the TAAM simulation effort. These targeted enhancements are depicted on Figure B-3 and include the following:

- Additional or relocated angled exit taxiway(s) to serve Runway 18L arrivals. These exits would help reduce excessive arrival runway occupancy times, potentially enhancing the runway's arrival and departure capacities.

- A southside crossfield taxiway system, at or near the southern ends of the Runway 18-36 system. This taxiway system would improve FAA controllers' ability to queue and sequence departures in north flow conditions and could also serve as a secondary deicing facility.

- Installation of land-and-hold short lighting to serve Runway 27 on the runway to the east of Taxiway N. Installation of this lighting, which is currently planned as part of the 2009 reconstruction of Runway 9-27, and adoption of land-and-hold-short procedures for Runway 27 would enable FedEx arrivals from Runway 18L or 36R to taxi north on Taxiway N to their parking positions without stopping for arrivals on Runway 27.

- Extension of Taxiway J to the north across the recently decommissioned air cargo apron to enhance taxiing flexibility and departure queuing and sequencing capability when the Airport is in south flow.

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*p. 17, *National Plan of Integrated Airport Systems* (NPIAS), 2009-2013, FAA, September 30, 2008.

The graphic also shows the planned realignment of Taxiway B and demolition of Taxiway V-3, which have been described previously. It is expected that these enhancements will be evaluated in greater detail in Phase 2 of the Master Plan Update.

It is important to note that all findings presented in this Technical Memorandum presume that existing air traffic control procedures and runway use configurations would be retained (or improved) during the course of the planning period. These procedures include dependent converging approach procedures to Runways 27 and 18L/18C in VMC conditions when the airport is operating in south flow. Changes to these procedures, such as making Runway 27 arrivals dependent on Runway 18R arrivals, could materially change these findings.

POTENTIAL IMPACTS OF TECHNOLOGY AND INDUSTRY TRENDS

Over the 20 year planning period considered in this study, there are a variety of technological advancements and industry changes that could have an impact on airfield facility requirements at the Airport. Key among these are technological improvements to the air traffic control system that are part of FAA's Next Generation Air Transportation System (NextGen) development program.

The FAA's NextGen program has been underway since the late 1990s, although its name has changed several times.* One of the central facets of NextGen is the transformation of the U.S. air traffic control system from ground-based navigation aids to satellite-based navigation aids. This transformation, which is already taking place in the en-route airspace and at select airports, promises to increase the accuracy of aircraft navigation and provide more flexible, robust air traffic procedure design. The transformation to satellite-based navigation will also ultimately reduce or eliminate the need for space-consuming ground based navigational aids such as VOR antennas, glide slope antennas, and localizer antennas.

Another facet of NextGen is to increase the availability and currency of air traffic data to all users of the air transportation system. This includes providing pilots with in-cockpit displays of air traffic information, so pilots can react to such information directly, and providing air traffic controllers with instantaneous aircraft position information obtained via satellite-based navigation systems, rather than via ground-based radar systems. A technology known as "automated dependent surveillance-broadcast" (ADS-B) is central in this effort. ADS-B utilizes radio transponders which broadcast detailed information regarding aircraft position, speed, altitude, type, and other information to ADS-B receivers. Such receivers can be located

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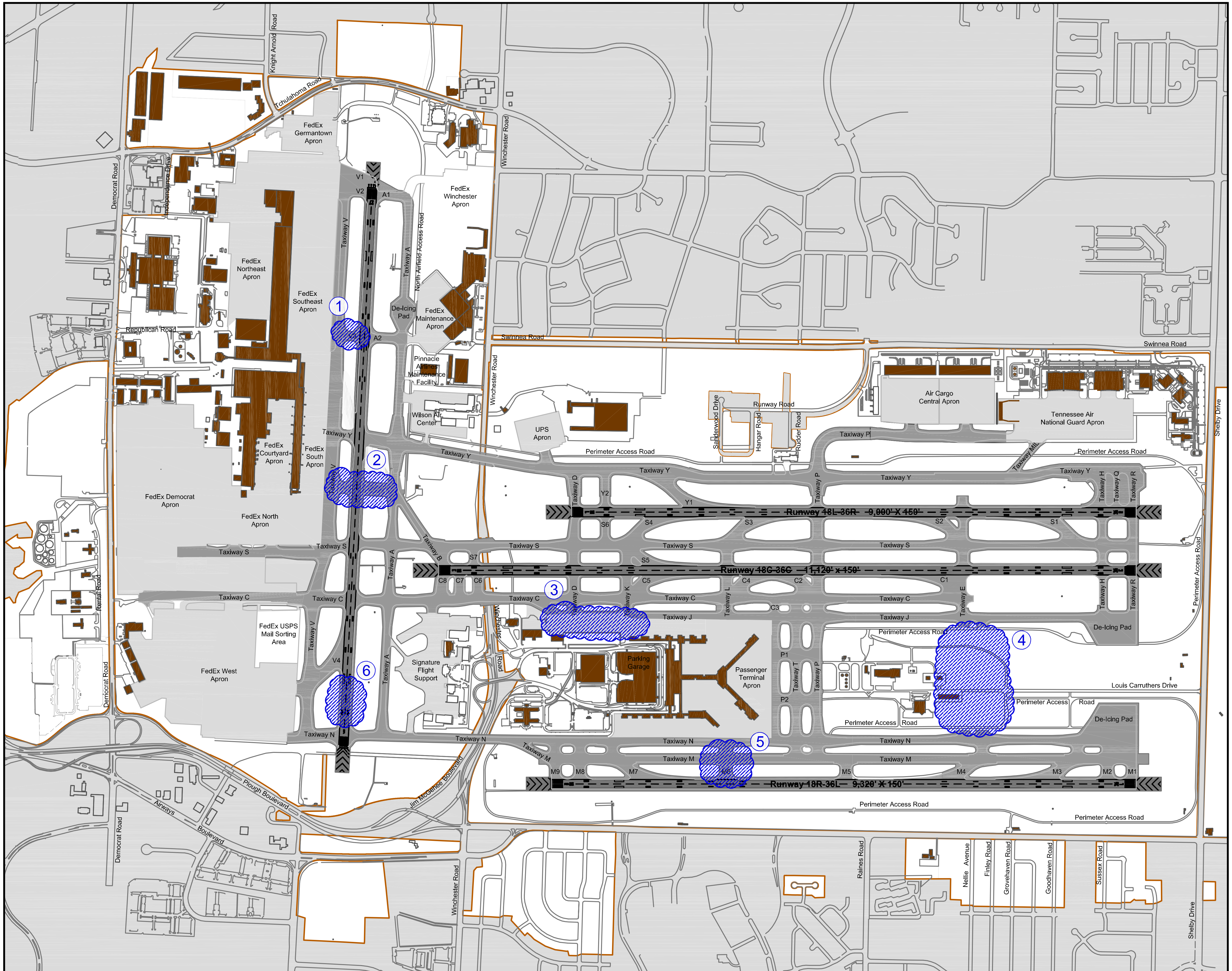
*A complete and current description of proposed NextGen program improvements, enabling technologies, and implementation timelines is presented in the report, Next Generation Air Transportation System Integrated Work Plan: A Functional Outline, Version 1.0, published by the Joint Planning and Development Office (JPDO), on September 30, 2008.



LEGEND

- Airport property line
- Apron pavement
- Runway pavement
- Taxiway pavement
- Buildings

Airfield Improvements

1. Demolition of Taxiway V3 (currently planned)
2. Reconfiguration of Taxiway B (currently planned)
3. Taxiway J extension through existing air cargo apron
4. South-side crossover taxiways and hold/de-icing apron
5. Additional or reconfigured exit taxiways
6. Land-and-hold short lights and associated procedures (currently planned)

Note: Location of potential airfield improvements is shown for illustrative purposes and does not necessarily reflect the recommended location for implementation.

Figure B-3
POTENTIAL AIRFIELD IMPROVEMENTS

Master Plan Update
Memphis International Airport
December 2009

JACOBS CONSULTANCY

aboard aircraft and in air traffic control facilities. As ADS-B use among aircraft operators and within the FAA increases in the coming decade, it is expected to supplement and eventually replace radar systems as the primary source of air traffic information.

A third important facet of NextGen is to automate and optimize traffic flows both in the terminal and en-route airspace environments, enabling pilots and controllers to do more with the same volume of airspace. This optimization, which relies in part on the other two facets of NextGen that have already been mentioned, is expected to allow controllers to sequence aircraft to arrival and departure runways more effectively, helping to ensure that available airspace and airfield capacity is not wasted because aircraft aren't fed through the air traffic system effectively enough to use it.

At the Airport, FedEx has been at the forefront of NextGen development and has been actively involved in pilot studies of ADS-B applications since the late 1990s. Accordingly, it is expected that the Airport will be one of the earliest beneficiaries of NextGen ATC surveillance and automation improvements.

Other NextGen improvements that hold promise at the Airport include the following:

- Satellite-based approach procedures that can facilitate instrument approach procedures in low visibility to runways not currently equipped with CAT III ILSs.

- Wake vortex detection and avoidance systems that enable wake-turbulence related in-trail separations and runway dependencies to be reduced when wind and weather conditions are favorable.

- ADS-B-based flight procedures and air traffic control rules that enable pilots to assume responsibility for their own separations from other aircraft, even in IMC conditions, facilitating "near-visual" operations in poor weather.

- Use of optimized descent profile (ODP) approach procedures to reduce fuel burn, aircraft emissions, and possibly noise impacts associated with Airport arrivals.

- Optimized taxiway routing and taxiway conflict management, utilizing data obtained from the ASDE-X ground surveillance system.

Some of these improvements will be enabled via facility and equipment improvements that are already planned for the Airport such as the aforementioned installation of ASDE-X, which is planned for 2011. However, much of the promise of NextGen will depend on the rates at which aircraft operators equip their aircraft to take advantage of NextGen capabilities.

From the perspective of the Master Plan Update, there are two actions that the Authority can take in the near-term future to better prepare itself for NextGen flight procedures and operational capabilities.

- To take advantage of new generation approach and departure procedures, prepare a comprehensive map of airspace obstructions in the vicinity of the Airport, including obstructions that impact one-engine inoperative departure surfaces. Consider mitigating obstructions that would preclude implementation of a CAT III approach to one or more of the Runway 18s.

- To ensure high levels of navigational performance, work with the FAA to install a permanent ground-based augmentation system at the airport, replacing the temporary system that is currently installed. This beacon enhances the accuracy of satellite-based navigation signals received by aircraft, facilitating low visibility approach and departure procedures.

In the longer term, it is recommended that the Authority monitor the progress of the FAA's NextGen program and actively collaborate with both the FAA and FedEx to determine when additional new technologies should be installed at the Airport and who should be responsible for their implementation.

AIRPORT DESIGN STANDARDS

As part of the airfield facilities requirements work effort, Jacobs Consultancy reviewed the Airport's existing airfield facilities to assess their compliance with current FAA airport design standards promulgated in FAA Advisory Circular 150/5300-13 (Change 13), *Airport Design*. As part of this review, Jacobs Consultancy also verified the disposition of current modifications to standards (MOSs) that the FAA has approved for the Airport.

The following paragraphs summarize the most important findings of this review.

Runway Safety Areas (RSAs). RSAs are rectangular areas that encompass runways and the land areas immediately around them. For runways serving Airplane Design Group (ADG) V aircraft, like those at the Airport, standard RSAs are 500 feet wide, centered on the runway, and extend 1,000 feet beyond each of the runway's physical ends. RSAs are required to be cleared, graded, and capable of supporting aircraft without causing damage to them. RSAs are intended to minimize damage to aircraft and injury to passenger and flight crew in the event of an aircraft excursion from the runway. Objects taller than three inches above grade are not permitted within RSAs unless they are (1) fixed by function and (2) mounted on frangible couplings that are no higher than three inches above grade.

At the Airport, localizer antennas serving Runways 18R, 36L and 18C are all within 1,000 feet of the physical ends of these runways (i.e., within standard RSAs of the runways). The FAA has determined that the presence of these localizers within the RSAs is permissible given that (1) the locations of the localizer antennas is fixed by their function and (2) the localizer antenna arrays are mounted on frangible couplings affixed to a concrete base that meets RSA requirements. In its RSA determinations for these runways, the FAA has also required the Authority to declare the landing distance available (LDA) of Runway 18R of 9,219 feet, 100 feet shorter than the physical length of the runway. This requirement reflects the fact that the RSA associated with the south end of Runway 18R-36L is 900 feet long, rather than the standard 1,000 feet long. Finally, the FAA has required all appurtenances other than the localizer antennas (e.g., equipment shacks) to be relocated outside of the RSAs.

Runway Protection Zones (RPZs). RPZs are trapezoidal areas beyond the ends of runways, centered on the extended runway centerline that are intended to protect people and property on the ground in the event of an aircraft accident. For precision instrument runways serving Airport Design Group V aircraft, like those at the Airport, RPZs are 2,500 feet long, 1,000 feet wide at their inner edge (i.e., closest to the runway), and 1,750 feet wide at their outer edge. The RPZs begin 200 feet beyond the physical end of their respective runways.

As stated in Paragraph 212 of *Airport Design*,

> *Land uses prohibited from the RPZ are residences and places of public assembly. (Churches, schools, hospitals, office buildings, shopping centers, and other uses with similar concentrations of persons typify places of public assembly.) Fuel storage facilities may not be located in the RPZ.*

Additionally, the FAA prohibits automobile parking facilities within the central portion of the RPZ, which for the runways at the Airport is a central rectangular area 800 feet wide that extends for the length of the RPZ.

The RPZs associated with the Airport's parallel runways all meet these land use requirements. On the other hand, the RPZs associated with Runways 9 and 27 both encompass non-compatible land uses, albeit beyond the Airport's property line.

To the west of the Airport, the Runway 9 RPZ encompasses several parcels north of East Brooks Road and west of Airways Boulevard that are not owned by the Authority. One of these parcels, located at the intersection of Brooks Road and Directors Row, is currently occupied by a commercial building that constitutes a place of public assembly. In this case, the RPZ encompasses the commercial building. A second parcel, located at the northwest corner of the intersection of Brooks Road and Airways Boulevard, is slated for development as a transit center by the Memphis Area Transit Agency (MATA). In this case, it is expected that only automobile parking facilities will be within the RPZ.

To the east of the Airport, the Runway 27 RPZ encompasses several parcels north of the extended runway centerline and south of Democrat Road. These parcels, which are located to the south of Holman Place, contain a mixture of low-rise light industrial and commercial buildings that constitute places of public assembly.

For both runway ends, it is recommended that the Authority attempt to acquire the parcels within the RPZ that contain places of public assembly. This includes the commercial parcel to the west of the Airport and the several light industrial/ commercial parcels to the east of the Airport. Once acquired, these parcels should be cleared in accordance with RPZ requirements.

MODIFICATIONS OF STANDARDS

The following is a list of the FAA Modifications of Standards either currently in place or formally requested and denied at the Airport:

- Allow ADG IV aircraft to use Taxiway N, between Taxiways M7 and T. Also allow a roadway inside the Taxiway N object free area. Both modifications denied September 21, 2006.

- Allow Group VI aircraft to operate on a taxiway width of 75 feet on Taxiways A, C, and Y. Conditional interim approval was granted on March 22, 2004, with the understanding that modifications will be in accordance with *Airports Engineering Brief #63, Use of Non-Standard 75-Foot Wide Straight Taxiing Sections for Airbus A380 Taxiing Operations*.

- Allow Group VI aircraft on Taxiway A under ADG V taxiway object free area criteria of 160 feet separation from taxiway centerline to adjacent vehicle service road. Conditional approval was granted on March 25, 2004, understanding that the Airport must maintain at least a 163-foot separation from Taxiway A to the adjacent vehicle service road. Additionally, Airbus A380 aircraft must taxi at taxilane speed of 15 mph.

- Use the closest nine feet of full-strength shoulder in providing the pavement edge margin for Group VI aircraft. Conditional approval granted March 25, 2004, contingent upon the Airport implementing an inspection and maintenance plan for taxiway sections with less than standard taxiway edge safety margins.

- Allow ADG VI operations with sub-standard 550 feet separation between Runway 18L-36R and parallel Taxiway Y. Conditional approval granted on April 23, 2004, provided that no Airbus A380 operations use Runway 18R-36L and A380 operations comply with the ATCT *A380 Operational Plan*.

- Allow ADG VI operations with sub-standard 527 feet separation between Runway 18L-36R and parallel Taxiway S. Conditional approval granted on April 23, 2004, provided that no Airbus A380 operations use Runway 18R-36L and A380 operations comply with the ATCT *A380 Operational Plan*.

- Allow ADG VI aircraft to operate on a runway width of 150 feet. Request was denied on March 25, 2004, citing *Airports Engineering Brief #65, Minimum Requirements to Widen Existing 150-foot Wide Runways for Airbus A380 Operations*.

- Allow 45-degree acute angled exit taxiways on Runway 18C-36C and Runway 18L-36R. Approval granted on May 30, 1990.

- Allow the use of polymer modified asphalt and the specification of performance graded asphalt on Taxiway N and Runway 9-27 (approved July 21, 2003).

- Counterpoise use and installation. Conditional approvals granted March 10, 2006.

OPERATIONAL AGREEMENTS WITH THE ATCT

The following is a list of restrictions in place at the Airport likely because of physical limitations on the airfield.

- Taxiway J, between Taxiways C3 and K, is limited to ADG III aircraft or smaller (approved September 21, 2006).

- Taxiway N, between Taxiways M6 and M8, is limited to ADG III aircraft or smaller.

- Taxiway V, between Taxiways S and Y, is limited to aircraft with tail heights less than 65′ - 10″.

- Aircraft or vehicles using Taxiway A should be held short of the Runway 18C approach course/Runway 36C departure course so that arriving or departing aircraft will not overfly them.

- Taxiway V, between Taxiways S and V3, is closed to B-74S or C-5 aircraft.

- Aircraft are not allowed on Taxiway J, north of Taxiway K, when aircraft are parked at Concourse C.

- Taxiway V, between Taxiway B and the approach end of Runway 27, is limited to ADG IV aircraft or smaller.

- Use of the taxilane between Taxiway A and the Signature Flight Center ramp is limited to ADG III aircraft or smaller with wingspans less than 110 feet. Use of the taxilane between Taxiway N and the Signature Flight Center ramp is only permitted for ADG II aircraft or smaller.

NAVIGATIONAL AND VISUAL AIDS

A review of navigational and visual aid needs at the Airport was conducted as part of the airfield facility requirements evaluation. To determine potential requirements, the Master Plan Update Team interviewed representatives from the Authority, the FAA, and FedEx and independently assessed the needs for additional or enhanced navigational and visual aids, including aids that are under development at part of the FAA's NextGen program.

Weather and runway use configuration data indicated that there was not a need to enhance the instrument landing systems (ILSs) that are currently in place at the Airport. As noted in the Inventory Working Paper, Runway 36L, 36C, and 36R are all equipped with Category III ILSs, which enable trained pilots flying equipped aircraft to land when cloud ceilings and visibility is essentially nil. The five other runway ends at the Airport—Runways 18L, 18C, 18R, 9, and 27—are all equipped with Category I ILSs. The approach procedures associated with all five of these Category I ILSs have the lowest weather minimums possible with Category I ILSs, notably decision heights of 200 feet above ground level and visibilities of ½ statute mile (e.g., 1,200 RVR).

As noted in the Inventory Working Paper, weather conditions that necessitate use of approach procedures below Category I only occur 0.7% of the time. During this 0.7% of the year, winds are calm or out of the north approximately 89% of the time, enabling use of the Category III ILSs associated with Runways 36L, 36C, and 36R. These results indicate that there is not an operational need to upgrade any of the Airport's Category I ILSs to Category II or Category III installations.

Consideration may need to be given to relocating the airport surveillance radar (ASR) antenna and remote transmitter-receiver (RTR) facility to an alternative site at the Airport. FedEx representatives have noted that the antennas associated with these two facilities can limit the payloads that can be carried by long-haul departures that use Runway 18C.* The effect that these two facilities have on departure payload carriage capabilities from Runway 18C will be reviewed in greater detail in Phase 2 of the Master Plan, in which one-engine inoperative departure surfaces will be analyzed to identify penetrations as part of the Airport Layout Plan. The south midfield area—bounded by Taxiway P on the north, Taxiway N on the west, the airport boundary on the south, and Taxiway J on the east is one potential site where these two facilities could be relocated. Sites east of Taxiway Y may also be promising for these facilities. Relocation of these two facilities should be timed to coincide with planned FAA facility upgrades to the extent possible to minimize cost and operational disruption.

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*E-mail correspondence from Steve Vail, FedEx, to Chris Oswald, Jacobs Consultancy, October 1, 2008.

A temporary ground augmentation system transmitter is currently installed at the Airport. This temporary installation should be replaced by a permanent installation during the planning period, preferably within the next five years. As noted previously, this transmitter corrects GPS signals broadcast by satellites and thus improves the accuracy of GPS signals received by aircraft-based GPS navigation systems. The improved signal accuracy facilitated by the ground augmentation system is considered a critical prerequisite to future NextGen flight procedures, including satellite-based Category II and Category III approach procedures. The exact timing of permanent transmitter installation should be determined in coordination with the FAA that, ideally, would fund the installation and maintenance costs of the transmitter.

As noted previously, the Authority is currently planning to install land-and-hold-short lighting on Runway 27 to the east of Taxiway N during the planned reconstruction of Runway 9-27 in 2009. In addition, during the runway reconstruction project the Authority intends to install the subsurface infrastructure needed to support installation of runway status lights (RWSLs) at the intersections of Runway 9-27 with Taxiways N, V4, C, S, B, Y, A2, A1, and V2/V1. These actions should be accompanied with (1) development of land-and-hold-short procedures for Runway 27 and (2) installation of the RWSL system itself to coincide with commissioning of the new airport traffic control tower and its ASDE-X system, which is a prerequisite to RWSL installation.

OBSTACLE CLEARANCE SURFACE ASSESSMENT

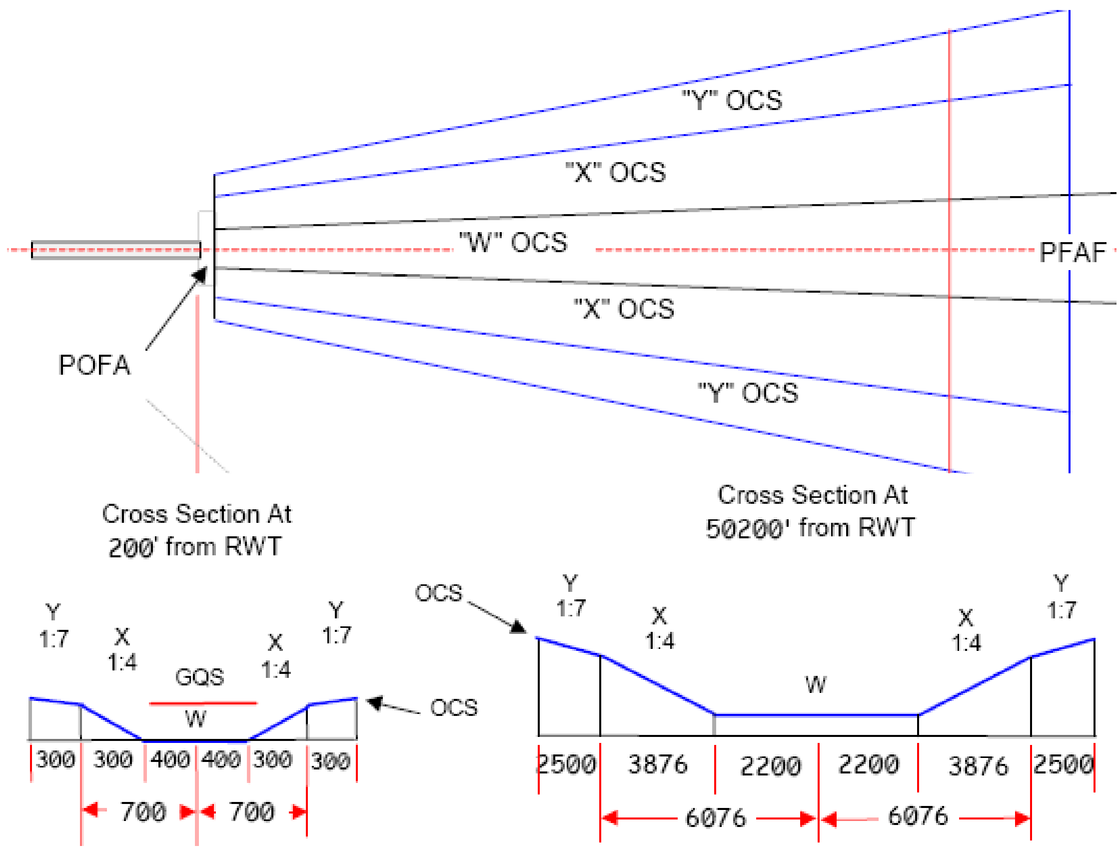
In the obstacle clearance assessment conducted as part of the Master Plan Update facility requirements evaluation, FAA United States Standard for Terminal Instrument Procedures (TERPS) approach and instrument departure obstacle clearance surfaces (OCSs) were evaluated. The potential obstacles considered in this assessment were taken from the June 2007 Photoslope obstacle survey that was prepared by GCR and Associates, Inc., for the Authority.

Surfaces Considered

All four of the Airport's runways are precision instrument runways and all eight runway ends are equipped with either Category I or Category III ILSs. The TERPS approach surfaces that are applicable to such precision instrument runways are shown on Figure B-4. As shown, the precision instrument approach surface is composed of three sections. These include a central section—termed the "W" surface—that rises along the extended centerline of the runway in the direction of approaching aircraft at a slope of 34:1, an inner wedge—termed the "X" surface—that rises perpendicular to the extended centerline of the runway at a slope of 4:1, and an outer wedge—termed the "Y" surface—that also rises perpendicular to the extended centerline of the runway at a slope of 7:1. All three of these sections begin 200 feet prior to a runway's arrival threshold at the elevation of the runway threshold and extend for a distance of 50,200 feet, in the direction of approaching aircraft.

Figure B-4

TERPS PRECISION OBSTACLE CLEARANCE SURFACE
Master Plan Update
Memphis International Airport



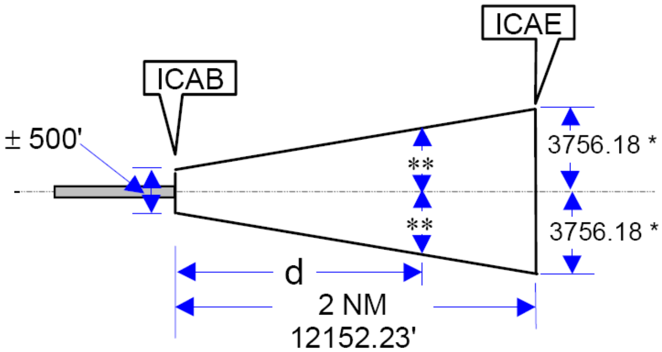
Source: FAA Order 8260.3B, *United States Standard for Terminal Instrument Procedures*.

Penetrations of TERPS precision instrument surfaces are typically addressed by either (1) either removing or lowering the penetrating obstacle, (2) implementing a displaced arrival threshold to eliminate the obstacle penetration, or (3) modifying the weather minimums (e.g., decision altitude and/or visibility minimum) associated with the approach.

The TERPS instrument departure obstacle clearance surface—also termed the initial climb area—is depicted on Figure B-5. This surface is trapezoidal in shape and begins at the declared departure end of the runway (DER) at the elevation of the DER. It rises at a slope of 40:1 in the direction of departing aircraft and extend for a distance of 12,152 feet (i.e., two nautical miles) from the DER.

Figure B-5

TERPS INSTRUMENT DEPARTURE OBSTACLE CLEARANCE SURFACE
Master Plan Update
Memphis International Airport



Source: FAA Order 8260.3B, *United States Standard for Terminal Instrument Procedures*.

Penetrations of the TERPS instrument departure obstacle clearance surface are typically addressed by (1) removing or lowering the penetrating obstacle, (2) increasing the minimum climb gradient associated with the departure procedure, or (3) defining a departure procedure that avoids the obstacle.

Evaluation Results

None of the objects in the 2007 Photoslope survey penetrate the TERPS approach surfaces associated with the Airport's eight runway ends.* On the other hand, several objects were found to penetrate the instrument departure surfaces associated with Runways 9, 27, 18L, 18C, and 18R (i.e., to the east, west, and north of the Airport, respectively). No objects were found to penetrate the instrument departure surfaces associated with Runways 36L, 36C, and 36R (i.e., to the south of the Airport).

With respect to the penetrations of the instrument departure surfaces, it is recommended all such penetrations be eliminated by either removing or lowering the objects to the extent possible. Doing so will improve margins of safety and

*Although some objects were found to penetrate 34:1 approach slopes in the Photoslope survey, none of these objects were found to be beneath the "W" surface and were instead beneath the higher "X" or "Y" surfaces and were not found to penetrate these surfaces.

reduce potential payload penalties for performance-challenged departures from these runways. As indicated in the Photoslope survey, most of these objects are trees or poles, which should be relatively easy to lower or remove.

As mentioned previously, consideration may need to be given to relocating the airport surveillance radar (ASR) antenna and remote transmitter-receiver (RTR) facility to an alternative site at the Airport. Although these facilities are not indicated as penetrations of the obstacle clearance surfaces considered in the Photoslope survey (including the FAA's 62.5:1 one-engine inoperative departure surface), FedEx representatives have noted that the antennas associated with these two facilities can limit the payloads that can be carried by long-haul departures that use Runway 18C.* The effect that these two facilities have on departure payload carriage capabilities from Runway 18C will be reviewed in greater detail in Phase 2 of the Master Plan Update, in which one-engine inoperative departure surfaces will be examined to identify penetrations. The south midfield area—bounded by Taxiway P on the north, Taxiway N on the west, the airport boundary on the south, and Taxiway J on the east is one potential site where these two facilities could be relocated. Sites east of Taxiway Y may also be promising for these facilities. Relocation of these two facilities should be timed to coincide with planned FAA facility upgrades to the extent possible to minimize cost and operational disruption.

There is a series of high-voltage electrical transmission towers running in an east-west direction located approximately 2 miles south of the Airport, with the tallest tower at an elevation of 506 feet. FedEx representatives have also noted that a radio transmitter located approximately 3 miles due south of the airport can also interfere with heavily-loaded Runway 18C departures. This antenna, which does not appear in the Photoslope survey because of its distance from the Airport, will also be evaluated in greater detail in Phase 2 of the Master Plan Update.

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*E-mail correspondence from Steve Vail, FedEx, to Chris Oswald, Jacobs Consultancy, October 1, 2008.

Technical Memorandum–C

PASSENGER TERMINAL COMPLEX

The following summarizes general planning factors and assumptions used to derive facility requirements for key functional areas of the passenger terminal complex. Requirements were determined based on a multitude of factors, including Authority staff input, simulation modeling, facilities provided at comparable airports, knowledge of industry-wide trends, airline surveys, and guidelines published in the International Air Transport Associations (IATA's) *Airport Development Reference Manual*; FAA Advisory Circular (AC) 150/5360-13, *Planning and Design Guidelines for Airport Terminal Facilities*; and FAA AC 150/5300-13, *Airport Design*. Requirements were generated for aircraft gates/parking positions, holdrooms/passenger departure lounges, ticketing and check-in positions, passenger security screening, baggage handling facilities, and Federal Inspection Service (FIS) screening facilities. Additional consideration is given to passenger circulation within the concourses and terminal infrastructure (mechanical, electrical, and plumbing systems).

GATES/AIRCRAFT PARKING

At present, 86 aircraft parking positions and 79 individual gates are provided on the apron surrounding the passenger terminal complex. Demand for active gate positions is summarized in Table C-1 and estimated based on the following planning guidelines and assumptions:

- Standard gate occupancy times are assumed to simulate the duration that a given operation will require use of a gate. Gate occupancy times include buffers to account for variability in the actual arrival and departure times of aircraft operations.

- Because aircraft gates are sized for specific groups of aircraft, the overall gate requirements are a combination of gate requirements for five different groups of aircraft: turboprop, regional jet, small narrowbody, large narrowbody, and widebody.

- Northwest Airlines is able to use gates with sterile access to the FIS for the domestic operations when not required by international flights.

- Because of the abundance of Northwest Airlines gates that are not used overnight, non-Northwest Airlines carriers park aircraft remaining overnight at Northwest Airlines gates as is currently practiced. Separate requirements for remain overnight (RON) positions are not developed.

Table C-1

SUMMARY OF PASSENGER TERMINAL FACILITIES REQUIREMENTS
Master Plan Update
Memphis International Airport

		Estimated requirement			
Functional element	Existing	Baseline (2007)	PAL 1 (2012)	PAL 2 (2017)	PAL 3 (2027)
Gates / aircraft parking *(a)*					
Preferential use scenario (no. of gates)					
Turboprop	11	10	10	5	-
Regional jet	30	40	46	58	73
Narrowbody jet—Group III	32	32	26	24	28
Narrowbody jet—Group IV	12	3	3	3	-
Widebody jet	1	1	2	2	2
Total	86	86	87	92	103
Common use scenario (no. of gates) (b)					
Turboprop	11	10	10	5	-
Regional jet	30	37	43	55	65
Narrowbody jet—Group III	32	31	25	24	27
Narrowbody jet—Group IV	12	2	1	1	-
Widebody jet	1	1	2	2	2
Total	86	81	81	87	94
Passenger holdrooms					
Preferential use scenario (sq ft)	131,270	130,400	130,850	138,200	153,000
Common use scenario (sq ft)	131,270	130,400	130,850	128,600	141,500
Ticketing and check-in					
Curbside check-in positions					
Lobby A	3	3	3	3	3
Lobby B	8	8	8	8	8
Lobby C	4	4	4	4	4
Total	15	15	15	15	15
Agent counters					
Lobby A	8	3	4	4	5
Lobby B	12	17	17	18	20
Lobby C	9	6	6	7	8
Total	29	26	27	29	33
Self-service kiosks					
Lobby A	10	3	4	4	3
Lobby B	39	17	18	20	23
Lobby C	13	6	6	9	8
Total	62	26	28	33	34
Total check-in positions	106	67	70	77	82

Table C-1 *(page 2 of 4)*
SUMMARY OF PASSENGER TERMINAL FACILITIES REQUIREMENTS
Master Plan Update
Memphis International Airport

		Estimated requirement			
Functional element	Existing	Baseline (2007)	PAL 1 (2012)	PAL 2 (2017)	PAL 3 (2027)
Ticketing and check-in *(continued)*					
Check-in queuing area (sq ft)					
Lobby A	1,220	300	600	600	600
Lobby B	4,160	2,800	3,000	3,500	4,200
Lobby C	1,310	700	800	1,000	1,200
Total	6,690	3,800	4,400	5,100	6,000
Passenger security screening					
Checkpoint lanes					
Lobby A	2	1	1	1	2
Lobby B	5	5	5	6	7
Lobby C	3	2	2	2	2
Total	10	8	8	9	11
Security queuing area (sq ft)					
Lobby A	1,330	100	100	350	550
Lobby B	1,600	2,700	2,800	2,800	2,900
Lobby C	950	500	500	600	600
Total	3,880	3,300	3,400	3,750	4,100
Baggage handling *(c)*					
Checked baggage EDS machines *(d)*					
East Zone	3	2	2	2	2
West Zone	3	2	2	2	2
Total	6	4	4	4	4
Outbound baggage make-up *(e)*					
Existing scenario (positions)					
American & Frontier	8	5	5	5	6
Delta & charter airlines	12	6	6	9	12
Northwest & Continental	96	99	99	101	109
United & Air Tran	5	5	5	8	8
US Airways	3	2	2	3	3
Total	124	117	117	126	138

Table C-1 *(page 3 of 4)*

SUMMARY OF PASSENGER TERMINAL FACILITIES REQUIREMENTS

Master Plan Update

Memphis International Airport

Functional element	Existing	Estimated requirement Baseline (2007)	PAL 1 (2012)	PAL 2 (2017)	PAL 3 (2027)
Baggage handling *(continued)*					
In-line security screening scenario					
American	17	4	4	4	5
Charter airlines	18	4	4	5	8
Northwest & Continental	105	99	99	101	109
Delta	18	4	4	4	7
United & Air Tran	9	5	5	8	8
US Airways & Frontier	18	3	3	4	4
Total	168	115	115	122	136
Inbound baggage handling (ln ft)					
Lobby A	130	30	35	35	60
Lobby B	240	100	100	100	110
Lobby C	225	50	65	75	75
Total	595	180	200	210	245
Baggage claim frontage (ln ft)					
Lobby A	135	95	95	95	175
Lobby B	660	295	295	295	335
Lobby C	195	150	190	225	230
Total	990	540	580	615	740
Baggage claim area (sq ft)					
Lobby A	1,585	1,500	1,500	1,500	2,700
Lobby B	9,700	4,600	4,600	4,500	5,200
Lobby C	2,135	2,400	3,000	3,500	3,600
Total	13,420	8,500	9,100	9,500	11,500
FIS/International arrivals facility					
Gates / aircraft parking *(a)*					
Narrowbody jet—Group III	1	1	-	-	2
Narrowbody jet—Group IV	1	1	1	1	-
Widebody jet	1	1	2	2	2
Total	3	3	3	3	4
Primary processing					
Number of booths *(f)*	5	4	4	4	5
Queuing area (sq ft)	2,885	2,300	2,300	2,300	2,900
Baggage claim					
Baggage claim frontage (ln ft)	190	200	200	200	300
Baggage claim area (sq ft)	2,710	2,000	2,100	2,100	2,900

Table C-1 *(page 4 of 4)*
SUMMARY OF PASSENGER TERMINAL FACILITIES REQUIREMENTS
Master Plan Update
Memphis International Airport

Functional element	Existing	Estimated requirement Baseline (2007)	PAL 1 (2012)	PAL 2 (2017)	PAL 3 (2027)
FIS/International arrivals facilities *(continued)*					
Secondary processing					
Referral passenger waiting (sq ft)	660	225	225	225	225
Exam podium—with baggage belt	4	--	--	--	--
Exam podium—with x-ray	1	1	1	1	1
Passenger security screening (lanes)	2	2	2	2	3
Checked baggage EDS machines	4	4	4	4	5

(a) Gate requirements include FIS gates that are also identified separately elsewhere in this table.
(b) Baseline and PAL 1 requirements assume continuance of current preferential gate use. Later years assume non-Northwest airlines operate from common-use gates.
(c) Baggage requirements assume near-term implementation of the planned in-line security screening and automated sorting system per the preliminary design.
(d) EDS = explosive detection screening machines.
(e) Airline groupings based on current ticket counter locations and physical design of baggage handling systems.
(f) Primary screening booths provide two agent positions each.

Source: Jacobs Consultancy, based on Computer Airport Simulation Technology (CAST) modeling, analytical methods, and professional judgment, July 2008.

Gate requirements are presented in Table C-1 for two distinct scenarios. The first assumes airlines will continue to use gates on an exclusive or preferential use basis as is currently practiced. For this scenario, a total of 103 parking positions are required at PAL 3. The second assumes airlines other than Northwest Airlines would transition to a common use arrangement, whereby airlines are provided gates as needed for their operations. Because the common use arrangement makes more efficient use of aircraft gates by the non-hub airlines, the overall PAL 3 gate requirement is reduced to 94.

As shown in Table C-1, the categorical distribution of aircraft gates evolves over the course of the planning period. The Airport currently has an approximately equal number of regional jet∗ and narrowbody parking positions. At the end of the planning period, it is anticipated that the Airport will require three times more regional jet than narrowbody positions because of the anticipated changes in

∗Includes both small (50-seat) and large (70-90 seat) varieties of regional jets.

passenger fleet mix. Also, because of the expected retirement of turboprop aircraft, the Airport will be able to gradually phase out parking positions for these aircraft.

While the Airport will require additional parking positions over the planning period, it is anticipated that these positions can be accommodated through improved utilization of the existing apron and manageable reconfiguration projects. Gate layout alternatives that achieve this objective will be developed in Phase II of the Master Plan Update.

PASSENGER HOLDROOMS

Requirements for holdrooms are presented for the overall terminal building and are directly related to the design aircraft size for each gate. Because it is unknown exactly where and how aircraft will be parked at each PAL, requirements for holdrooms are presented for the terminal as a whole. The number of passengers that should be accommodated in each holdroom is calculated assuming 80% of the design aircraft's passengers require seats, and that standing and seated passengers occupy 13 and 18 square feet each, respectively. It is also assumed that passengers waiting for flights do not "spill over" into concession or circulation areas.

Requirements for holdrooms are also presented for the preferential and common use scenarios described for aircraft parking positions. As shown in Table C-1, the Airport will require additional holdroom capacity at PAL 2 if the current exclusive/preferential use policy is maintained. The required area fluctuates over the course of the planning period because of a long-term trend toward smaller aircraft operating at the Airport in combination with a long-term increase in overall passenger aircraft operations. At PAL 3, the Airport will require approximately 153,000 square feet of holdrooms, a 16% increase over what is currently available.

Should the Airport reduce its overall quantity of gates by implementing a common use arrangement for non-Northwest Airlines carriers, then the current holdroom capacity will be sufficient through PAL 2. At PAL 3, the Airport will need to provide approximately 141,500 square feet of holdrooms, an approximate 8% increase over what is currently available.

TICKETING AND CHECK-IN

Approximately 106 passenger check-in positions are provided in the lobby areas on the upper level of Terminals A, B, and C. These positions include airline agent desks, electronic kiosks, and curbside positions allocated to individual airlines on an exclusive-use basis. Future check-in facility requirements were based on the following assumptions and guidelines:

- 80% of originating passengers will require check-in facilities at the Airport throughout the planning period. While new and maturing technologies have the potential to reduce this number, this conservative assumption ensures adequate space is reserved for on-Airport ticketing and check-in.

- Check-in positions will continue to be allocated on an exclusive-use basis to individual airlines.

- Check-in positions process passengers at different rates. Curbside, agent, kiosk with baggage check, and kiosk without baggage check positions are assumed to process 20, 24, 30, and 50 passengers per hour, respectively. Process rates are assumed to remain constant over the planning period, which is a conservative assumption given recent trends to separate check-in and boarding pass retrieval from baggage check. However, because of ongoing changes in airline check-in procedures and use of electronic kiosks, conservative assumptions are used to develop check-in requirements.

- To maintain current passenger service levels, it was assumed that passengers can wait a maximum of ten minutes for check-in. Passengers will occupy 14 square feet per person of space while waiting in queue.

- Ticket counters in all three terminals were moved further into the lobby areas when checked baggage security screening requirements were increased in the early 2000s so that explosive detection screening (EDS) equipment could be accommodated behind the counters. This analysis assumes that this equipment will be relocated to baggage handling areas in the near-term and that ticket counters can be moved back to their original locations, thereby freeing up additional lobby space for passenger queues.

To account for exclusive use of dedicated check-in facilities by different airlines, whose individual peaks do not coincide with the terminal peak, the estimated peak hour for each airline was used to assess check-in requirements based on traffic patterns inherent in the future passenger airline flight schedules.

As shown in Table C-1, the Airport currently provides a total of 106 check-in positions, with 21, 59, and 26 total positions in Terminals A, B, and C, respectively. It is anticipated that only 82 total positions will be required at PAL 3, fewer than currently available. Additionally, each of the three terminals has sufficient capacity to meet the check-in demand for the entire planning period. The one exception is in Terminal B, where it is anticipated that 20 agent positions will be required at PAL 3, an increase of 8 positions over what is currently provided. Ticketing lobbies also have sufficient area to meet the spatial requirements for queues of passengers waiting to check-in for departing flights, provided that the ticket counters are returned to their original positions when checked baggage security screening is relocated.

Passenger queuing area in Terminals A and C is projected to be sufficient throughout the planning period. Terminal B will be slightly over it's theoretical capacity at PAL 3, needing an additional 40 square feet of queuing area for passengers checking in. It should also be noted that the proximity of ticketing and check-in areas to the Terminal B security checkpoint and escalators leading to and coming from the baggage claim one level below creates pedestrian cross-flows and, during peak periods, congestion.

PASSENGER SECURITY SCREENING

Three passenger security screening checkpoints are currently provided, one in each terminal. The checkpoints connect each terminal's ticketing lobby to its passenger concourses, all of which are also connected to one another post-security via sterile walkways. At present the A, B, and C security checkpoints provide 2, 5, and 3 lanes*, respectively, for screening of passengers and their carry-on baggage. Future passenger security screening checkpoint requirements are based on the following planning guidelines and assumptions:

- Based on observations at Airports nationwide, an average throughput of 175 persons per lane per hour was assumed. This assumption is conservative since technological improvements have the potential to increase passenger throughput over the planning period.

- Employee screening demand was added to the passenger volumes at all checkpoints and assumed to be 5% of daily enplanements.

- To maintain acceptable levels of passenger service, it was assumed that passengers can wait a maximum of ten minutes for security screening. Passengers will occupy 13 square feet per person of space while waiting in queue.

- Passengers will utilize the security screening checkpoint located in the terminal in which they check-in regardless of congestion. Active management of passenger queues to redirect passengers to checkpoints with less congestion could reduce overall screening wait times.

Table C-1 shows that, under these assumptions, the existing capacities of Checkpoints A and C are sufficient to meet the PAL 3 demand of two lanes at each checkpoint. However, two additional lanes will be required at Checkpoint B; one at PAL 2 and the second at PAL 3. It is important to note, however, that screening requirements vary depending on the prevailing security requirements enforced at any given time by the TSA. To that end, it is recommended that passenger checkpoints be reassessed regularly.

Approximately 1,330, 1,600, and 950 square feet of space is currently provided for passenger queuing area at the front of Checkpoints A, B, and C, respectively. While Checkpoints A and C have sufficient queuing area throughout the planning period, Checkpoint B is currently undersized for current levels of throughput based on the assumptions outlined above. As shown in Table C-1, it is estimated that

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*Lanes are determined by the number of baggage x-ray screening machines present at an individual checkpoint. Multiple lanes may share magnetometers.

Checkpoint B currently requires approximately 2,700 square feet of queuing space and 2,900 square feet at PAL 3.

Additionally, it should be noted that the physical layout of the Terminal B lobby creates cross-flows of departing and arriving passengers between Checkpoint B and escalators that connect the ticketing lobby to baggage claim areas one level below. The resulting congestion affects the exit lane at Checkpoint B, which was recently narrowed in order to provide additional space for passenger security screening. The physical layout of all of these functions is prone to congestion today and is likely to worsen during peak periods going forward as originating enplanement levels increase.

BAGGAGE HANDLING

The following sections describe facility requirements of baggage handling areas of the passenger terminal complex, including checked baggage security screening, outbound baggage make-up, inbound baggage handling, and baggage claim. Facility requirements for baggage handling assume that the Airport will modify current baggage handling, screening, and sorting systems consistent with preliminary engineering plans. These plans, which were developed to a 30% design in 2007, serve as the basis for estimating future requirements.

All baggage requirements were developed assuming that domestic passengers check an average of 0.8 bags and international passengers check an average of 1.2 bags each.

Checked Baggage Security Screening

All checked baggage is currently screened in EDS machines located in several locations throughout the three passenger terminals. In the proposed baggage system renovations, two distinct "zones" would be created. The East Zone would provide three in-line EDS machines capable of processing approximately 1,200 bags per hour per machine and would screen baggage originating at check-in areas in Terminal A and half of Terminal B. The West Zone would also provide three in-line machines to screen baggage from the other half of Terminal B and Terminal C.

Table C-1 summarizes checked baggage screening requirements. The proposed in-line checked baggage screening system is adequate to screen the expected demand through PAL 3. Based on the above assumptions and the future flight schedules, each zone will only require two EDS machines at PAL 3. Not only do the in-line EDS machines provide greater throughput rates over the existing equipment at the Airport but they also can be used by any airline within that zone. Because each airline experiences peak baggage demand at different times of day, sharing equipment such as EDS machines reduces the overall number of machines required.

Separate checked baggage screening facilities are provided in the FIS facility to screen baggage arriving on international flights and connecting onto outbound flights at the Airport. These functions are described with the FIS facility at the end of this Technical Memorandum.

Outbound Baggage Make-up

Outbound baggage is sorted and loaded onto one or more carts allocated to each departing flight. This function is presently performed in baggage makeup areas on the ground level of the passenger terminal. The size of the make-up areas would increase and expand to portions of the apron level beneath the passenger concourses in the proposed baggage system renovations. Requirements for baggage make-up are expressed in terms of the number of carts needed to be staged adjacent to baggage conveyance systems. Most airlines currently share make-up devices, as outlined in Table C-1, and will continue to do so in the renovated configuration.

Facility requirements for baggage make-up are presented for two scenarios. The first assumes that the existing make-up positions will remain for the duration of the planning period. The second assumes that the baggage system renovations are implemented in the near-term, prior to PAL 1. Outbound make-up requirements are based on planning guidelines and assumptions, as follows:

- Baggage cart staging begins two hours prior to and ends 15 minutes prior to a flight's scheduled departure time.
- Each cart accommodates 40 bags and no more than two carts will be staged for any flight. Should the number of passengers traveling on a particular flight require more than two carts worth of baggage, it is assumed that the carts would get rotated out once they reach capacity and replaced with empty carts.
- Airlines will be assigned to make-up devices consistent with the location of their check-in facilities as necessitated by the physical layout of the baggage conveyance system.

Table C-1 summarizes outbound baggage make-up requirements for the planning period for each scenario. If the existing layout were to be maintained, the 124 positions that are provided today will become insufficient at PAL 2, when 126 positions will be needed. A total of 138 positions are needed at PAL 3. Furthermore, the distribution of cart parking positions within the outbound make-up areas do not provide Northwest and Continental Airlines with sufficient positions for the duration of the planning period. Currently, these two airlines have 96 positions while requiring 99 positions today, increasing to 109 at PAL 3. Additionally, United Airlines and AirTran Airways will require three more positions at PAL 2.

With the baggage system renovations, a total of 168 cart parking positions would be provided upon completion of the project. Because different combinations of airlines would share space in this configuration, the overall PAL 3 requirement is

136 positions, slightly lower than for the first scenario. The combined Northwest and Continental Airlines baggage requires 109 cart parking positions at PAL 3. Based on the preliminary plans, only 105 would be required upon completion of the renovation project. It is recommended that the design be slightly modified before construction to ensure that the project meets the PAL 3 demand for each of the airlines.

Inbound Baggage Handling

Baggage from flights arriving at the Airport and belonging to passengers whose final destination is Memphis is unloaded in the baggage handing areas on the ground level of Terminals A, B, and C and placed on conveyor belts. These belts transport the baggage to claim devices located in passenger areas in each terminal. Requirements for inbound baggage handling represent the overall linear frontage of conveyor belt required in the baggage handling area for active unloading of passenger baggage.

The approximately 600 linear feet of conveyor belt frontage that exists today provides more than enough capacity for unloading of baggage throughout the planning period.

Baggage Claim

Baggage claim facilities currently occupy 13,420 square feet of space on the ground level of each terminal, providing 990 linear feet of retrieval frontage on 10 different devices. Requirements for total baggage claim area and claim frontage were estimated based on the following guidelines and assumptions:

- Airlines would use claim devices in the same terminal as their check-in facilities. While each airline may have their preferred specific claim device, it is assumed that the claims would be allocated on a common use basis within each terminal.

- Approximately 70% of domestic arriving passenger will need to claim checked baggage at the Airport. Of those passengers, only 80% will be in the baggage claim area at a given time and only 67% will require space adjacent to the claim device. An allowance of 0.3 additional persons per passenger was added to the requirements for baggage claim area to represent meeter/greeter activity.

- Baggage would first appear at the claim device ten minutes after a flight's arrival and would be unloaded at a rate of 12.5 bags per minute. A claim device would be considered in use for 10 minutes after the last bag was unloaded.

- Each person in the baggage claim area requires 18 square feet of space in the claim area and two linear feet against the claim device.

Table C-1 summarizes the requirements for baggage claim areas. As shown, there is abundant device frontage and claim area provided throughout the planning period in Terminal B. However, both Terminals A and C require additional retrieval frontage and overall area. Terminal A will require an additional 40 feet of device frontage and 1,100 additional square feet of overall space at PAL 3. Terminal C will require 35 more feet of device frontage at PAL 3. The 2,135 square feet of area currently provided does not satisfy the existing demand of 2,400 square feet. This demand will increase to approximately 3,600 square feet at PAL 3.

FEDERAL INSPECTION SERVICE

The Airport's FIS, located on the apron level at the end of the southwestern leg of Concourse B, provides primary and secondary immigration and customs screening of passengers, baggage claims, baggage re-check areas for connecting passengers, and checked baggage and passenger security screening facilities. Requirements are presented for the following: number of aircraft parking positions; primary processing area (i.e. passport check); international baggage claim; and secondary processing facilities (i.e. customs forms and baggage inspection).

FIS facilities are based on the following planning guidelines and assumptions:

- Primary processing is facilitated by immigration officials working in booths. Each booth holds two agents and provides two lanes of screening capable of processing 100 passengers per hour.

- Secondary processing provides exam podiums equipped with either baggage belts or x-ray machines as well as passenger waiting areas. Approximately 5% of total passengers clearing primary processing are directed to secondary screening, where 50% of those undergo in-depth inspections of their possessions and paperwork.

- Checked baggage security screening is done within the FIS area using four EDS machines with a combined throughput rate of 390 bags per hour per machine.

- Requirements for aircraft gates, baggage claim, and passenger security screening within the FIS were developed using the same assumptions that are described in each processes individual section previously in this Technical Memorandum.

Table C-1 summarizes the required facilities within the FIS. At present, there are three aircraft gates—two narrowbody and one widebody—at the end of Concourse B that provide simultaneous aircraft parking positions with secure connectivity to the FIS. If there are not any widebody aircraft parked at the Airport, there are four narrowbody gates available. It is anticipated that a second widebody gate will be needed in PAL 1 and a total of four gates—two narrowbody and two widebody—in PAL 3.

The Airport currently provides five booths and 2,885 square feet of passenger queuing area to facilitate primary immigration inspection. While the overall number of booths appears to be sufficient, Authority feedback and field observation indicate that during peak periods the queuing area, which can accommodate approximately 300 - 350 passengers, is not able to meet the passenger demand. It is recommended that additional queuing area be provided for passengers awaiting primary screening prior to PAL 1.

The FIS currently has a single baggage carousel that provides approximately 190 linear feet of retrieval frontage. It is estimated that the Airport provide 200 linear feet of baggage claim frontage for existing operations and 300 linear feet at PAL 3. The overall baggage claim area, which today occupies 2,710 square feet, is projected to become deficient at PAL 3, when 2,900 square feet will be required. Based on the projected international passenger volumes, secondary screening facilities are sufficient throughout the planning period.

In addition to the immigration functions accommodated within the FIS, the TSA also performs passenger and checked baggage security screening inside the FIS. Because of the FIS's location at the end of Concourse B, all arriving international passengers, regardless of destination, are required to pass through security screening at the FIS. The two lanes currently provided will become insufficient at PAL 3, when a third lane will be needed. Arriving international passengers connecting on to other flights also must re-check their baggage at the FIS, where the TSA screens it using EDS machines. At PAL 3, one additional EDS machine will be required to accommodate projected baggage volumes needing re-screening.

Based on Authority input and field observation, the current space allocated to the TSA does not provide for sufficient queuing space for passengers waiting to both drop their baggage and undergo re-screening themselves. The current facility, which was designed and constructed before more stringent security requirements were in place, does not provide enough space for TSA operations. During peak periods, passengers can experience delays at both baggage and passenger re-screening, and so it is recommended that additional space be allocated for the TSA in the FIS at current levels of aviation activity.

It is important to note that FIS requirements are extremely sensitive to the timing of international flights at the Airport. Relatively small changes in airline flight schedules that cause arriving international flights to overlap can significantly increase facility requirements within the FIS in order to maintain the levels of service assumed in this analysis.

CONCOURSE CIRCULATION

Field observation and input from Authority staff identified congestion for pedestrian circulation on Concourse B as an area of concern. Passenger flows on Concourse B experience concentrated bursts of activity during Northwest Airlines' connecting banks. During a typical bank, each gate on the concourse may accommodate an arriving flight and a departing flight within a period of ninety minutes or less. This concentrated activity pattern combined with relatively narrow corridor widths can result in high levels of congestion and degraded level of service.

Specific congestion points on Concourse B are located at the base of the concourse near gate B1, and at the base of the two "legs" near gates B27 and B9. The measured corridor widths at these locations are 20 feet and 14 feet, respectively. The effective corridor widths—i.e. widths actually used when passengers maintain a clearance from enclosing walls and a buffer zone between opposing flows—are even narrower. For two-way corridors, the effective width is typically 4.5 feet narrower than the actual width. A high-level assessment of potential passenger flow volumes that could result if every gate on Concourse B accommodated one gate turn in a 60 minute period indicated that these corridors would likely operate at a level-of-service "D" under these conditions.

INFRASTRUCTURE

A comprehensive assessment of the current condition, capacity, and age of mechanical, electrical, and plumbing systems within the passenger terminal building was prepared concurrent with the inventory for the Master Plan Update. This assessment, coupled with anecdotal information from Authority staff, concluded that several basic building systems (1) are currently operating at or above their functional capacities; (2) have components that require heavy maintenance, overhaul, or replacement; and/or (3) will restrict future additions to the building without simultaneously upgrading the capacity of the system in question.

Table C-2 provides a summary of the current capacities and useful life remaining of various building systems evaluated for the Master Plan Update by area of the Passenger Terminal. Estimates for each region of the passenger terminal were developed by looking holistically at the pieces of each system that provide service to that area. The aggregate numbers presented in Table C-2, which provide a high-level overview of the findings, may not convey limitations of each specific component within the system.

As shown in Table C-2, mechanical systems providing ventilation air for Concourses A and B are operating at 94% at 102% of their functional capacities, respectively, and are beyond the end of their useful lives. Additionally, plumbing systems providing fresh water to all parts of the passenger terminal and sewer systems in Concourse A are operating significantly above their functional capacities. Other systems, such as the electrical for Concourse C, ventilation in the terminal processor, and hot water in Concourses A and C, are all operating above 90% of their functional capacities. It is estimated that the cost to replace equipment currently operating beyond its recommended service life is approximately $9.0M.

The findings of the infrastructure assessment will be incorporated in the alternatives analysis that will determine the scope and timing of future improvements in later phases of the Master Plan Update.

Table C-2

SUMMARY OF PASSENGER TERMINAL INFRASTRUCTURE ASSESSMENT
Master Plan Update
Memphis International Airport

	Current system capacity (%) *(a)*	Useful life remaining *(b)*
Electrical System		
Terminal *(c)*	50%	5
Concourse A	60	13
Concourse B	67	13
Concourse C	94	13
Mechanical—Ventilation Air		
Terminal *(c)*	98%	15
Concourse A	94	--
Concourse B	102	--
Concourse C	102	15
Mechanical—Chilled Water		
Terminal *(c)*	88%	5
Concourse A	95	5
Concourse B	89	25
Concourse C	80	25
Central Plant	88	6
Mechanical—Hot Water		
Terminal *(c)*	85%	10
Concourse A	95	10
Concourse B	82	40
Concourse C	90	10
Central Plant	85	5
Plumbing—Domestic Water		
Terminal *(c)*	125%	15
Concourse A	125	15
Concourse B	125	15
Concourse C	125	15
Plumbing—Sanitary Sewer		
Terminal *(c)*	70%	15
Concourse A	150	15
Concourse B	70	15
Concourse C	70	15

(a) System capacities estimated based on the performance of individual system components.
(b) Useful life remaining calculated based on accepted industry standards and professional judgment, when applicable.
(c) Terminal includes the entirety of the main terminal building at all levels.

Source: Allen & Hoshall, Inc., June 2008.

Technical Memorandum–D

GROUND TRANSPORTATION AND PARKING

The following summarizes estimated requirements for vehicular circulation, curbsides, parking, and rental car facilities at the Airport. These requirements were developed based on data collected during the preparation of the inventory, anecdotal information from Authority staff, experience at comparable airports, previous studies commissioned by the Authority, and the expectation that the Airport would strive to provide a high level-of-service throughout the planning period.

AIRPORT ACCESS

At present, primary access to the Airport is provided by Plough Boulevard, which connects to Interstate 240, and Winchester Road, a major east-west arterial roadway that bisects the Airport campus. Additionally, FedEx air cargo facilities on the northern side of the Airport are served by Tchulahoma Road, which also connects to Interstate 240. These access corridors, the majority of which are under the jurisdiction of various state and local governments, suffer from congestion issues during peak periods, particularly at the key intersections of Plough Boulevard/Winchester Road/Airways Blvd and Democrat Road/Tchulahoma Road.

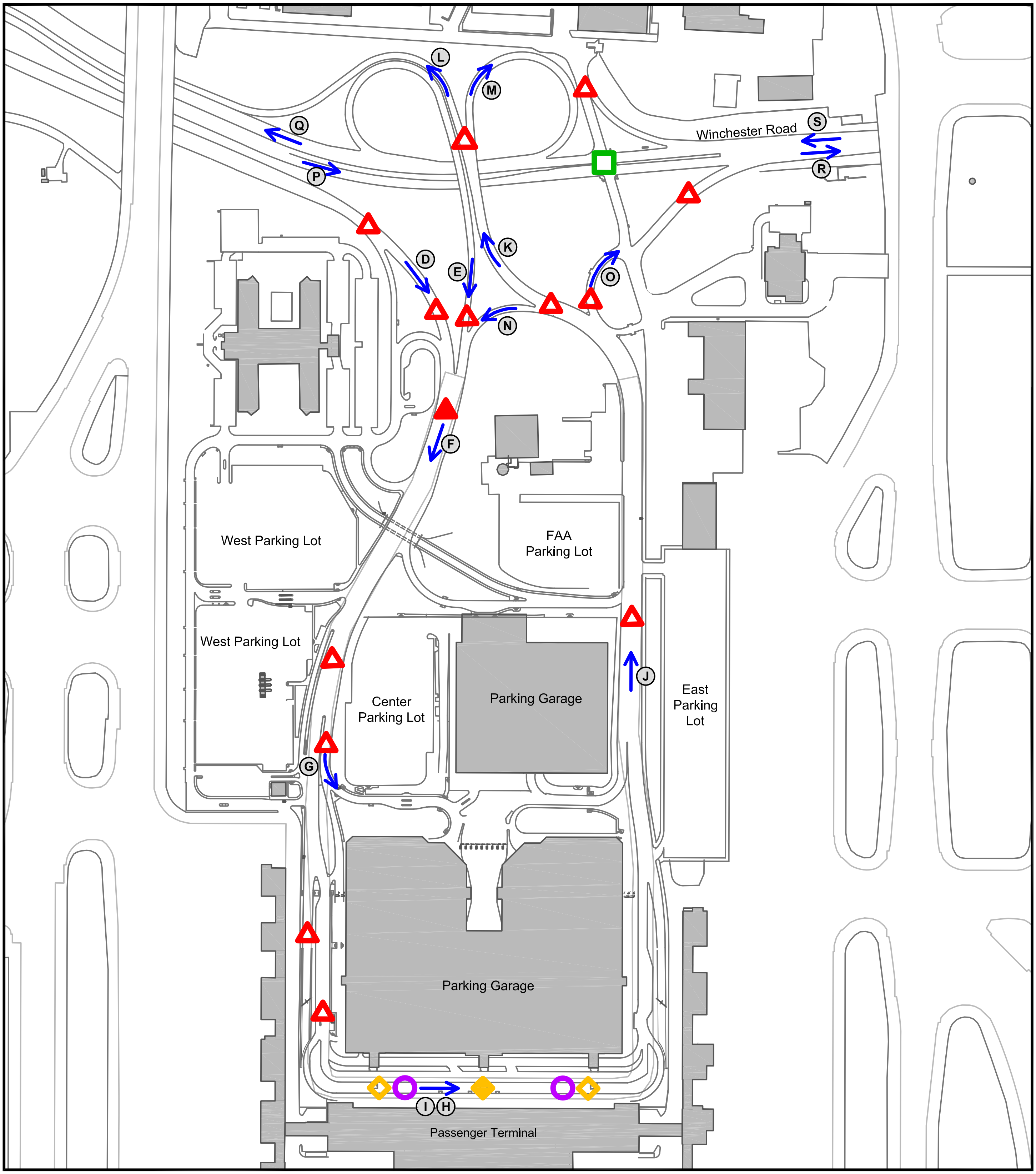
PASSENGER TERMINAL CIRCULATION ROADWAYS AND INTERSECTIONS

The following section presents analyses of roadway and intersection capacities for key access facilities serving the passenger terminal area.

Roadway Links

Passenger terminal circulation roadway requirements are based on an analysis of current and projected design-hour traffic volumes for individual roadway links as shown on Figure D-1. For each roadway link, the projected design-hour volume was compared to the assumed hourly link capacity to determine whether an acceptable level-of-service is and will continue to be provided. Using traffic counts obtained during February 2008, peak month (May) volumes were estimated using a comparison of historical traffic volumes entering and exiting the terminals area during an off-peak month (January) versus May.

Projected traffic volumes for future PALs were calculated assuming that roadway traffic in the terminal area would increase at the same growth rate as originating enplanements. Future volumes also include the planned addition of rental car ready and return traffic on selected roadway links within the passenger terminal. These volumes were taken from the Draft *Surface Traffic Model Working Paper* published by Jacobs Consultancy in December 2009.



LEGEND

- Traffic volume count [February 2008]
- Traffic volume count [2005 and 2007]
- Turning movement count [February 2008]
- Vehicle classification survey [February 2008]
- Pedestrian survey [February 2008]
- Dwell time survey [February 2008]
- Traffic volume link location
- Link identifier [see Table D-1]

N

0 200' 400' 800'

Figure D-1

DATA COLLECTION LOCATIONS
PASSENGER TERMINAL COMPLEX

Master Plan Update
Memphis International Airport
December 2009

JACOBS CONSULTANCY

For Winchester Road, which serves high volumes on non-Airport traffic, all traffic was assumed to grow at the same rate as originating enplanements. This was determined to be a conservative assumption since, as described in the MPO's *Memphis Long-Range Transportation Plan*, regional population (and therefore traffic) is expected to increase at an average annual growth rate of between 1% and 1.4% (which is lower than the projected average annual growth for originating enplanements at the Airport). Table D-1 summarizes the existing and projected traffic volumes for roadway links in the passenger terminal area. Links H and I, which are not included in Table D-1, represent the curbside roadways and are discussed separately in this Technical Memorandum.

For each link, for each PAL, roadway volumes were compared to the existing capacity to calculate a volume/capacity ratio that is indicative of level-of-service. For all the roadways in the passenger terminal area, a volume/capacity ratio of 0.6 or lower indicates that roadways are performing at an acceptable level-of-service—during peak periods, traffic flows smoothly but vehicles are traveling close together and individual motorists find it more difficult to change lanes without other motorists' cooperation in providing a gap. This volume/capacity ratio threshold reflects a more-stringent standard than may be used for typical urban transportation planning because for roadways used by airline passengers, the potential result of congestion is that a passenger may miss their flight whereas a driver not trying to meet a flight may only be a few minutes late for work.

As shown in Table D-1, most of the existing roadways in the passenger terminal area should have sufficient capacity to provide an acceptable level-of-service through PAL 3. The return-to-terminal road (Link N) is expected to require a second lane by PAL 3 and the road for traffic leaving the terminal area to westbound Plough Boulevard (Link L) is expected to require a second lane by PAL 3.

Traffic Signals

Capacity and level-of-service on Winchester Road will be affected by the signalized intersection at Winchester Road and Cargo Road. Using turning movement counts collected during February 2008, the hour experiencing the highest total volume through the intersection was identified. These volumes were then adjusted to peak month estimated volumes (using the method described above) and increased at the same rate as originating enplanements to the establish the volumes associated with the future PALs. For 2008 and each PAL, a planning-level analysis was conducted for the intersection using a "critical lane" method prescribed in the *Highway Capacity Manual*. This method calculates the critical conflicting movements at the intersection to estimate the volume/capacity ratio for the intersection. Using this method, an analyst can identify if and when the activity at the intersection will become sufficient to warrant a capacity increase for the intersection, such as adjustments to geometry or signal cycle timing.

Table D-1

PASSENGER TERMINAL AREA ROADWAY REQUIREMENTS
Master Plan Update
Memphis International Airport

		Peak-hour volume (vehicles/hour) *(b)*				Existing capacity		Required number of lanes			
Link *(a)*	Description	Existing (2008)	PAL 1 (2012)	PAL 2 (2017)	PAL 3 (2027)	Lanes	Vehicles per hour	Existing (2008)	PAL 1 (2012)	PAL 2 (2017)	PAL 3 (2027)
D	Ramp -- Winchester Road EB to Terminal Roadway	800	950	1,080	1,370	2	3,200	2	2	2	2
E	Ramp -- Winchester Road WB to Terminal Roadway	90	110	130	160	1	1,000	1	1	1	1
F	Terminal Roadway -- inbound adjacent to hotel	1,150	1,350	1,530	1,950	5	5,000	5	5	5	5
G	Ramp -- Terminal Roadway to short- and long-term parking in garage	400	460	520	660	2	1,600	2	2	2	2
J	Terminal Roadway -- outbound adjacent to new garage	1,330	1,460	1,650	2,100	4	4,000	4	4	4	4
K	Terminal Roadway -- outbound bridge over Winchester Road	810	970	1,100	1,400	2	3,200	2	2	2	2
L	Ramp -- Terminal Roadway to WB Plough Blvd	680	810	910	1,160	1	1,600	1	1	1	*[2]*
M	Ramp -- Terminal Roadway to WB Winchester Road	130	170	190	240	1	1,000	1	1	1	1
N	Ramp -- Terminal Roadway outbound return to airport	430	510	580	740	1	600	1	1	1	*[2]*
O	Ramp -- Terminal Roadway outbound to Winchester Road EB	120	150	170	210	1	600	1	1	1	1
P	Winchester Road EB -- after terminal access ramp *(c)*	1,250	1,430	1,620	2,060	3	6,000	3	3	3	3
Q	Winchester Road WB -- after terminal access ramp *(c)*	1,390	1,580	1,790	2,270	3	6,000	3	3	3	3
R	Winchester Road EB -- after terminal outbound ramp *c)*	1,350	1,540	1,750	2,220	4	8,000	4	4	4	4
S	Winchester Road WB -- before terminal access ramp *(c)*	1,380	1,570	1,780	2,270	3	6,000	3	3	3	3

Note: Lane requirements in brackets indicate that a lane has been added to maintain the desired volume/capacity ratio.

(a) See Figure D-1.
(b) Volumes for PALs 1-3 assume that rental car activity is relocated into the new parking garage.
(c) Capacity and level-of-service is also affected by signalized intersection at Winchester Boulevard and Cargo Road.

Source: Jacobs Consultancy, December 2009.

Using this method, it was determined that the intersection of Winchester Road and Cargo Road currently operates at a volume/capacity ratio of 0.53. By PAL 1, the ratio is 0.60 and by PAL 2, the ratio is 0.67, neither of which typically require mitigation. By PAL 3, however, the volume capacity ratio reaches 0.86, which is sufficiently close to capacity to warrant the consideration of physical and/or operational strategies to increase the capacity of the intersection.

NON-TERMINAL AREA ROADWAYS AND INTERSECTIONS

The following section presents analyses of roadway and intersection capacities for key access facilities located on the perimeter of the Airport, including.

On-Airport Roadway Links

On-Airport roadway requirements for non-terminal-area roadways are based on an analysis of current and projected design-hour traffic volumes for individual roadway links. As shown on Table D-2, for each roadway link, the projected design-hour volume was compared to the assumed hourly link capacity to determine whether an acceptable level-of-service is and will continue to be provided. For Democrat Road and Swinnea Road, where Airport cargo-related traffic comprises a high share of total traffic, February 2008 traffic volumes were escalated for future PALs assuming that roadway traffic would increase at the same growth rate as annual air cargo tonnage. For Louis Carruthers Drive, where Airport support-related traffic comprises a high share of total traffic, February 2008 traffic volumes were adjusted to reflect peak month (May) conditions and escalated for future PALs assuming the same growth rate as passenger-related aircraft operations.

For each link, for each PAL, roadway volumes were compared to the existing capacity to calculate a volume/capacity ratio that is indicative of level-of-service. For all the roadways not in the passenger terminal area, a volume/capacity ratio of 0.8 or lower indicates that roadways are performing at an acceptable level-of-service—during peak periods, a driver's ability to maneuver is restricted and travel speed is reduced, but conditions are not unacceptable for commuting traffic and minor disruptions to traffic flow can still be accommodated without significant reduction in service. This volume/capacity ratio threshold reflects a standard often used in urban transportation planning for roadways serving a high share of commuting traffic during peak hours.

As shown in Table D-2, by PAL 1, eastbound Democrat Road, near Plough Road, will require a third lane to maintain the desired level of service. By PAL 3, both directions of Democrat Road, near Tchulahoma Road, will require a third lane to maintain the desired level of service(these findings are consistent with the conclusions of the MPO, which has recommended that Democrat Road, between Airways Boulevard and Tchulahoma Road, be widened to three lanes in each direction). It should also be noted that the level of service and congestion on Democrat Road is also governed by conditions at the traffic signals at the intersections of Democrat Road and Plough Road, and Democrat Road and Tchulahoma Road; these signals are discussed below.

Table D-2

NON-TERMINAL AREA ROADWAY REQUIREMENTS
Master Plan Update
Memphis International Airport

	Peak-hour volume (vehicles per hour)								Existing capacity				Required number of lanes							
	Existing (2008)		PAL 1 (2012)		PAL 2 (2017)		PAL 3 (2027)		Lanes *(b)*		Vehicles per hour		Existing (2008)		PAL 1 (2012)		PAL 2 (2017)		PAL 3 (2027)	
Link description	WB/ NB	EB/ SB	WB/ NB	EB/ SB	WB/ NB	EB/ SB	WB/ NB	EB/ SB	WB/ NB	EB/ SB	WB/ NB	EB/ SB	WB/ NB	EB/ SB	WB/ NB	EB/ SB	WB/ NB	EB/ SB	WB/ NB	EB/ SB
Democrat Road, east of Plough Blvd *(c)*	970	1,510	1,110	1,730	1,240	1,950	1,480	2,310	2	2	2,000	2,000	2	2	2	[3]	2	3	2	*3*
Democrat Rd, west of Tchulahoma Rd *(d)*	1,130	1,080	1,290	1,240	1,450	1,400	1,720	1,660	2	2	2,000	2,000	2	2	2	2	2	2	[3]	[3]
Louis Carruthers Dr, north of Shelby Dr *(e)*	160	330	170	350	180	360	200	400	1	1	700	700	1	1	1	1	1	1	1	1
Swinnea Road, north of Shelby Dr. *(f, g)*	410	420	470	480	530	540	630	640	2	2	2,000	2,000	2	2	2	2	2	2	2	2

Note: Lane requirements in brackets indicate that a lane has been added to maintain the desired volume/capacity ratio.

(a) See Figure D-1.
(b) Lane count does not include dedicated turn lanes.
(c) Capacity and level-of-service is also affected by signalized intersection at Democrat Road and Tchulahoma Road.
(d) Capacity and level-of-service is also affected by signalized intersection of Democrat Road and the Plough Road ramps.
(e) Capacity and level-of-service is also affected by signalized intersection at Louis Carruthers Drive and Shelby Drive.
(f) Traffic volumes are based on July 2008 traffic counts provided by Tennessee Department of Transportation.
(g) Capacity and level-of-service is also affected by signalized intersection at Swinnea Road and Shelby Drive.

Source: Jacobs Consultancy, September 2008.

Perimeter Roadway Links

Roadways along the perimeter of the Airport, including Airways Boulevard and Shelby Drive, experience high volumes of non-Airport traffic and future conditions on these links will likely be governed by regional traffic growth. Based on the MPO's *Memphis Long-Range Transportation Plan*, which analyzed existing and future needs for roadways throughout the Memphis region, no immediate needs were identified for Airways and Shelby Drive.

Traffic Signals

Capacity and level-of-service on Democrat Road and Swinnea Road will be affected by signalized intersections. Using turning movement counts collected during February and July 2008, the hour experiencing the highest total volume through each intersection was identified. For Democrat Road, these volumes were then adjusted to peak month estimated volumes (using the method described above) and increased at the same rate as air cargo tonnage to the establish the volumes associated with the future PALs. For Swinnea Road, traffic turning from or onto Swinnea was increased at the same rate as air cargo tonnage while all other traffic was increased at 1% per year (to reflect regional traffic growth). For 2008 and each PAL, a planning-level analysis was conducted for the intersection using a "critical lane" method described above in the discussion of terminal-area traffic signals.

Democrat Road and Plough Road. Based on the February 2008 traffic counts, 7:45 a.m. to 8:45 a.m. was identified as the peak hour for this intersection. For February 2008 it was determined that the intersection operated at a volume/capacity ratio of 0.37 (the existing configuration allows eastbound and northbound right turns to avoid the traffic signal). By PAL 1 the ratio is expected to be 0.49, by PAL 2 the ratio is expected to be 0.55, and by PAL 3, the ratio is expected to be 0.66. Based on these results, no significant improvements are required for this intersection through PAL 3.

Democrat Road and Tchulahoma Road. Based on the February 2008 traffic counts, 7:30 a.m. to 8:30 a.m. was identified as the peak hour for this intersection. For February 2008 it was determined that the intersection operated at a volume/capacity ratio of 0.77. By PAL 1 the ratio is expected to be 0.83, by PAL 2 the ratio is expected to be 1.03, and by PAL 3, the ratio is expected to be 1.30. It should also be noted that there may be other peak hours (such as during a shift change at FedEx) where peak volumes for one particular movement may be significantly higher than during the intersection peak hour. For example, during the intersection peak hour, eastbound traffic totaled approximately 470 vehicles. Based on traffic counts conducted one week later near this intersection, peak eastbound traffic totaled approximately 1,500 vehicles. In such cases, congestion may occur at the intersection because the peak volume for the critical movement may not be able to be accommodated within the available capacity of the signal. Field observations at this intersection have confirmed that significant levels of congestion occur at this traffic signal during the afternoons.

Based on these results, geometric or operational improvements may be required by PAL 1 for the peak hour of the intersection to operate at an acceptable level of service. However, such improvements are likely justified today, as evidenced by field observations of congestion and high eastbound traffic volumes occurring during the afternoon.

Swinnea Road and Shelby Drive. Based on the February 2008 traffic counts, 3:45 p.m. to 4:45 p.m. was identified as the peak hour for this intersection. For February 2008 it was determined that the intersection operated at a volume/capacity ratio of 0.72. By PAL 1 the ratio is expected to be 0.78, by PAL 2 the ratio is expected to be 0.84, and by PAL 3, the ratio is expected to be 0.97. Based on these results, by PAL 2, geometric or operational improvements may be required for this intersection to operate at an acceptable level of service.

REGIONAL PLANNING EFFORTS

To address congestion issues, the Memphis Area Metropolitan Planning Organization (the MPO) has recommended improvements to the following components of the regional access system in the vicinity of the Airport.

- Democrat Road, between Airways Boulevard and Tchulahoma Road
- Interchange of I-240 and Plough Boulevard
- Intersections of Winchester Road and Airways Boulevard, and Winchester Road and Plough Boulevard
- Winchester Road, between Plough Boulevard and Swinnea Road

The continued development and eventual implementation of these roadway improvement projects are important to ensuring adequate access is provided to both the passenger terminal complex as well as other aviation-related developments surrounding the Airport. Airport development alternatives should reflect and incorporate, as necessary, these improvements recommended by the MPO.

CURBSIDE FACILITIES

The terminal curbside is configured in a two-level arrangement, with departing passengers dropped off on the upper level outside the ticketing lobbies and arriving passengers picked up on the ground level. The upper-level roadway has two separate three-lane roadways while the ground-level roadway three separate roadways, each with two or three lanes.

Design-hour traffic volumes, determined using the approach described for other roadway links, were generated for the ground- and upper-level curbsides at each PAL. Data from field observations were also used to determine (1) a vehicle fleet mix, indicating the relative proportions of different vehicle modes (private auto, taxi, etc) within the design hour; (2) vehicle dwell times by mode; and (3) the amount of time that pedestrians using crosswalks on both levels that connecting to outer curbsides and the parking garage restrict the free flow of vehicular traffic on curbside roadways. Using these data, requirements for the enplaning and deplaning curbsides were determined based on the following assumptions and guidelines:

- Vehicular fleet mix, dwell times, stand requirements (the length of curb required for a vehicle to stop and load/unload passengers and baggage), and pedestrian activity will remain consistent throughout the planning period.

- For the inner lanes of the upper and ground level, approximately two thirds of all traffic is assumed to use the Terminal B (primarily Northwest Airlines) curbsides. This estimate is based on Northwest Airlines' overall market share of approximately 80% of enplaned passengers, adjusted to reflect that, during the upper- and ground-level curbside peak periods, other carriers probably have a larger share of traffic than they do during the middle of the day.

- Curbsides will be long enough to satisfy parking demand 95% of the time during the design hour, based on a Poisson distribution of the average demand, at demand-capacity ratio of 1.0 or better. This assumes continued use of the existing three-lane curbside roadways and active and visible enforcement to ensure that drivers do not double-park to load or unload.

- Curbside roadways will meet volume demand at a demand-capacity ratio of 0.6 or better.

Table D-3 summarizes the required curbside length throughout the planning period. At present, approximately 1,650 linear feet of curbside on the upper level and 2,500 linear feet on the ground level are available for active unloading/loading of passengers and baggage and is adequate for current activity levels.

Table D-3

CURBSIDE REQUIREMENTS
Master Plan Update
Memphis International Airport

	Existing	Estimated requirement Baseline (2007)	PAL 1 (2012)	PAL 2 (2017)	PAL 3 (2027)
Upper (departures) level					
Inner lanes *(a)*					
Curbside length (feet)—total	825	375	425	475	575
Curbside length (feet)—Terminal B only *(b)*	370	275	300	350	425
Number of lanes *(c)*	3	3	3	4	4
Outer lanes *(d)*					
Curbside length (feet)—total	825	200	270	270	330
Number of lanes *(c)*	2	2	2	2	2
Ground (arrivals) level					
Inner lanes *(e)*					
Curbside length (feet)—total	810	400	450	475	600
Curbside length (feet)—Terminal B only *(b)*	370	275	325	350	425
Number of lanes *(c)*	3	3	3	4	4
Middle lanes					
Rental car shuttle curb (feet) *(f)*	--	350	--	--	--
Taxi curb (feet)	--	80	100	100	120
Hotel/motel shuttle curb *(f)*	--	180	270	270	270
Total length (feet)	840	610	370	370	370
Number of lanes *(c)*	2	2	2	2	2
Outer lanes					
Pre-arranged limousines (feet)	--	30	30	30	30
Airport parking shuttle (feet) *(f)*	--	90	90	90	90
Off-Airport parking shuttle (feet) *(f)*	--	180	180	240	300
Employee parking shuttle (feet) *(f)*	--	90	90	90	90
Charter bus (feet)	--	80	80	80	80
Public transit (feet)	--	50	50	50	50
Other (feet) *(g)*	--	60	60	60	60
Total length (feet)	855	580	580	640	700
Number of lanes *(c)*	2	2	2	2	2

(a) Upper level inner lanes primarily serve private vehicles and taxis.
(b) Assumes Terminal B experiences two thirds of the total traffic during the morning and afternoon peak hours.
(c) Number of combined parking and travel lanes needed to meet demand at acceptable level-of-service.
(d) Upper level outer lanes serve all commercial vehicles except taxis. All modes, except charter buses, are assumed to make two stops along the curbside.
(e) Ground level inner lanes serve private vehicles only.
(f) Modes make two stops along the curbside. Rental car shuttles make two stops along the curbside. Prior to PAL 1, new rental car facilities will be open within the terminal complex, eliminating the need for passenger shuttles.
(g) Includes Airport and police vehicles as well as shuttles for FedEx and FBOs.

Source: Jacobs Consultancy, September 2008.

On the upper level, while overall existing inner curbside is expected to be able to accommodate total demand through PAL 3, demand for the Terminal B curb is expected to exceed capacity soon after PAL 2. At PAL 2, traffic volumes using the upper level curbside roadway inner lanes will require a fourth lane to operate at an acceptable level-of-service. The need for this lane could be reduced by: (1) encouraging drivers of private vehicles to drop off passengers on the outer curbside; (2) encouraging passengers bound for Terminal B to use curbside in front of Terminals A or C; or (3) using the short-term parking area in the garage. Additionally, the current enforcement strategy, where traffic officers actively control pedestrian crossings to minimize the delay for drivers, should be maintained.

On the upper level outer curbside, the existing roadway is expected to be able to accommodate demand through PAL 3. Sufficient capacity is available that a portion of traffic currently using the inner curbside could also be accommodated on the outer curbside.

On the ground level, similar to the projections for the upper level, while the existing inner curbside is expected to be able to accommodate total demand through PAL 3, demand for the Terminal B curb is expected to exceed capacity soon after PAL 2. At PAL 2, traffic volumes using the ground level curbside roadway inner lanes will need a fourth lane to operate at an acceptable level-of-service. The need for this lane could be reduced by (1) encouraging drivers of private vehicles to pick up passengers on the outer curbsides; (2) encouraging drivers bound for Terminal B to use curbside in front of Terminals A or C; or (3) using the short-term parking area in the garage. In addition, it is suggested that traffic officers seek to actively control pedestrian crossings to minimize the delay for drivers.

On the ground level middle lanes, used exclusively by commercial vehicles, curbside capacity will begin far outpacing demand once rental car shuttle activity is made obsolete by the opening of new parking garage with close-in rental car ready and return spaces. On the ground level outer lanes, also used exclusively by commercial vehicles, the existing curbside is expected to be long enough to meet demand through PAL 3.

PARKING

The Authority operates parking facilities in various locations on-Airport for both the traveling public and Airport employees. The following paragraphs describe future requirements for vehicular parking throughout the planning period.

Public Parking

Currently, the Authority provides a total of 4,425 public parking spaces: 2,750 in the parking garage, 975 in the Center surface lot, and 700 in the West surface lot. The Authority is planning to construct a 4,250-space parking garage (of which 2,750 spaces would be used for public parking) on the site of the current Center surface lot and develop a new 1,000-space East surface lot for public parking use during the construction period. Once the planned garage is completed, the Airport will provide 6,195 public-parking spaces. Off-Airport, three private lots provide an additional 2,270 spaces with regular shuttles from the lots to the terminal buildings.

Table D-4 presents the estimated public parking requirements through PAL 3. Public parking requirements are presented for:

- **Design day demand –** Used to estimate future needs for permanent parking facilities (i.e., parking structures or paved surface lots intended exclusively for public parking), "design day" parking demand is based on the observed peak parking occupancy for the 30th busiest day during 2007 and is expected to increase at a rate proportional to the increase in annual origin and destination (local) passengers. For PALs 1, 2, and 3, the "design day" requirements for long-term parking reflect the Authority's goal to increase the share of long-term parking accommodated in Airport-operated parking facilities. Thus, long-term parking requirements assume that off-Airport parking facilities will continue to meet their existing demand, but all future growth in that demand will be accommodated in Airport-operated parking facilities. Design day parking requirements also include a 10% circulation factor to account for a typical parker's inability to locate the last available spaces in a parking facility.

- **Holiday/overflow demand –** Used to estimate future needs during particularly busy holiday travel periods, holiday/overflow demand is based on the highest observed occupancy in 2007 and is expected to increase at a rate proportional to the increase in annual origin and destination (local) passengers. Holiday/overflow demand does not include a circulation factor and is calculated as the difference between the future busiest day demand and the future design day demand. Often, holiday/overflow demand that can not be accommodated in permanent parking facilities can be accommodated in temporary surface lots or within parking facilities usually reserved for other uses (such as employee parking).

Table D-4

PARKING REQUIREMENTS
Master Plan Update
Memphis International Airport

		Estimated requirement			
	Existing *(a)*	Baseline (2007)	PAL 1 (2012)	PAL 2 (2017)	PAL 3 (2027)
Public parking					
Design day *(b)*					
Short-term *(c)*	870	900	1,000	1,100	1,450
Long-term *(d)*	5,325	3,200	4,000	4,800	6,700
Total	6,195	4,100	5,000	5,900	8,150
Holiday/overflow	--	20	25	30	40
Off-Airport demand	2,270	2,270	2,270	2,270	2,270
Employee parking *(e)*					
"Design day" *(b)*	3,150	1,700	1,850	1,950	2,250

(a) Existing public parking capacities include 2,750 spaces of the planned parking garage and the 1,000-space East Lot.
(b) Includes a 10% circulation factor to account for a parker's inability to locate available spaces in a facility approaching capacity.
(c) Demand currently accommodated in the short-term areas of the existing parking garage.
(d) Demand currently accommodated in the long-term areas of the existing parking garage and Center and West surface lots. PAL 1, 2, and 3 demand includes future growth in demand currently accommodated off-Airport.
(e) Authority-controlled employee parking facilities only. Does not include major employee parking facilities operated by FedEx and other large tenants.

Source: Jacobs Consultancy, December 2009.

- **Off-Airport demand –** Currently, approximately 2,270 off-Airport public parking spaces are utilized in conjunction with the on-Airport parking facilities to meet Airport-related parking demand. Demand for these spaces is expected to increase at a rate proportional to the increase in annual origin and destination (local) passengers. It is assumed that off-Airport operators will continue to meet their existing demand, but that future growth in that demand will be included in the Airport's "design day" demand for long-term parking due to the Authority's goal to increase the market share of parking accommodated in on-Airport parking facilities.

As shown in Table D-4, short-term baseline parking demand in the existing parking garage currently exceeds the currently allocated capacity. Presently, overflow short-term demand is currently directed to park in other areas of the garage during peak periods. Short-term parking demand during the "design day" is expected to grow from 900 spaces at the baseline to 1,450 spaces at PAL 3.

Long-term parking demand, after the planned completion of the new parking garage, will have sufficient capacity through PAL 2, but will require additional capacity by PAL 3. Approximately 4,000 public parking spaces will be required at PAL 1 and 6,700 at PAL 3. As shown in Table D-4, the "holiday/overflow" demand is an additional 20 spaces at the baseline level and an additional 40 spaces at PAL 3.

Employee Parking

The Authority operates employee parking facilities in a portion of the West Lot within the passenger terminal complex as well as in a remote lot on Democrat Road. In total, there are approximately 3,150 spaces dedicated to employee parking at the Airport. The lot is used by Authority and staff based primarily in the passenger terminal area but not by other major on-Airport employers (i.e. FedEx or UPS). The observed typically busy-day occupancy during 2007 was approximately 1,700 spaces.

Future employee parking requirements, presented in Table D-4, are based on observed occupancy for the 30th busiest day in 2007 and include a 10% circulation factor. Growth in the employee parking demand is assumed to increase at the average annual growth rates for (1) total passenger enplanements and (2) passenger aircraft operations. As shown in Table D-4, the existing supply of employee parking spaces is sufficient to accommodate the approximately 2,250 employee spaces required at PAL 3.

RENTAL CAR FACILITIES

Requirements for rental car facilities are based on (1) existing activity of the rental car operators currently serving the Airport; (2) survey responses from individual rental car companies describing spatial and functional needs; (3) industry standards for rental car operations; and (4) assumptions regarding the future configuration of the rental car facilities. Requirements for future PALs are based on the projected growth of origin and destination (local) enplaned passengers.

At present, seven rental car brands operate from on-Airport property on Democrat Road and one brand operates from an off-Airport site on Airways Boulevard. In total, the eight companies use approximately 25 acres of land for current operations. It is assumed that that all eight companies will begin operating from a consolidated ready/return area located close to the passenger terminals with quick turn-around (QTA) space located adjacent to, or with walking distance of, the ready/return area. In the event that the rental car customer, vehicle, and service areas are configured differently, the estimated sizes for each individual component could change. However, the overall area required for the entire operation would be consistent to the total requirement presented in Table D-5.

Table D-5

RENTAL CAR REQUIREMENTS
Master Plan Update
Memphis International Airport

		Estimated requirement			
	Existing *(a)*	Baseline (2007)	PAL 1 (2012)	PAL 2 (2017)	PAL 3 (2027)
Customer area					
Customer counters	--	34	36	39	49
Ready/return area (stalls)	--	1,100	1,200	1,400	1,700
Equivalent total area (acres)	--	9	10	12	14
Quick turn-around (QTA) facilities					
Fuel nozzles	--	46	50	60	70
Car washes	--	10	10	11	12
Vehicle stacking (spaces) *(b)*	--	280	300	360	420
Vehicle staging (spaces) *(c)*	--	1,450	1,600	1,810	2,280
Equivalent total area (acres)	--	8	9	10	13
Total area (acres)					
Customer facility	--	9	10	12	14
Quick turn-around (QTA) facilities	--	8	9	10	13
Support service facilities *(d)*	--	19	21	24	30
Grand total area (acres)	25 *(a)*	37	40	46	57

(a) Quantities for existing rental car facilities, with the exception of the total site area, which is estimated for on- and off-Airport rental car companies, are not currently known and are not necessary, as future requirements assume transition to a consolidated facility.
(b) Area for vehicles queued for service at the fuel/wash area and immediate dispatch to the ready/return area.
(c) Area for vehicles to be serviced that are not needed immediately, but will be needed within a 24-hour period.
(d) Includes area for administration, maintenance, and overflow vehicle storage.

Source: Jacobs Consultancy, from transaction data provided by the Memphis-Shelby County Airport Authority and survey data from rental car companies, September 2008.

Table D-5 outlines the rental car requirements and details the size and timing of growth in future facilities. As shown, it is estimated that a consolidated rental car facility would currently require approximately 37 acres, including 9 acres (including 1,100 ready/return spaces) for customer facilities, 8 acres for QTA operations, and 19 acres for support service facilities, which could occur at a separate site than customer operations. At PAL 3, rental car facilities will require approximately 57 acres, including 14 acres (including 1,700 ready/return spaces) for customer facilities, 13 acres for QTA operations, and 30 acres for support service facilities, which could occur separately from the rest of the operation.

Technical Memorandum–E

AIR CARGO, GENERAL AVIATION, AND MILITARY

This Technical Memorandum provides an overview of airport facilities required to accommodate air cargo, general aviation, and military operations at Memphis International Airport (the Airport) throughout the planning period.

AIR CARGO

The following summarizes estimated air cargo facility requirements necessary to meet demand levels through the 20-year planning period. Estimated requirements are provided for warehousing/storage, aircraft parking, access and vehicle parking, and the size, configuration, and desired locations for land. Estimates are based on industry best practices related to cargo planning.

Because FedEx retains planning authority for their facilities, this Master Plan Update excludes planning related to this operator; accordingly, FedEx facility requirements are not included in this Technical Memorandum.

Overview

Unlike passengers, air cargo is indifferent to routing, number of stops, or type of aircraft used—so long as delivery deadlines are met. The area dedicated to air cargo operations and the efficiency with which it is used are often a matter of land availability rather than a determination based on mathematical formulas. For example, the air cargo facilities at New York's John F. Kennedy International Airport are about four times larger in land area than the facilities at Tokyo International Airport/Narita, even though the amount of air cargo shipped from each is similar.

In addition, air cargo can be processed in a variety of ways at an airport, especially considering the individual business practices of the integrated carriers. Such factors influence requirements for air cargo-related facilities. For example, UPS has a corporate strategy to minimize space leased at airports and, in most instances, transfers expedited freight containers through relatively small airport facilities to larger, off-airport facilities where cargo is sorted for delivery. While this strategy minimizes on-airport space requirements, relatively large aircraft parking and ground support equipment (GSE) maneuvering areas (as compared to indoor facility square footage) are essential to effective operations. Other carriers, such as FedEx (excluding their Memphis operations), decide whether to sort on- or off-airport on a case by-case basis and employ sophisticated planning software to determine the sort locations within city boundaries from which to most effectively serve the largest proportion of shipping customers.

Warehouse and storage space requirements vary significantly among the various types of air cargo operators. The activities that take place inside the cargo facility, the freight processing efficiency, and need for additional space to handle future freight volumes differ from operator to operator. For example, integrated carriers use warehouse facilities to sort packages and transfer/load trucks to deliver time-sensitive packages, while heavy-freight carriers use facility space for pallet building/breakdown and freight storage. The result is a significantly higher processing rate, and better facility utilization for integrated carriers. Anecdotally, a typical integrated carrier's warehouse is relatively empty, while a heavy freight carrier's warehouse will tend to be more "full," as pallets are built and stored before being loaded onto aircraft. An important derivative from the varying operations and levels of efficiency is the need for additional space or facility expansion to accommodate future freight volumes. Integrated carriers can accommodate regular increases in cargo volumes without significant additional facility space because of their superior efficiency. Additional personnel, conveyor belts, pickup/delivery vehicles, and staging areas for GSE, aircraft, or trucks can increase processing ability without major facility expansion. On the other hand, heavy-freight operators require incremental increases in warehouse space to accommodate increases in freight volume.

Cargo Warehouse and Storage Requirements

Including implementation of Cargo Central Phase I, the Airport includes approximately 336,000 square feet of cargo processing and warehouse space. This includes UPS's Oakhaven Distribution Center, a 300,000 square-foot sorting hub occupying 84 acres on the eastern side of the airfield adjacent to the intersection of Swinnea and Winchester Roads; and 36,000 square feet of warehouse space associated with Cargo Central.

Typical on-airport processing and warehouse space requirements primarily depend on the types of operators using the facility. The generally accepted cargo facility use ratio is between 0.75 and 1.25 annual tons per square foot of warehouse space. A 2006 planning document prepared for the Authority determined that the ultimate Cargo Central facilities could accommodate up to 282,000 annual tons of cargo, or a facility use ratio of the typical planning axiom of one annual ton per square foot.

Specific mention of UPS' operation at Memphis is warranted given the relatively large amount of warehouse space UPS currently occupies compared to the annual air cargo tonnage accommodated by UPS at the Airport—approximately 27,000 tons in 2007. UPS utilizes a majority of their existing warehouse space to process ground based activity. This freight is typically defined as outsized shipments and boxes that cannot traverse the typical sorting equipment and therefore require additional facility space. In addition, less time sensitive shipments are often stored in the warehouse until they can be included in a larger consolidation to be transported by either trucks or railcar. In most cases, ground activity is typically handled off-airport (for cost purposes) but UPS realizes synergies via combining ground and air cargo at it's Memphis facility. It should be noted that UPS has additional facility space throughout the Memphis region and will likely continue to route portions of future ground volumes over those facilities. To determine facility requirements, it is anticipated that UPS will require incremental increases in space to accommodate growth in both air and ground volumes throughout the planning horizon.

To determine specific requirements, a facility use ratio of 1.25 annual tons per square foot was used to determine the future requirements for all other air cargo facilities, reflecting expected increases in international cargo activity. These ratios were applied to the cargo activity forecasts to determine space requirements at each PAL. Requirements for processing and warehouse space are summarized in Table E-1.

Table E-1

AIR CARGO REQUIREMENTS
Master Plan Update
Memphis International Airport

		Estimated requirement			
	Existing	Baseline (2007)	PAL 1 (2012)	PAL 2 (2017)	PAL 3 (2027)
Forecast air cargo tonnage *(a)*		69,875	97,000	119,000	172,000
Warehouse space (sq ft)					
UPS *(b)*	300,000	300,000	450,000	450,000	600,000
Other carriers *(c)*	36,000	36,000	120,000	150,000	215,000
Total	336,000	336,000	570,000	600,000	815,000
Air carrier parking positions *(d)*					
UPS	4	4	5	7	9
Other carriers	6	6	7	8	10
Total	10	10	12	15	19
Feeder aircraft parking positions *(d)*					
UPS	2	2	3	4	6
Other carriers	--	--	--	--	--
Total	2	2	3	4	6
Aircraft parking apron (sq ft)					
UPS	400,000	400,000	400,000	500,000	600,000
Other carriers	650,000	650,000	650,000	650,000	650,000
Total	1,050,000	1,050,000	1,050,000	1,150,000	1,250,000

Note: Requirements are exclusive of FedEx and USPS facilities.

(a) Assumed approximately 40% accommodated by UPS.
(b) Assumes UPS will continue to process significant amounts of ground packages at MEM facilities.
(c) Assumes 1.0 square foot of warehouse space required for every 1.25 tons of cargo.
(d) Assumes air carrier and feeder aircraft parking positions require 50,000 and 15,000 square feet per position, respectively.

Source: Jacobs Consultancy, September 2008.

Aircraft Parking Apron Space

Including implementation of Cargo Central Phases I, the Airport provides approximately 400,000 square feet of aircraft parking space on the UPS apron and 650,000 square feet at Cargo Central. Both aprons can accommodate aircraft up to ADG VI (i.e. aircraft with wingspans between 214 and 262 feet and tail heights in between 66 and 80 feet) aircraft in their existing configurations.

Future cargo apron requirements are influenced by the number and size of cargo aircraft expected to use the apron simultaneously. Future requirements were developed using the projected cargo aircraft fleet mix and the following planning guidelines and assumptions:

- To account for potential delays in cargo aircraft loading, a conservative peak four-hour period was used to estimate current demand during the design day. Based on this assumption, six air carrier aircraft parking positions and zero feeder aircraft parking positions are presently required.

- Increases in required aircraft parking positions would be proportional to forecast increases in average day peak month (ADPM) air cargo aircraft operations throughout the planning period.

- Approximately 40,000 square feet of apron space would be required for each air carrier aircraft parking position, which is based on actual requirements for the B-757-200, and inclusive of GSE staging and circulation space.

- Approximately 15,000 square feet of apron space would be required for each feeder aircraft parking position, which is based on a 79-foot wingspan design aircraft (the maximum for ADG II) and inclusive of GSE staging and circulation space.

As shown in Table E-1, ten air carrier aircraft parking positions and two feeder aircraft parking positions are required at PAL 1. At PAL 3, 19 air carrier aircraft parking positions and six feeder aircraft parking positions will be required. This corresponds to an apron area of approximately 1,050,000 square feet at PAL 1 and 1,250,000 square feet at PAL 3.

Landside Access and Vehicle Parking

One of the most important characteristics of the air cargo industry is its reliance on trucking as a means of transporting freight. Almost 25% of integrated carrier's domestic shipments are transported exclusively through trucking. Accordingly, proper planning for truck and vehicular access, parking, and staging at air cargo facilities are an important part of air cargo planning, and efficient ground access will is a vital component of the Airport's Cargo Central

There are many different approaches to planning for truck and vehicular access at airport cargo facilities. At land constrained airports an ideal ratio of truck staging areas or employee/customer parking spaces can not be provided. In locations that are not significantly land-constrained, there are general planning guidelines for vehicular access that are used within the industry. For truck docks adjoining warehousing/storage facilities, 10 docks are planned for each 20,000 square feet of warehouse space (an equal number of trailer staging spots are planned for each dock). Similarly, 20 employee/customer parking spots are recommended for every 10,000 square feet of indoor space. However, each building is designed differently and various users are likely to require specific modifications to these planning-level guidelines.

Location Requirements

Location requirements in terms of location/site needs required over the planning period are summarized in the following bullets:

- Areas reserved for air cargo should remain on the east side of the airfield so as to not interfere with operations within the passenger terminal complex, as well as provide ingress and egress for vehicular/truck activity.

- Consolidation of air cargo facilities and operations may be desirable in the long-term to preserve Airport areas for commercial-related development.

- Land developed in association with Cargo Central should be preserved for cross-dock and distribution facilities. The Memphis region is experiencing an increase in warehouse development associated with freight forwarding activities, namely cross-dock and storage/inventory facilities. While these buildings do not need direct airfield access, the efficient connectivity between these areas and the on-airport cargo processing facilities is a critical component of a successful long-term cargo program.

GENERAL AVIATION

The following summarizes general aviation facility requirements necessary to meet demand through the 20-year planning period. General aviation facility requirements are expressed in terms of total land area and location/site needs, and were derived based on a review of existing facilities, market factors, activity forecasts developed for the Master Plan Update, and discussions with Authority and key staff from the Airport's two fixed based operators—Signature Flight Support (Signature) and Wilson Air Center (Wilson).

Demand Trends and Market Factors

General aviation operations at the Airport are affected by the following demand trends and market factors:

- The Airport generally accommodates higher-end general aviation users. The transient mix of aircraft includes corporate operators, air taxi/private charters (e.g., college and professional sports teams); general aviation freight operators, including FedEx support operations and freight forwarding activity; military and Federal prison system operations.

- Compared with surrounding, smaller general aviation airports, the Airport provides general aviation users better services, amenities, and facilities, including: 24-hour ATC services and radar coverage; instrument approach capabilities; adequate airfield capacity; aircraft rescue and fighting; and two full-service FBOs that accommodate the higher-end GA market segment.

- The majority of the region's recreational and general aviation training activity is accommodated at the Authority's two designated reliever airports—Charles W. Baker and General Dewitt Spain—and other general aviation airports located throughout the metropolitan area, including Olive Branch, Millington, and West Memphis airports. None of these surrounding airports are competitive with the high-end market accommodated at the Airport.

- The Airport's tenant hangar occupancy rate is nearly 100%. Since the Memphis climate is not ideal for long-term outside/ramp tie-down aircraft storage, future growth in based aircraft will be constrained unless additional aircraft storage facilities are constructed.

- Competition among the Airport's two FBOs is primarily price-based. In general, Wilson accommodates the majority of air taxi/private charters, general aviation freight operators, and military operations; while Signature accommodates a larger percentage of the total corporate activity. Both FBOs accommodate an approximately equal percentage of the existing based aircraft.

- Changes in the corporate jet fleet mix are leading to increases in larger corporate general aviation aircraft, such as the Gulfstream V, Bombardier Global Express, and Boeing Business Jet, all of which require substantial maneuvering areas and encompass large apron footprints when parked/based compared to smaller corporate jets.

Facility and Operational Considerations

The following summarizes facility and operating considerations related to general aviation operations.

- Both FBOs have central airfield locations that minimize taxiing distances and access to metropolitan areas and terminal facilities via Winchester Boulevard (Wilson operates approximately 25 shuttle trips between their terminal and the Airport's passenger terminal daily).

- There are no reported conflicts between general aviation and FedEx air cargo operations, primarily because peak FedEx activity does not coincide with periods of heavy general aviation traffic. Generally speaking, aircraft maintenance activity at the adjacent Pinnacle Airlines and FedEx maintenance facilities does not conflict with Wilson operations. However, jet blasts from some large aircraft (i.e. the C-5A), during ground maneuvering have been investigated near Taxiways A and Y.

- Wilson intends to develop and lease a two-acre parcel of land during 2008. Once this occurs, the Wilson site will be fully developed. Signature has land areas available for it to expand its aircraft parking apron and hangar facilities.

- While neither FBO conducts significant deicing operations during the winter months, both offer deicing services to their clients.

- Both FBOs have fuel farms located on their sites that store and dispense Jet A and AvGas. In addition to serving their own clients, Wilson provides the aviation fuels for UPS operations.

- To reserve primary apron areas for transient corporate operations, Wilson has considered "remote" FBO operations to accommodate large air taxi/private charter operations, some military activity, and general aviation freight operations. Remote operations require a dedicated apron, small passenger processing facility, and vehicular access to the main facility and/or the passenger terminal.

Spatial and Location Requirements

Spatial requirements for future general aviation operations were identified using a policy-based approach rather than a quantitative approach identifying the number and type of future facilities. General aviation requirements are expressed in terms of the total land area and the location/site needs that will be required over the planning period. The following assumptions were developed to identify general aviation spatial requirements:

- Consolidation of general aviation FBO operations may be desirable to preserve land areas for future commercial or cargo-related development. Areas reserved for future general aviation should be centrally located on the airfield and provide direct access to both on- and off-Airport roadways.

- Forecast general aviation demand does not indicate the need for more than two FBOs. The Airport should continue to accommodate a minimum of two FBOs to facilitate competitive pricing and service offerings.

- Given market trends and projected increases in larger corporate general aviation aircraft, additional hangar capacity will be required beyond PAL 2.

Select general aviation facilities and future total land area requirements are summarized in Table E-2 below. As presented, forecast demand does not necessitate an increase in total land area dedicated to general aviation beyond 30 total acres, although there is a need to accommodate additional apron areas and hangar capacity for projected increases in the high-end general aviation turbojet fleet mix.

Table E-2

GENERAL AVIATION REQUIREMENTS
Master Plan Update
Memphis International Airport

		Estimated requirements			
	Existing	Baseline (2007)	PAL 1 (2012)	PAL 2 (2017)	PAL 3 (2027)
Lease area (acres)	30	30	30	30	30
Apron area (sq ft)	1,170,000	1,170,000	1,182,000	1,520,000	1,931,000
Hangar space (sq ft)	200,000	226,000	228,000	294,000	373,000

Source: Jacobs Consultancy, July 2008.

MILITARY

The Airport, home to the 164th Airlift Wing of the Tennessee Air National Guard (TnANG), is the in the process of relocating the existing military facilities from their location on the northern edge of the airfield along Democrat Road to a new 118-acre site in the southeastern corner of the airfield. The new facilities, which will become operational in 2009, are assumed to be adequately sized and located to support the TnANG's needs for the duration of the planning period. Accordingly, specific requirements for military facilities will not be analyzed or discussed in detail in this Master Plan Update.

Technical Memorandum–F

AVIATION SUPPORT FACILITIES

This Technical Memorandum provides an overview of airport support facilities required to accommodate future demand at Memphis International Airport (the Airport) throughout the planning period. The memorandum also provides a qualitative assessment regarding the Airport's role and requirements for emergency response facilities.

AIRLINE AND AIRPORT SUPPORT

The following identifies the size, general configuration, and approximate location of land areas that should be reserved for airline and airport support functions, including aircraft rescue and fire fighting facilities (ARFF); airport traffic control tower (ATCT); Airport and Authority administration facilities; Airport equipment and maintenance; airline support facilities; and glycol and deicing fluid storage.

Aircraft Rescue and Fire Fighting

The Airport's ARFF station was constructed in 2008 and is classified as Index D. FAR Part 139, *Certification and Operations: Land Airports Serving Certain Air Carriers,* states that Index D relates to airports where the serviced aircraft are at least 159 feet long, but less than 199 feet long. Based on the projected fleet mix and the Index D facilities provided, it is not expected that additional ARFF facilities or equipment will be required throughout the planning period. In addition, the ARFF station is sited so that emergency response times meet FAA requirements.

Airport Traffic Control Tower

A new ATCT is currently being constructed on the north side of the passenger terminal complex and will be operational in 2011. The new ATCT is designed for Activity Level 12 (ATC12) and will be constructed to a height of 335 feet. The base building will encompass 24,500 square feet and accommodate the Memphis TRACON and administrative functions. Once constructed, the new tower is located to provide adequate airfield visibility and has room for equipment and personnel upgrades in the future. It is assumed that no change in the ATCT layout, size, and location will be required during the planning period.

Airport Administration

Airport Authority offices encompass a total of approximately 128,000 square feet, and are located among three separate locations on the Airport – throughout the passenger terminal building on all levels (90,000 square feet); in a building adjacent to the airfield maintenance facility located at the intersection of Tchulahoma and Winchester roads (about 20,000 square feet); and at the "Project Center" located on the west side of the Airport along Airways Boulevard (18,000 square feet). The Authority employs approximately 300 staff.

Based on anecdotal information from Authority staff, it is not expected that additional Airport administration space will be required throughout the planning period. The Authority's administration space requirements are well understood, have not changed for many years, and are not envisioned to change in the future. However, consolidation of Authority office into two 64,000 square foot facilities is recommended to minimize operating costs and increase efficiencies among staff. The potential to accommodate such facilities will be considered in ensuing elements of the Master Plan Update.

Airport Equipment and Maintenance

Authority maintenance equipment and operations are housed in an approximately 80,000 square-foot building used for the storage and maintenance of airfield and airport maintenance equipment. Airport and airfield maintenance facilities needs do not necessarily increase proportionally to activity but are more a function of the overall pavement and grassy areas requiring maintenance and climatic conditions (for snow/ice removal). In addition, the condition of airside facilities dictates maintenance requirements, as pavements in poor condition require more maintenance equipment and personnel than do those in good condition.

The current facility is in good condition and adequately sized to accommodate operations and the existing maintenance fleet. Based on anecdotal information from Authority staff and an inventory of existing facilities, it is not expected that additional maintenance facilities will be required during the planning period.

Airline Support

Requirement for facilities that are leased by or directly support airline operations are typically established based on airline business decisions. Nevertheless, the following provides a general overview of future airline support requirements.

- **Ground Support Equipment Storage and Maintenance** – GSE storage and maintenance facilities are currently located in buildings originally designed for air cargo warehousing immediately to the north of the passenger terminal complex. GSE functions will continue to be provided in these buildings for most airlines (some of which are to be demolished in 2008), while Northwest Airlines will relocate GSE maintenance and storage to an expanded building located in the midfield area south of Taxiway P. The Authority plans to build an additional GSE maintenance and storage building in the midfield area if and when airlines require more space. No additional GSE storage facilities are assumed to be required.

- **Aircraft Maintenance** – Pinnacle Airlines, a Northwest Airlines' regional/ commuter affiliate, operates from a 41,000 square-foot maintenance facility located immediately east of Wilson Air Center. It is assumed this facility is suitably sized for commuter and regional aircraft. However, to provide for potential long-term airline maintenance requirements, an approximately 50,000-square-foot area capable of accommodating an aircraft maintenance facility for a new generation Boeing 737 or equivalent narrowbody aircraft should be reserved.

- **Flight Kitchen** – The Airport's existing full-service flight kitchen is located south of the passenger terminal complex and is operated by Gate Gourmet. At present, the flight kitchen is used to provide in-flight catering amenities to the passenger airlines operating from the terminal complex. Based on current activity levels, industry trends that are generally reducing catering requirements, and the level of use of the flight kitchen, it is expected that the existing flight kitchen (or new, equally sized facility) can accommodate aviation demand throughout the planning period.

De-icing Fluid Storage and Processing

De-icing fluid is stored at three on-Airport locations: (1) 20,000-gallon above-ground tanks located near each de-icing pad; (2) 20,000-gallon above-ground tanks adjacent to the fuel farm; and (3) 300- to 500-gallon tanks located north of Concourse C and west of Taxiway C. Glycol is not supplied by the Authority; airlines are responsible for their own supplies. Tank storage capacity is routinely supplemented by 50-gallon drums of glycol located in individual airlines areas. Therefore, no additional capacity is expected to be required throughout the planning period.

Deicing fluid recovery is currently accomplished by collecting fluids in the pavement drainage system surrounding de-icing pads and diverting the flow from the sanitary sewer system to a pump that transfers the fluids into two 22,000-gallon above ground tanks. The Authority is currently undertaking a separate study to determine a permanent, long-term glycol recovery, treatment, and discharge plan. Requirements from this study will be incorporated into future analysis of alternatives and land uses in later phases of the Master Plan Update.

FUEL STORAGE AND DISTRIBUTION

The following paragraphs describe the requirements for Airport fuel storage facilities, focusing on the passenger terminal fuel farm and fuel farms at the two general aviation facilities. Fuel storage requirements are not addressed for FedEx or the Tennessee Air National Guard (TnANG), since both tenants assume responsibility to operate and expand their facilities, as warranted.

Fuel storage requirements are expressed both in terms of gross tank storage volume as well as land area required to ensure that no other facilities encroach on future fuel storage facility needs.

Passenger Terminal Fuel Farm

Jet fuel used by the airlines and non-FedEx or UPS cargo airlines is stored in two 420,000-gallon tanks and three 210,000-gallon tanks owned by Northwest Airlines. These tanks are located in the midfield area south of Taxiway P and accessible via Louis Carruthers Drive. Requirements for fuel storage are based on historical analysis of fuel flowage and aircraft operations data from 2007, as well as the following planning guidelines and assumptions:

- During 2007, an average of 256,000 gallons of jet fuel per day was dispensed from the passenger terminal fuel farm for approximately 293 daily aircraft departures. Each departure averaged a fuel uplift of 875 gallons.

- Historical aviation fuel reserves* (in days' supply) were estimated by dividing the net usable storage capacity by the average daily fuel dispensed. The net usable storage capacity was assumed to be 90% of the gross storage capacity of the tanks and equals 1,323,000 gallons. The farm typically had between a 4- and 5-day supply of reserve fuel during 2007.

- Future jet fuel requirements are estimated by applying average jet fuel dispensed per aircraft departure to the forecast average day peak month (ADPM) airline and non-FedEx and UPS air cargo operations forecast. As described in the forecasts for the Master Plan Update, APDM activity accounts for 8.8% of the annual total.

- At present, approximately 1,470,000 gallons (gross storage capacity) of jet fuel are stored on a 1.5 acre site that includes areas for storage tanks and facilities to support the fueling operation. This amounts to a planning factor of 0.043 square feet of land per gallon of storage, which is assumed to remain constant over the planning period. While conservative, this assumption ensures the sufficient area for ancillary facilities relating to fuel storage (load racks, truck parking, etc) is preserved.

Table F-1 summarizes the gross volumetric storage and land area requirements for future fueling facilities. As shown, to maintain a 10-day supply of fuel in reserve for the baseline level of aviation activity, approximately 2.8 million gallons of gross storage volume and 2.8 acres of land would be required. At PAL 3, storage requirements range from approximately 1 million gallons for a 3-day reserve supply to 3.5 million gallons for a 10-day reserve supply, occupying land areas between approximately 1 and 3.4 acres.

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*The number of days' worth of fuel stored on-site in reserve is an airline business decision and it is difficult to estimate which reserve period is most appropriate in determining fuel storage requirements. In addition, the number and configuration of the tanks provided are ultimately determined by the airlines based on operating considerations, such as the tank filling and fuel settling process, as well as the reserve supply desired.

Table F-1

PASSENGER TERMINAL FUEL FARM STORAGE REQUIREMENTS
Master Plan Update
Memphis International Airport

	Estimated requirement			
	Baseline (2007)	PAL 1 (2012)	PAL 2 (2017)	PAL 3 (2027)
3-day reserve supply				
Storage requirement (gal)	849,000	904,000	925,600	1,047,600
Land are requirements (acres)	0.8	0.8	0.9	1.0
5-day reserve supply				
Storage requirement (gal)	1,415,000	1,506,700	1,542,800	1,748,100
Land are requirements (acres)	1.4	1.5	1.5	1.7
7-day reserve supply				
Storage requirement (gal)	1,981,000	2,109,400	2,159,900	2,444,500
Land are requirements (acres)	1.9	2.0	2.1	2.4
10-day reserve supply				
Storage requirement (gal)	2,830,000	3,013,300	3,085,500	3,492,200
Land are requirements (acres)	2.8	2.9	3.0	3.4

Notes: The number and configuration of fuel tanks are a business and operations decision, determined by the airlines or fuel farm operator.

Source: Jacobs Consultancy, August 2008.

The passenger terminal fuel farm supplies fuel directly to most aircraft parking positions via a hydrant fuel system. Future requirements for this system will be studied as part of the alternatives analysis of the Master Plan Update, as well as the Authority's ongoing passenger terminal apron replacement and rehabilitation study.

General Aviation Fuel Farms

Both Signature Flight Support (Signature) and Wilson Air Center (Wilson) store and provide Jet A and AvGas aviation fuels at their facilities. In addition to serving general aviation aircraft, Wilson provides Jet A fuel to UPS aircraft. It is not expected that additional general aviation fuel storage capacity will be required during the planning period, based on the following conclusions:

- No increases in AvGas storage capacity are likely over the planning period because growth in operations by lower-end general aviation aircraft (i.e. AvGas users) is expected to be limited, and the existing 45,000 gallons of AvGas storage is sufficient to accommodate existing and forecast demand.

- Neither Signature nor Wilson has expressed specific concerns regarding current fuel storage capabilities. Wilson, however, is site constrained, creating artificial limits on their overall general aviation activity and fuel consumption. Signature has land available for fuel farm expansion, if necessary.

- The area available for general aviation fuel storage is adequate to accommodate additional AvGas of Jet A tanks if a business decision were made by either FBO to construct additional storage capacity. Furthermore, additional Jet A fuel storage could be made available to the FBOs from the passenger terminal fuel farm on an as-needed basis should future demand warrant.

EMERGENCY RESPONSE FACILITIES

The following identifies facilities, land envelope, and supporting infrastructure suitable to accommodate emergency response facilities at the Airport.

Overview

As with many regions in the world, the Memphis area is prone to unexpected and potentially severe natural disasters – earthquakes along the active New Madrid fault, floods on the Mississippi River, and tornados being among the many potential threats. Hence, the Authority is considering reserving on-airport land areas and dedicating facilities to a Disaster Staging Center (DSC), which would provide staging facilities for National Guard, Federal Emergency Management Agency (FEMA), Tennessee Emergency Management Agency (TEMA) and other relief organizations in the event of a severe disaster in the Memphis region.

There are several advantages to developing a permanent DSC at the Airport, including, but not limited to the following:

- Strategic geographic location along the Mississippi River—approximately halfway between St. Louis and New Orleans, which can provide ready-access to areas throughout the river valley via rail, road, and air.

- Location outside of areas susceptible to a 100-year flood event—the Airport is well-positioned to avoid damage from river flooding at an elevation of approximately 340 feet.

- Suitable land areas—available land areas with airfield and landside access are available on the east side of the Airport.

- New 15-acre dedicated air cargo apron and site—including warehousing and storage facilities that could be converted to disaster relief support facilities if necessary.

- New on-airport TnANG base—including warehousing facilities and capability to accommodate large cargo/transport aircraft.

Disaster Staging Center Requirements

In concept, a DSC would provide facilities that could support various emergency situations, such as disaster relief; and non-emergency situations, such as personnel training for emergency response preparedness. Suggested facilities include, but are not limited to the following:

- **Aircraft Parking Apron and Hangars** – Required to support staging and operation of helicopters and fixed-wing aircraft for emergency missions. Two approximately 40,000 square-foot hangars and 10 acres of aircraft parking apron, with sufficient obstruction clearance for helicopter operations and maneuvering would be suitable.

- **Command and Control Center** – Relief operations would be coordinated at a command and control center, located adjacent to the aircraft parking apron. An on-site central utility building and antenna farm would ensure uninterrupted power and communications.

- **Vehicle Staging Area** – Adequate vehicle parking and maneuvering space would be needed for the transport of non-airlifted supplies, and transfer of disaster refugees, injured personnel, or relief workers who arrive via ground transportation modes.

- **Dormitory Facilities** – Permanent or temporary housing (approximately one 5,000 square-foot facility for each 50 personnel) would be required to accommodate personnel on a temporary or extended basis. Temporary tension fabric structures (about 10,000 square feet) could provide additional dormitory-style accommodations or kitchen facilities.

- **Warehousing Facilities** – In the buildup to a severe natural disaster, supplies could be stockpiled at warehousing facilities at the DSC to ensure an uninterrupted supply of relief items to disaster victims. Approximate 10,000 square-foot refrigerated storage facilities could house medical supplies and perishable items. Dry storage facilities would be used for longer-term storage of non-perishable goods.

- **Medical Facility** – Sheltered medical facilities with ready access to the aircraft apron and vehicle staging area, would be necessary to treat disaster refugees, injured personnel, or process relief workers as they arrive via aircraft or helicopter.

Spatial and Location Requirements

A potential DSC at the Airport would require a land envelop of approximately 20 to 30 acres and location in the general proximity to the TnANG and ARFF ready-response facilities. The following generalized requirements should be considered:

- **Airfield** – Aircraft parking aprons; uninhibited airfield access; and central location that could continue to accommodate aviation operations in the event airfield structures (bridges) crossing Winchester Boulevard were rendered unusable.
- **Landside** – Adjacent warehouse facilities that could be converted and utilized for a variety of functions, including warehousing, dormitories, or medical response. Adjacent, open, and available land areas for contingency and/or temporary facilities.
- **Access** – Two lane vehicle access to the site; access to the Interstate; and access to Swinea Road.
- **Utilities** – General utilities required for operation include electrical, potable water, fuel retention facilities (approximate five -day supply) and sewer connectivity.

Preservation of space and an on-Airport location for DSC facilities will be considered in ensuing tasks of the Master Plan Update. If a DSC location and layout is identified, additional coordination with FAA ATC staff is recommended to identify approach and departure procedures for emergency response aircraft operations.

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FINAL WORKING PAPER

AIRFIELD ALTERNATIVES
MASTER PLAN UPDATE
Memphis International Airport

Prepared for

Memphis-Shelby County Airport Authority
Memphis, Tennessee

January 2010

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AIRFIELD ALTERNATIVES

This Working Paper describes (1) alternatives that were considered to accommodate airfield facility requirements for Memphis International Airport (the Airport) through 2027; (2) the alternatives identification and evaluation process; and (3) the recommended airfield development plan.

BACKGROUND AND OBJECTIVES

The following sections summarize previous findings related to airfield requirements and the approach and objectives of the airfield alternatives development process.

Summary of Phase I Findings

The primary conclusions from the Master Plan Update Phase I airfield/airspace simulation analyses and facility requirements task are as follows:

1. The existing airfield capacity is adequate to accommodate at least 453,600 annual aircraft operations (the activity forecast for 2027) with modest levels of delay. This finding can be considered "conservative" based on the following:

   – The airfield capacity analysis included extensive coordination with FedEx staff and simulation of the existing airspace and airfield at current and future demand levels using the Total Airport and Airspace Modeler (TAAM).

   – The simulation was completed using a flight schedule containing a higher level of daily aircraft operations than forecast. The schedule was based on a blend of average day, peak month passenger activity (i.e., May) and average day, peak month cargo activity (i.e., December).

   – Next Generation Air Transportation System (NextGen) technologies are anticipated to provide additional runway capacity without investment in major airfield infrastructure (i.e., new runways or taxiways).

2. Major new airfield facilities are not needed throughout the planning period.

3. Anticipated fleet mix changes, mainly the replacement of Boeing 727 aircraft with Boeing 757 aircraft in the FedEx fleet, will not have substantive adverse impacts on airfield capacity.

4. Numerous opportunities for targeted airfield facilities improvements exist to address identified requirements, described below:

   – Reduce arrival runway occupancy times on Runway 36L

   – Provide additional queuing and holding space for aircraft in sequence to depart Runway 18C

   – Implement specific taxiway modifications to simplify taxi paths and enhance controllers' ability to re-sequence departure queues

   – Provide consolidated deicing pad(s) for fluid collection and treatment

During Phase I of the Master Plan Update it was also concluded that the effects of long-term passenger terminal development on the airfield must be carefully evaluated and alternatives for mitigating these effects identified and incorporated into the recommended airfield development plan. Accordingly, the objectives of the airfield analyses completed during Phase II of the Master Plan Update were to (1) identify and evaluate the alternatives for targeted improvements and the potential effects of other factors related to airfield development; (2) identify and evaluate alternatives for mitigating the effects on the airfield of long-term terminal development; and (3) prepare a recommended airfield development plan.

Approach and Key Assumptions

The Jacobs Consultancy Master Plan Team employed a collaborative approach to identify alternatives and prepare the recommended airfield development plan. The approach involved meetings and input from Memphis-Shelby County Airport Authority (the Authority) staff; FAA staff, including both the Air Traffic Organization (i.e., Memphis Tower and TRACON) and Memphis Airports District Office; representatives from FedEx and Delta Air Lines; and other stakeholder and tenants including the FBOs and Tennessee Air National Guard. Two on-site technical meetings with the key stakeholders were held, as described below.

- **Technical Meeting #1 (January 21 and 22, 2009) –** This meeting included a review of airfield requirements, discussion of targeted airfield improvements, and exploration of potential airfield impacts resulting from alternative terminal development concepts.

- **Technical Meeting #2 (March 24, 2009**) **–** This meeting included the review and evaluation of specific airfield improvement concepts, the review of airfield operations and facilities improvements necessitated by the preferred terminal development alternative, and discussion of the recommended airfield development plan.

For the purposes of identifying practical alternatives, the following airfield projects currently programmed for construction during the planning period were assumed in place:

- Reconstruction of Runway 9-27, Taxiway V, Taxiway A and the passenger terminal apron
- Realignment of Taxiway B
- Demolition of Taxiway V3
- Fillet improvements necessary for the Boeing 777 freighter
- East-west connector taxiway between Taxiways P and Y

The development of airfield alternatives was guided by three principal planning objectives:

- **Minimize Delay to Enhance Schedule Reliability –** FedEx's business is built on schedule reliability which can be significantly affected by even moderate delays, if those delays affect the FedEx afternoon or nighttime sorts.
- **Improve Aircraft Departure Queuing and Staging Areas –** By removing existing taxiway restrictions near runway ends and providing additional aircraft queuing space, air traffic controllers will have greater flexibility to re-sequence aircraft in the queue.
- **Enhance Efficiency of "Mixed" Operations –** It is anticipated that future airline schedules will increase the need for mixed runway operations (i.e., arrivals and departures using the same runway), particularly during periods of overlap between passenger and cargo operations.

Recognizing uncertainties associated with long-range aviation demand forecasting, three planning activity levels (PALs) were identified to represent future levels of activity at which key airfield improvements would be necessary. Because activity levels could deviate from the forecasts for any number of reasons, the use of PAL "triggers" allows for facilities planning that is realistically tied to future activity levels as they occur, rather than arbitrary milestone years. For this Master Plan Update, PAL 1, PAL 2, and PAL 3 generally correspond to aviation activity forecast for 2012, 2017, and 2027, respectively. Passenger airline activity associated with each PAL is summarized in Table 1.

Table 1

HISTORICAL AND FORECAST AIRCRAFT OPERATIONS
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	Historical		Forecast		
			PAL 1	PAL 2	PAL 3
	(2006)	(2007)	(2012)	(2017)	(2027)
Passenger	201,170	197,748	210,900	215,200	243,100
Air cargo	135,500	133,580	137,400	140,200	157,800
General aviation	46,566	42,128	39,000	43,000	51,000
Military	1,587	1,533	1,700	1,700	1,700
Total	384,823	374,989	389,000	400,100	453,600

Sources: Historical—Memphis-Shelby County Airport Authority records.
Forecast—Jacobs Consultancy, July 2008.

AIRFIELD DEVELOPMENT ALTERNATIVES

This section describes (1) the development of alternatives related to targeted airfield improvements to address requirements identified in Phase I of the Master Plan Update, and (2) the assessment of other factors related to airfield development.

Targeted Airfield Improvements

The following describes the development of projects to provide targeted improvements to airfield operations.

Runway 36L Exit Taxiways. Relocated or reconfigured angled exit taxiway(s) on Runway 36L were considered to reduce runway occupancy time and facilitate mixed operations (i.e., using the runway simultaneously for both arriving and departing aircraft). The preferred calm wind runway use configuration at the Airport is north flow, which occurs approximately 80% of the year and involves departures on Runways 36C and 36L and arrivals on Runways 36L, 36R and 27. The only angled runway exit on Runway 36L is M7, located approximately 7,800 feet from the runway threshold, which is used mainly by FedEx operations. Most passenger operations use right-angled exit M6, located approximately 6,500 feet from the runway threshold. The right-angled exit M5, located approximately 4,400 feet from the runway threshold, can only be used by small propeller-driven aircraft and a small fraction of regional jets.

Runway 18R-36L is used frequently for mixed operations throughout the day, especially during periods of overlap between passenger and cargo banks. The afternoon period, which includes the overlap of a passenger arrival bank with a FedEx departure push, was observed to result in excessive delays in the TAAM simulation analysis. The model showed that FedEx departures could not depart in the gap between consecutive passenger arrivals, resulting in a lengthy departure queue. The overlap becomes more pronounced and more of a problem with future flight schedules, thus increasing the time during which mixed operations must occur, particularly on Runway 36L. The lack of optimally placed angled runway exits causes a loss of departure capacity or necessitates greater spacing of arrivals to permit departures because of excessive arrival runway occupancy times.

Reconfigured M6, shown on Figure 1, was sited based on (1) benchmarking of exit taxiway locations at runways of similar lengths at comparable airports, (2) existing runway exit usage for Runway 36L calculated with the Runway Exit Interactive Design Model, developed by Virginia Tech for the FAA, and (3) the demonstrated effectiveness of Runway 36R exit S3, which FAA staff confirmed is a well placed and heavily used runway exit.

No other Runway 36L exit taxiway alternatives were considered.

Cross Field Taxiway/Deicing Pad. Currently, no connection between the east and west runways is provided south of Taxiway P. Based on discussions with FAA and Airport stakeholders, as well as analysis of TAAM simulation output during the Phase I, the decision was made to explore new cross field taxiways which might also be used in conjunction with deicing operations.

The findings from Technical Meeting #1 suggested that existing cross field Taxiways T and P are sufficient to accommodate cross field operations and that any additional cross field taxiways would likely be used only during deicing operations. Therefore, subsequent analyses focused on a cross field taxiway and "pad" located to facilitate centralized deicing operations rather than to enhance cross field taxiing capability.

According to Authority staff, the Tennessee Department of Environmental Conservation (TDEC) is imposing new, more stringent requirements on water quality which will not be met with the current deicing operation in place at the Airport. Collection and treatment of glycol will most likely be necessary to bring the Airport into compliance with TDEC's standards. A Glycol Management Study is currently underway to investigate deicing operations and make recommendations as to how the Authority can comply with TDEC standards. In the event that a consolidated deicing fluid collection system is found to be necessary, it is assumed such a facility would be located at the centralized deicing pad.

Stakeholder input suggested that a consolidated deicing pad should be sized to accommodate at least four wide body (ADG* IV) parking positions, and configured for use in north flow since weather conditions usually necessitate use of Runways 36L, 36C, and 36R during weather events.

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*Airplane Design Group (ADG) is a categorization of aircraft according to their wingspans and tail heights. Aircraft in ADG IV have wingspans between 118 and 171 feet and tail heights between 45 and 60 feet.

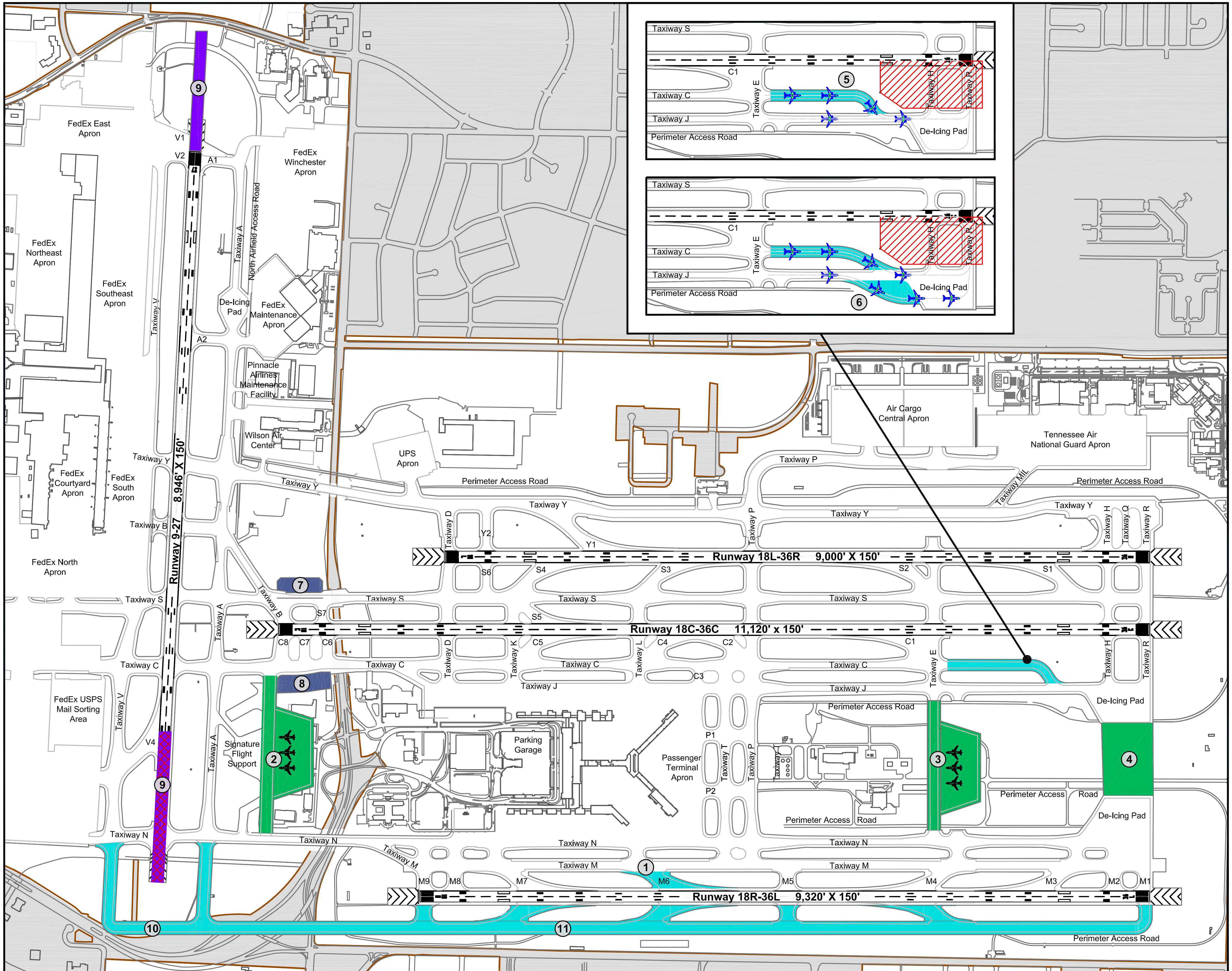
Locations considered for a consolidated deicing pad are shown on Figure 1 as Projects 2, 3, and 4. Project 2, deicing pad north, located on the existing Signature FBO ramp at former Taxiway W, was dismissed due to its unfavorable location since deicing most frequently takes place in north flow and would require demolition of the Signature ramp. Project 3, deicing pad central, located in the south midfield at Taxiway E, was dismissed due to its distance from the runway ends. Project 4, deicing pad south, was selected as the preferred location of a centralized deicing pad based on proximity to runway ends most frequently used in deicing conditions, and flexibility it provides for aircraft to use either Runway 36C or 36L. Project 4, deicing pad south, will be recommended pending the results of the Glycol Management Study.

Taxiway C Extension. In discussions with stakeholders concerning additional cross field taxiways, described in the previous section, FAA staff suggested that an extension of Taxiway C would be more beneficial than any cross field taxiway on the south side of the airfield. An extended Taxiway C would provide more queuing space for Runway 36C, the primary departure runway in north flow, and a more direct taxi path for departures to reach the end of Runway 36C, avoiding two tight 90-degree turns when transitioning from Taxiway C to Taxiway J.

Taxiway C can not be extended on its current alignment because of the Runway 36C glideslope. Relocating the 36C glideslope antenna to allow for extension of Taxiway C on its current alignment is not a possibility because both the glideslope antenna and tails of large aircraft on the extended Taxiway C would become penetrations to the CAT II/III inner-transitional obstacle free zone and missed approach surface.

Two alternatives for extending Taxiway C were developed, assuming the glideslope antenna could not be relocated, and are identified as Projects 5 and 6 on Figure 1. For Project 5, Taxiway C would be extended in its current alignment, and then connect with Taxiway J such that the glideslope critical area is avoided. For Project 6, Taxiway C would be extended as in Project 5 and Taxiway J realigned by adding additional pavement to the north of existing Taxiway J deicing pad to provide two independent taxiway centerlines to the runway end.

Project 5 was dismissed because it introduces a potential choke point where Taxiways C and J intersect, and essentially provides no operational benefit other than additional queuing space. Project 6 was selected as the preferred alternative and a workable compromise to relocating the glideslope antenna because it would provide benefits in queuing and staging departures from multiple taxiway feeds, while avoiding the introduction of a taxiway intersection.



LEGEND

- Airport property line
- Pavement to be removed
- Glideslope critical area
- Taxiway deicing pads
- Departure hold pads
- Taxiway improvements
- Runway modification

Project alternatives considered

1. Angled M6 exit taxiway
2. Deicing pad north
3. Deicing pad central
4. Deicing pad south
5. Taxiway C extension
6. Taxiway C extension and Taxiway J realignment
7. Taxiway S hold pad
8. Taxiway C hold pad
9. Runway 9-27 eastward shift
10. Runway 27 end-around taxiway
11. Parallel west side taxiway

N

0' 600' 1,200' 2,400'

Figure 1
AIRFIELD ALTERNATIVES AND CONSIDERED PROJECTS

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Holding Area for Runway 18C Departures. The portion of Taxiway J north of Taxiway K, which is designated a non-movement area and formerly used for aircraft parking by non-FedEx and non-UPS air cargo carriers, has been reprogrammed for use as a departure holding pad to support Runway 18C departures. When in south flow, Runway 18C is often a primary departure runway. However, because of the proximity of Runway 18C to the passenger terminal complex, there are limited options for holding aircraft that require additional time due to mechanical problems, air traffic control mandated ground holds, or other issues. Before this portion of Taxiway J was made available for staging Runway 18C departures, aircraft requiring additional time had to taxi to the hold pads at the extreme south of the airfield.

The future development of the passenger terminal, described in greater detail in subsequent paragraphs, includes extending Concourse C to the north into the area now serving as a Runway 18C departure hold pad. As such, various locations to replace the existing hold pad, which greatly enhances the departure queue flexibility for air traffic control, were considered. The replacement holding areas were sized to accommodate two A-320 aircraft simultaneously and are shown on Figure 1 as Projects 7 and 8.

For Project 7, the Taxiway S hold pad is located to the east of Taxiway S, near the end of Runway 18C. For Project 8, the Taxiway C hold pad is located to the west of Taxiway C, taking up a portion of the existing Signature FBO ramp. A third option was considered—an operational solution involving taxiing aircraft needing to exit the departure queue to the north on Taxiway C, west on Taxiway A, and then south on Taxiway S.

The operational solution was dismissed because of potential interference with Taxiway S northbound flows. Project 7, the Taxiway S hold pad, was dismissed as because it would encroach on the Runway 18L arrival path and 40:1 departure obstacle clearance surface. Project 8, the Taxiway C hold pad, was selected as the preferred hold pad alternative because of its proximity to the existing hold pad which provides the greatest level of flexibility for controllers.

West Side Taxiway Complex. The following three airfield improvement projects were considered previously, but were deemed to not provide enough benefit to be justified as independent projects:

- Shifting of Runway 9-27 to the east
- End-around taxiway at the west end of Runway 9-27
- Parallel taxiway on the west side of Runway 18R-36L

At Technical Meeting #1, some interest was expressed in exploring a combination of these three potential airfield improvements (dubbed the west side taxiway complex). Packaged together, the three projects are complementary and result in synergies unrealized with implementation of each project individually. The west side taxiway would relieve the bottleneck on Taxiway N across Winchester Road, and would connect directly into providing an end-around taxiway allowing free-flowing taxiing, independent of operations on Runway 9-27, directly to/from Runway 18R-36L. In order to provide the end-around taxiway, Runway 9-27 would need to be shifted to the east; however this shift could enhance capacity by reducing the dependencies between operations using Runway 27 and Runways 18L or 18C simultaneously.

The potential benefits and synergies of the west side taxiway complex, as a long term concept outside of the planning period, were explored as part of the study of alternatives. The benefits of the west side taxiway complex would be:

- Reduced crossings of Runway 9-27
- Improved departure rate on Runway 9-27 due to decreased runway crossings
- Reduced taxiing interference on the west side of the passenger terminal (fewer taxiing restrictions to FedEx aircraft taxiing to their ramp)
- Reduced interference between landings on Runway 9-27 and landings on Runways 18L and 18C
- Reduced taxiing distances for landings on Runway 27 going to the FedEx ramp

The parallel west side taxiway shown on Figure 1 is separated from Runway 18R-36L by 400 feet, the minimum to comply with design standards for ADG V. Runway-taxiway separation would drive the degree of associated costs and challenges, including (1) property acquisition, (2) relocation of Plough Boulevard, Winchester Road, and Tchulahoma Road, (3) relocation of the glideslopes for Runways 18R and 36L, and (4) operational limitations on taxiway use, especially in low visibility conditions. Implementing the west side taxiway complex also would involve relocating Runway 9-27 to the east, maintaining its existing length, to allow Taxiway N to become an end-around taxiway at the required minimum 2,500-foot separation from the runway end with no grade differential.

Stakeholders concluded that the west side taxiway complex is not feasible because of issues with constructability and cost associated with bridging the Winchester/Plough interchange, as well as proximity to Airways Boulevard. Also, the degree of the shift in Runway 9-27 would not be enough to eliminate the dependencies between arrivals on Runway 27 and Runways 18C or 18L. Consequently, the west side taxiway complex project was not carried forward into the recommended plan.

As an alternate to the west side taxiway complex, stakeholders at Technical Meeting #2 suggested shifting Runway 9-27 to the east approximately 4,000 feet to decouple arrivals on Runway 27 and Runways 18C or 18L and provide an end-around taxiway at existing Taxiway N. Such a shift in runway alignment would eliminate the dependence between arrivals on Runways 27 and 18L/18C in VFR conditions, thus eliminating the need for the converging runway display aid (CRDA) and increasing arrival capacity in south flow. An end-around taxiway at Taxiway N would provide the same benefits as explained above, including reduced crossings of Runway 9-27 and improved departure rates from Runway 27.

However, this project and other runway alternatives were not considered in the Master Plan because there is no demand-driven need for additional runway capacity. Implementation of land-and-hold-short operations (LAHSO) at Taxiway N is expected to capture some of the same benefits as an end-around taxiway would provide, without the need for substantial property acquisition and capital investment.

Other Factors Related to Airfield Development

In analyzing the targeted airfield improvements described in the previous section, other airfield components including runway length, airport design standards, obstacle clearance, navigation aids, and seismic vulnerabilities were considered. These are discussed below.

Runway Length. To verify that the Airport's existing 11,120-foot Runway 18C-36C is of adequate length to accommodate the aircraft in the projected fleet mix forecast, the most demanding aircraft—the Boeing 777 Freighter (B-777-F), which is expected to join the FedEx fleet in September 2009—was used to calculate runway length requirements.

Takeoff length requirements were calculated using *Airplane Characteristics for Airport Planning*, assuming a B-777-F operating at maximum takeoff weight (MTOW) at both standard temperature of 59° Fahrenheit and the mean daily maximum temperature during the hottest month at the Airport of 92° Fahrenheit. Resulting required takeoff lengths are 10,520 feet on a standard day and 12,700 feet at the mean-max temperature, suggesting that the B-777-F may be need a longer runway than provided by 18C-36C on hot days if departing at maximum takeoff weight.

However, discussions with FedEx staff at Airfield Technical Meeting #1 revealed that independent takeoff length calculations were performed by FedEx specific to its planned use of the B-777-F, taking into account factors such as expected payload, takeoff weight, and range. FedEx's calculations verified that Runway 18C-36C is of sufficient length for departures of the B-777-F, and consequently runway extension alternatives were not considered as part of the Master Plan.

Airport Design Standards. A complete review of modifications of standards and design deficiencies was conducted during Phase I, including review of land uses within runway protection zones (RPZ). The RPZs associated with the Airport's parallel runways all meet land use requirements outlined in FAA Advisory Circular 150/5300-13, Airport Design. On the other hand, the RPZs associated with

Runways 9 and 27 both encompass non-compatible land uses beyond the Airport's property line, as shown on Figure 2.

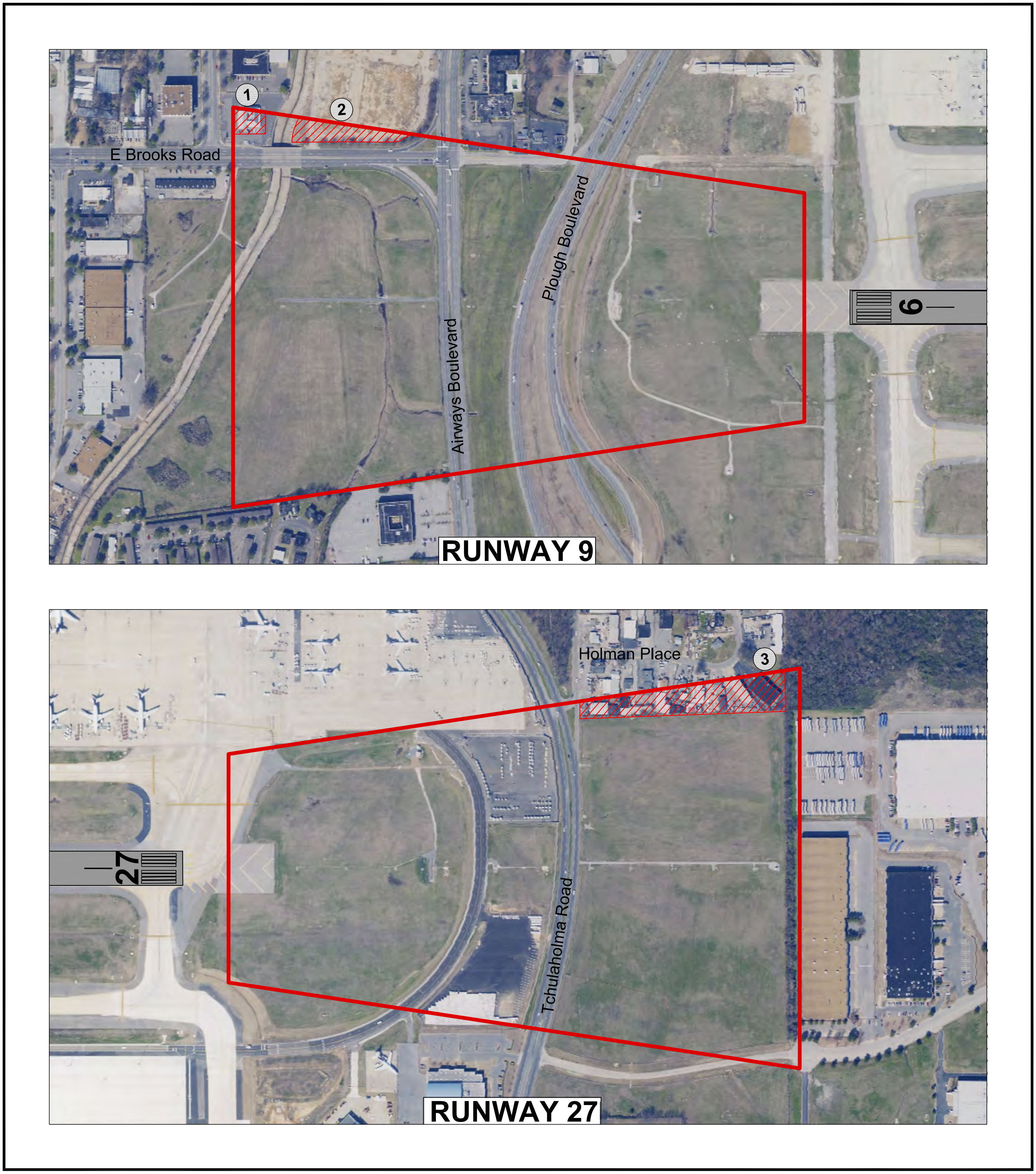
To the west of the Airport, the Runway 9 RPZ encompasses several parcels north of East Brooks Road and west of Airways Boulevard that are not owned by the Authority. One of these parcels, located at the intersection of Brooks Road and Directors Row, is currently occupied by a commercial building that constitutes a place of public assembly. In this case, the RPZ encompasses the commercial building. A second parcel, located at the northwest corner of the intersection of Brooks Road and Airways Boulevard, is slated for development as a transit center by the Memphis Area Transit Agency. In this case, it is expected that only automobile parking facilities will be within the RPZ, which is permitted outside of the extended object free area within the RPZ.

To the east of the Airport, the Runway 27 RPZ encompasses several parcels north of the extended runway centerline and south of Democrat Road. These parcels, which are located to the south of Holman Place, contain a mixture of low-rise light industrial and commercial buildings that constitute places of public assembly.

For both runway ends, it is recommended that the Authority attempt to acquire the parcels within the RPZ that contain places of public assembly. This includes the commercial parcel to the west of the Airport and the several light industrial/ commercial parcels to the east of the Airport. Once acquired, these parcels should be cleared in accordance with RPZ requirements.

Obstacle Clearance. While not penetrations to any obstacle clearance surfaces, the antennas associated with the airport surveillance radar (ASR) and remote transmitter-receiver (RTR) facility, as well as a series of high voltage electrical towers approximately 2 miles south of the Airport were identified as obstructions that might limit the payloads that can be carried by long-haul departures from Runway 18C. The effect that these facilities have on departure payload carriage capabilities from Runway 18C was discussed at Technical Meeting #1, and FedEx staff verified that one-engine inoperative calculations had been performed for their most demanding aircraft finding no issue with the above mentioned facilities.

Navigation Aids. A review of electronic and visual navigation aid needs at the Airport was conducted as part of the airfield facility requirements evaluation. To determine potential requirements, the Master Plan Team interviewed representatives from the Authority, FAA, and FedEx and independently assessed the needs for additional or enhanced electronic and visual navigation aids, including aids that are under development as part of the FAA's NextGen program.



LEGEND

Runway Protection Zone (RPZ)

Incompatible land use

Incompatible land uses within the RPZ

1. Commerical building
2. Memphis Area Transit Agency facility
3. Light industrial and commerical buildings

N

0 300' 600' 1200'

Figure 2

RUNWAY 9-27 RUNWAY PROTECTION ZONE LAND USE COMPLIANCE

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A temporary ground augmentation system transmitter is currently installed at the Airport. This temporary installation should be replaced by a permanent installation during the planning period. This transmitter corrects GPS signals broadcast by satellites and thus improves the accuracy of GPS signals received by aircraft-based GPS navigation systems. The improved signal accuracy facilitated by the ground augmentation system is considered a critical prerequisite to future NextGen flight procedures, including satellite-based Category II and Category III approach procedures. The exact timing of permanent transmitter installation should be determined in coordination with the FAA that, ideally, would fund the installation and maintenance costs of the transmitter.

As noted previously, the Authority is currently planning to install land-and-hold-short lighting on Runway 27 to the east of Taxiway N during the planned reconstruction of Runway 9-27 in 2009. In addition, during the runway reconstruction project, the Authority intends to install the subsurface infrastructure needed to support installation of runway status lights (RWSLs) at the intersections of Runway 9-27 with Taxiways N, V4, C, S, B, Y, A2, A1, and V2/V1. These actions should be accompanied with (1) development of land-and-hold-short procedures for Runway 27 and (2) installation of the RWSL system itself to coincide with commissioning of the new airport traffic control tower and its ASDE-X system, which is a prerequisite to RWSL installation.

The ASDE-X will be brought online with the commissioning of the new airport traffic control tower in 2011. This system requires a primary antenna that will be placed atop the new tower as well as four remote transmitters to be located around the airfield (locations depicted on the current Airport Layout Plan). The Airport received airspace determinations from the FAA for these remote transmitters in September 2009.

Finally, it is recommended that the Authority continue to monitor the progress of FAA's NextGen program and actively collaborate with both FAA and FedEx to determine when additional new technologies should be installed at the Airport and who should be responsible for their implementation.

Seismic Vulnerabilities. A seismic risk assessment was conducted concurrently with the Master Plan Update to evaluate the vulnerabilities of the airfield pavement and structures to a potential seismic event. The findings of this study recommended retrofits to airfield bridges across Winchester Road. These structures include: (1) a reinforced concrete bridge that supports Taxiway Y; (2) a reinforced concrete bridge supporting Runway 18C-36C and Taxiways C and S; (3) a bridge supporting the Winchester vehicular roadway interchange; and (4) a bridge that supports Taxiway N. Most structures contain spans ranging between 150 and 200 feet, varying with the width of Winchester Road below.

AIRFIELD IMPLICATIONS OF TERMINAL CONCEPTS

The preferred terminal concept and the long-term terminal vision are described in *Terminal Development Alternatives.* The impacts of the preferred terminal development plan on airfield operations and means to mitigate those impacts were identified, confirmed with stakeholders, and are summarized below.

Partial Closure of Taxiway J

The preferred terminal concept includes the construction of two pavilions (i.e., sections of concourse that are aligned perpendicular to the existing concourse) extending from Concourse C to the east and necessitating the closure of existing Taxiway J north of Taxiway L. After careful study and coordination with Airport stakeholders, the Team concluded that the partial closure will not have a major impact on airfield operations.

Taxiway J is currently not used as a major airfield circulator, instead its use is limited to passenger aircraft gating on Concourse C. Taxiway J is restricted to ADG III or smaller aircraft, limiting its use in any greater capacity. With the partial closure, aircraft gating on Concourse C will transition to Taxiway C rather than using Taxiway J as a through taxiway.

Aircraft parking positions on the pavilions have been planned to avoid any pushbacks onto Taxiway C, a major airfield thoroughfare. Instead, Taxiway J will become apron area used for pushbacks and engine startups. Avoiding any interruption to flow on Taxiway C is essential because Taxiway C serves as the primary location for queuing departures to Runway 18C, the main departure runway in south flow. Moreover, relocating the departure queue to Taxiway S is inadvisable because the necessary runway crossing would hamper the departure rate from Runway 18C, increase controller workload, and pose increased risk of runway incursion and restrict the flow of FedEx arrivals using Taxiway S northbound to their hub.

Loss of Runway 18C Departure Hold Pad

In addition to the closure of Taxiway J north of Taxiway L, the planned future extensions to Concourse C will require relocation of a departure hold pad and staging area currently located on excess apron area that used to be aircraft parking for air cargo carriers. It is anticipated that these terminal projects would be in place at PAL 2. The preferred plan to replace the lost hold pad was described previously.

Long-term Relocation of Taxiways T and P

The long-term vision for the passenger terminal includes the future construction of a satellite concourse located on the same east-west alignment as existing Taxiway T. This concourse would utilize Taxiway P for aircraft pushbacks from gates located along its south façade. Both Taxiways T and P play an essential role in facilitating ground movements of aircraft at the Airport and need to be replaced in kind as close to their current location as possible if displaced by future terminal construction.

Typically, Taxiway T is used in the eastbound direction and Taxiway P is used in the westbound direction. These taxiways are used to cross departures to the appropriate side of the airfield (westbound departures to 18R-36L, eastbound departures to 18C-36C or 18L-36R) to avoid needing to cross over aircraft after they are airborne. Arrivals as well use the east or west runways corresponding to the side of the airspace they enter from, and then taxi to their assigned gate using either Taxiway T or P.

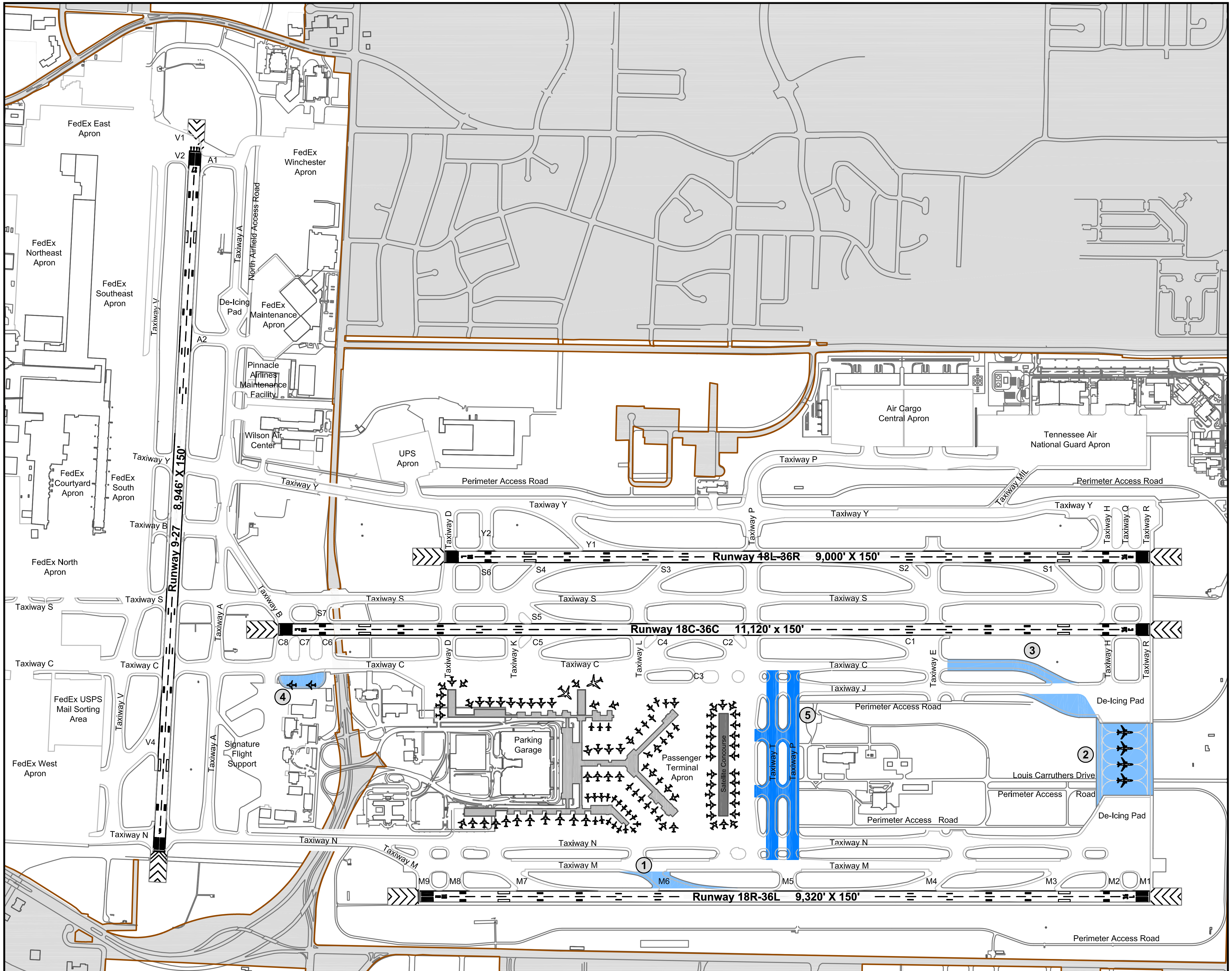
Two minimum ADG V cross field taxiways to replace existing Taxiways T and P would be needed with construction of the satellite concourse. The Team explored a range of replacement siting options for Taxiways T and P for the purposes of achieving required operational needs and minimizing disruption to existing facilities in the south midfield. The siting of replacement Taxiways T and P was documented in a May 6, 2009 technical memorandum (see Appendix A); the key findings regarding ADG requirements and alignment with taxiway M5 are summarized below.

- **Airplane Design Group –** ADG V is adequate for design of replacement Taxiways T and P considering the current and anticipated future use of the taxiways is primarily by passenger aircraft to/from the proper runway end to/from the side of the terminal at which they gate. FedEx aircraft would be the most likely future users of ADG VI aircraft at the Airport; however, it is assumed that FedEx would continue their current operation by assigning parking positions to the apron closest to their arrival or departure runway, eliminating the need for use of Taxiways T or P.

- **Alignment with Taxiway M5 –** Stakeholder feedback suggested aligning replacement Taxiway T with M5, an exit taxiway from Runway 18R-36L. However, the location of M5 makes it difficult for any aircraft larger than most propeller-driven aircraft and a small fraction of regional jet aircraft to use after landing on Runway 18R-36L. Consequently, very few aircraft that require use of Taxiway T or P would also be using the M5 exit which makes aligning the taxiways unjustifiable given the displacement of additional facilities.

RECOMMENDED AIRFIELD DEVELOPMENT PLAN

The preferred airfield development projects were refined based on discussions at Technical Meeting #2 and shown on the Recommended Airfield Development Plan, shown on Figure 3. The recommended plan, cost estimates, and phasing are described in the following sections. Each of the recommended projects is assigned a PAL for implementation based on anticipated future airfield needs.



LEGEND

Airport property line

Recommended airfield project

Potential long-term airfield project

Recommended terminal development

Ultimate long-term terminal vision

Recommended projects	Phase
1 Angled M6 exit taxiway	PAL 1
2 Consolidated deicing pad and crossfield taxiways	PAL 2
3 Taxiway C extension and Taxiway J realignment	PAL 3
4 Runway 18C departure hold pad	PAL 3
5 Replacement Taxiways T and P	Long-term

N

0' 600' 1,200' 2,400'

Figure 3

RECOMMENDED AIRFIELD DEVELOPMENT PLAN

Master Plan Update
Memphis International Airport
November 2009

JACOBS CONSULTANCY

Angled M6 Exit Taxiway

This project involves realigning Runway 36L exit taxiway M6 from a 90-degree exit to an angled exit. It is sited approximately 5,200 feet from the runway threshold on the same alignment as Runway 36R exit S3. This project is recommended for implementation at PAL 1 because it could be used immediately to enhance mixed operations. The project will provide even greater benefits in the future with the expected increase in periods of mixed operations at the Airport.

Consolidated Deicing Pad and South Side Cross Field Taxiways

This project involves joining existing Runway 36L and 36C deicing pads to create a centralized deicing pad of size capable of parking four ADG IV aircraft. This project would necessitate lowering Louis Carruthers Drive and placing it in a tunnel beneath the new centralized deicing pad or closing Lois Carruthers Drive. Dual ADG V taxiways would be accommodated on the deicing pad for use in all weather conditions.

Since a need was not established for additional cross field taxiway capability at the Airport, the recommendation of the deicing pad is contingent on the findings of the Glycol Management Study. The location and geometrics of the deicing pad, as shown on Figure 4, were confirmed with respect to operational requirements with stakeholders. If a centralized deicing pad is recommended in the Glycol Management Study, this project is recommended for construction in PAL 2 unless required sooner by TDEC.

Taxiway C Extension and Taxiway J Realignment

This project involves a southward extension of Taxiway C to join with existing Taxiway J, which will be realigned by filling in pavement north of the Runway 36C deicing pad. Extending Taxiway C and realigning Taxiway J will increase the number of feeds to Runway 18C from the west side from one to two, allowing flexibility for controllers to separate aircraft by size or departure fix. This project is included at PAL 3 because it would be triggered by a change in schedule pattern that has more overlap between passenger and cargo departure pushes, which is not expected to occur until later in the planning period. If NextGen technologies make the use of glideslopes obsolete, Taxiway C could be extended directly south to Taxiway R on its current alignment.

Runway 18C Departure Hold Pad

This project involves construction of a departure hold pad to the west of Taxiway C between C6 and C8 located on the existing FBO ramp. The hold pad would be sized to accommodate two Airbus A-320 aircraft. Construction of the East Lot in 2010 will temporarily eliminate use of a portion of the former air cargo apron at the north end of Taxiway J as a hold pad until completion of the new parking garage. However, the Master Plan recommended hold pad is scheduled for PAL 3, because alternate area to the north of the East Lot could be made available to stage departures until northward terminal development on Concourse C will permanently eliminate these apron areas.

Cost Estimates and Phasing Plan

Rough order of magnitude cost estimates were prepared for projects which are part of the Recommended Airfield Development Plan and are presented in Table 2. The detailed report of the cost estimator responsible for preparing the estimates is included in Appendix B. Cost estimates are shown in 2009 dollars and include a soft cost allowance inclusive of construction contingency, design evolution, planning and design, and project and construction management. The suggested PAL for each project in the Recommended Airfield Development Plan to be implemented is also included in Table 2.

Table 2

RECOMMENDED AIRFIELD PROJECT COST ESTIMATES
Master Plan Update
Memphis International Airport

	Cost estimates (in $ millions) *(a)*			
	Construction	Contingency *(b)*	Owner soft costs *(c)*	Total
PAL 1				
Angled M6 exit taxiway	$ 2.37	$0.47	$0.66	$ 3.51
PAL 2				
Consolidated deicing pad and cross field taxiways *(d)*	24.76	4.95	6.89	36.60
PAL 3				
Taxiway C extension and Taxiway J realignment	6.39	1.28	1.78	6.39
Runway 18C departure hold pad	2.92	0.58	0.81	4.32
Total	**$36.4**	**$7.3**	**$10.1**	**$53.9**

(a) Costs presented in 2009 dollars.
(b) Includes markups for design contingency and construction contingency.
(c) Includes markups for project and construction management, design fees, construction administration, materials testing, and other associated services.
(d) Recommendation subject to findings of Glycol Management Study.

Source: Connico, May 2009.

Ultimate Airfield Plan

If a satellite concourse is constructed according to the long-term terminal vision, Taxiways T and P will need to be relocated. Analysis of alternative locations for siting replacement Taxiways T and P was completed for the purpose of achieving required operational needs and minimizing disruption to existing facilities—the results of these analyses are included in Appendix A.

The recommended siting of Taxiways T and P is shown on Figure 3. Facilities in the south midfield likely to be impacted include the fuel farm and airfield electrical vault. Sites for needed replacement facilities will be considered at the time the satellite concourse becomes needed. Taxiway T would need to be replaced immediately upon initiation of construction of the satellite concourse, while Taxiway P could be maintained until the concourse is double-loaded with gates, in which case it would also need to be replaced.

Appendix A

SITING OF REPLACEMENT TAXIWAYS T AND P

JACOBS
CONSULTANCY

525 West Monroe Street, Suite 1350
Chicago, Illinois 60661 U.S.A.
1.312.612.6026 Fax: 1.312.655.9706

May 6, 2009

MEMORANDUM

To: Mr. James Hay, Director of Development
Memphis-Shelby County Airport Authority

From: Eric Bernhardt/Suzanne Akkoush, Jacobs Consultancy

Subject: Master Plan Update—Siting of Replacement Taxiways T and P

The preferred long-term vision for the passenger terminal complex includes the future construction of a satellite concourse located on the same east-west alignment as existing Taxiway T. This concourse would utilize Taxiway P for aircraft pushbacks from gates located along its south façade. Both Taxiways T and P play an essential role in facilitating ground movements of aircraft at the Airport and need to be replaced in kind as close to their current location as possible if displaced by future terminal construction.

At a meeting on April 22, 2009, the Authority asked Jacobs Consultancy to further detail various alternatives for siting replacement Taxiways T and P in the interest of preserving as many of the existing south midfield facilities as possible. As shown on the attached figure, facilities presently located in the area targeted for the replacement taxiways include the passenger terminal fuel farm, an airfield electrical vault, a chiller complex operated by Delta Air Lines, a glycol storage facility operated by Delta Air Lines, and a catering kitchen. The purpose of this memorandum is to (1) present a range of alternative locations for siting replacement Taxiways T and P; and (2) recommend an alternative that both achieves the required operational needs and minimizes disruption to existing facilities.

The attached table details the alternatives considered and the resulting impacted facilities associated with each. The attached figure graphically depicts the proposed location of the satellite concourse, the existing location of airport support facilities, and the southern extent of the taxiway object free area (TOFA) of relocated Taxiway P for each alternative—the governing boundary in determining whether a given facility is impacted by the relocated taxiways.

The proposed location of the satellite concourse is driven by the width required for apron circulation—302 feet—which allows for two ADG III taxilanes to the south of Concourse B. The terminal envelope dimension of the satellite concourse is determined by the building clearance, aircraft length, tail clearance, and service road—215 feet on each side from the face of the concourse—and the building width—120 feet. The width from the southern extent of the terminal envelope of the satellite concourse to the southern extent of the relocated Taxiway P TOFA ranges from 775 to 1066 feet, including an ADG III taxilane to serve the southern side of the satellite concourse, Taxiway T, Taxiway P and TOFA. It is important to note that in Alternatives A1 and A2, Taxiway T is aligned with M5 and Taxiway P is sited at minimum spacing from Taxiway T, while in Alternatives B1 and B2 the taxiways are sited at minimum spacing from the taxilane on the south side of the satellite concourse.

Description of Variables

There are two key variables that govern potential impacts to facilities in the south midfield, described below and summarized in the attached table.

> *Taxiway ADG*—the Aircraft Design Group governs the geometric and dimensional requirements of taxiway design. For this analysis, both ADG V and ADG VI were considered which satisfy the requirements for Boeing 777 and Airbus A380 aircrafts, respectively.
>
> *Taxiway T alignment with M5*—feedback received from key stakeholders at Airfield Technical Meeting #2, held in Memphis on March 24, 2009, suggested aligning replacement Taxiway T with M5, an exit taxiway from Runway 18R-36L. The location of M5 makes it difficult for any aircraft larger than most propeller-driven aircraft and a small fraction of regional jet aircraft to use after landing on the runway. Alternatives A1 and A2 assume Taxiway T is located on the same alignment as M5.

Impacted Facilities

As previously discussed, there are five facilities that could be impacted in the alternatives considered in this analysis. The extent to which facilities are impacted is dependent on the variables listed above.

Recommendation

Jacobs Consultancy recommends selecting Alternative B1, which consists of two ADG V taxiways with Taxiways T not aligned with M5. This alternative was chosen based on the following findings:

1. ADG V is sufficient for the design of Taxiways T and P, considering the current and anticipated future use of the taxiways is primarily by passenger aircraft to/from the proper runway end to/from the side of the terminal at which they gate. FedEx aircraft would be the most likely future users of ADG VI aircraft at the Airport; however, it is assumed that FedEx

would continue their current operation by assigning parking positions to the apron closest to their arrival or departure runway, eliminating the need for use of Taxiways T or P.

2. Aligning Taxiway T with M5 is not necessary and unjustifiable given the displacement of additional facilities. Very few aircraft that require use of Taxiway T or P would also be using the M5 exit.

* * * * *

If you have any questions or comments regarding the content of this memorandum, please call me at 312.612.6026. Our team will incorporate these findings and recommendations into the preferred airfield plan and document accordingly in the forthcoming *Airfield Alternatives Working Paper*.

SEA/rlh

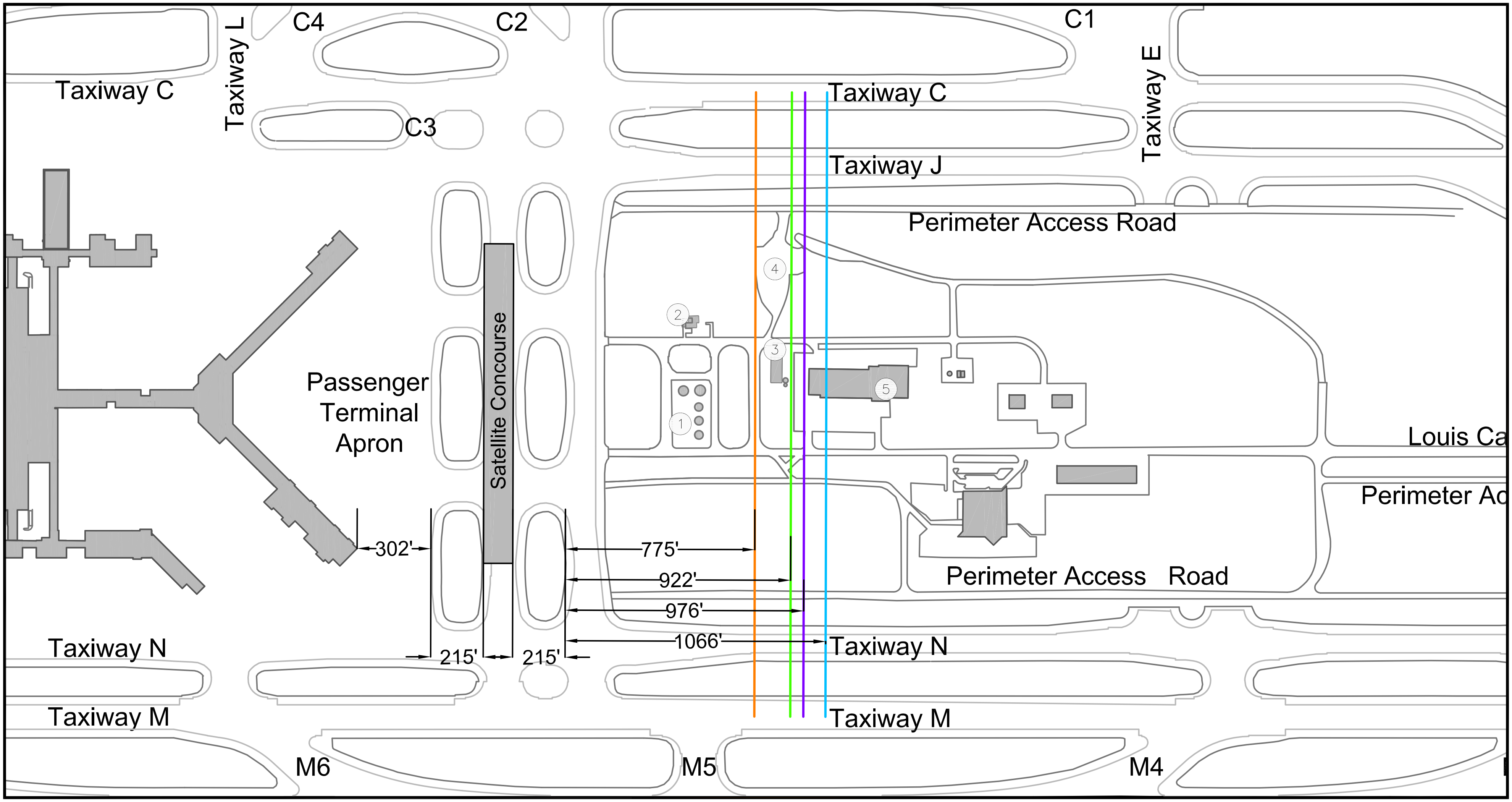
cc Mr. John Greaud, Memphis-Shelby County Airport Authority
Mr. C.F. Booth, Jacobs Consultancy
Mr. Robert Hoxie, Jacobs Consultancy

SITING OF REPLACEMENT TAXIWAYS T AND P
Master Plan Update
Memphis International Airport

			Facilities impacted *(a)*				
Alternative	ADG of Taxiways T and P	Taxiway T aligned with M5	Catering kitchen	Delta Air Lines chiller	Delta Air Lines glycol storage	Airfield electrical vault	Fuel farm
A1	V	Yes		X	X	X	X
A2	VI	Yes	X	X	X	X	X
B1	V	No				X	X
B2	VI	No		X	X	X	X

Notes:
(a) Impacts to existing facilites include complete ot partial loss to a facility's structure

Source:
Jacobs Consultancy, May 2009



SOUTHERN EXTENT OF TAXIWAY P TOFA

- Alternative A1
- Alternative A2
- Alternative B1
- Alternative B2

FACILITES INDEX

1. Fuel farm
2. Airfield electrical vault
3. Delta chiller
4. Delta glycol facility
5. Catering kitchen

N

0' 300' 600' 1,200'

ALTERNATIVES FOR REPLACEMENT OF TAXIWAYS T AND P

Master Plan Update
Memphis International Airport
May 2009

JACOBS CONSULTANCY

Note: TOFA = Taxiway Object Free Area

Appendix B

COST ESTIMATES

Memphis International Airport
Memphis, Tennessee

Master Plan Update
Airfield Projects

MASTER PLAN
MEMPHIS INTERNATIONAL AIRPORT

Order of Magnitude Alternative Estimates

April 20, 2009

Prepared by:

Connico Incorporated
2594 N. Mount Juliet Road
Mount Juliet, TN 37122-3007

Prepared for:

Jacobs Consultancy, Inc.
525 West Monroe, Suite 1300
Chicago, Illinois 60661

CONNICO INCORPORATED

Nashville • Cincinnati

a Rider Levett Bucknall company

April 20, 2009

Mr. Eric Bernhardt
Jacobs Consultancy, Inc.
525 West Monroe, Suite 1300
Chicago, Illinois 60661

RE: Master Plan
Memphis International Airport
Memphis, Tennessee
Order of Magnitude Alternative Estimates – Airfield Projects

Dear Mr. Bernhardt:

We are pleased to present the Order of Magnitude Alternative Estimates for the referenced Master Plan Update. The Order of Magnitude Estimates have been drawn from information received from Jacobs Consultancy, Inc., through April 20, 2009.

Included within the report are our Estimate Notes, which outlines the criteria and allowances that were used to produce the estimate.

We appreciate the opportunity of working with you on this project. Should you have any questions or need additional information, please contact us at your convenience.

Sincerely,
CONNICO INCORPORATED

Connie S. Gowder, CCC, AVS
cgowder@connico.com
President

David J. Hunley, P.E.
dhunley@connico.com
Vice President

Attachment
File No. 2466.08.2.notes.04.20.09.doc

TABLE OF CONTENTS

EXECUTIVE SUMMARY

TASK OUTLINE

- Jacobs Consultancy, Inc. retained Connico Incorporated as cost consultants to provide an opinion of probable cost for the Master Plan Update at the Memphis International Airport in Memphis, Tennessee. The estimate was based on plans, narratives and other information, as noted in Exhibit A of this report.

- In providing opinions of probable construction cost (cost estimates), the Client understands that the Consultant has no control over the cost or availability of labor, equipment or materials, or over market conditions or the Contractor's method of pricing, and that the Consultant's opinions of probable construction costs are made on the basis of the Consultant's professional judgment and experience. The Consultant makes no warranty, express or implied, that the bids or the negotiated cost of the Work will not vary from the Consultant's opinion of probable construction cost.

- The Opinion of Probable Cost has been prepared based on information prepared/provided by others. Connico has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions that may be incorporated as a result of erroneous information provided by others.

PROJECT DESCRIPTION

- This Master Plan analysis includes cost analysis of all of the airfield improvements that are defined by the plan as follows:

Project 1: Realigned exit taxiway M6

This project involves realigning Runway 36L exit taxiway M6 from a 90-degree exit to an angled exit. It is sited approximately 5,200 feet down runway in line with exit S3 from Runway 36R. Existing pavement may be demoed or reused as needed.

Project 2: Taxiway C extension/Taxiway J realignment

This project involves a southward extension of Taxiway C to join with existing Taxiway J. The taxiway will be 75 feet wide with 35 foot wide shoulders. Also, Taxiway J will be realigned by filling in approximately 159,000 square feet of pavement north of the Runway 36C deicing pad.

Project 3A: Runway 18C departure hold pad

This project involves construction of a departure hold pad to the west of Taxiway C between C6 and C8 located on the existing FBO ramp. The departure hold pad measures approximately 102,000 square feet of pavement. FBO facilities that would need demolished are included. We are aware of challenging topography in the planned location.

Project 3B: Runway 18C departure hold pad

This project involves filling in approximately 44,600 square feet of pavement to the west of Taxiway C between the existing fire station access and former air cargo ramp to provide a departure hold pad.

Project 4: Centralized Deicing Pad

This project involves joining existing Runway 36L and 36C deicing pads to create a centralized deicing pad. This project would necessitate lowering Louis Carruthers Drive to tunnel underneath the new centralized deicing pad, and these costs are included.

Ultimate Projects (shown on Figure 2-2)

This project is beyond the 20-year planning period.

Project 5: Replacement of Taxiways T and P

This project includes the replacement of Taxiways T and P, extending from Taxiway M to Taxiway C, and replication of north-south "stubs" P1 and P2. Taxiways T and P are 100 feet wide with 35 foot shoulders. Taxiway T will be sited in line with M5, with stubs built to connect to the future Taxiway P and P1 and P2. Taxiway P will be located to the south at 324 feet of separation. Demolition of the fuel farm is included in the estimate. An allowance/contingency is included for environmental remediation of the former fuel farm site.

ESTIMATE NOTES

GENERAL

- Connico performed a site observation on April 17, 2009 to aid in the preparation of this estimate.

- This is estimate is prepared using the normal Civil Engineering Cost Estimate template that has been adapted to the format used to date in the Master Plan Estimates.

- The following markups are included in the estimate, based on traditional design, bid, build:

General Contractor Markups	
General Conditions	8.0%
General Contractors Fee	5.0%
Payment & Performance Bonds	1.0%

The general contractor markups above are imbedded in the unit prices per normal Civil Engineering Cost Practices.

Estimating Design Evolution	10.0%
Construction Contingency	10.0%
LEED Requirements	0.0%
Escalation	0.0%
Owner Soft Costs	
Project Management	3.0%
Construction Manager	6.0%
Planning & Preconstruction	0.2%
Architectural/Engineering Design	8.0%
Architectural/Engineering Construction Admin	2.0%
Airport Staff	1.7%
Materials Testing	1.4%
Plan Check Services	0.1%
Cost Estimating and Scheduling	0.3%
Other	0.5%
Artwork	0.0%

- A ten percent (10%) estimating design evolution has been included in the estimate for unforeseen work and final detailing that may be necessary to accomplish the project scope of work. The design evolution is not intended to be used for additions to the general scope of work.

- The estimate is costed on the understanding that there will be free and open competition at all levels of contracting, that there will not be a restricted bidders list either for general or trade contractors, that there will be at minimum three general contract bidders and at minimum three sub bids will be available for each trade involved. The Owner can facilitate these conditions by ensuring that the project is publicly advertised for bids in general circulation as well as trade publications where advertisements for bid are regularly posted, that prequalification requirements, if prequalification of either general or sub bidders is contemplated, are not unduly restrictive, and by maintaining good industry relations.

- The Opinion of Probable Cost is based on April 2009 dollars with no adjustment for escalation.

- The estimate includes a construction contingency to be utilized for changes and or additions to the scope of work during construction.

- The estimate excludes design/build fees, building permit and fees, overtime and after hours work.

- Allowances included within the Opinion of Probable Cost are amounts the Owner should expect to spend.

- The Opinion of Probable Cost does not include any allowance for fees normally attributed to the Owner such as Real Estate fees, Impact fees, Tap fees, etc.

- Temporary site storage, parking for contractor is assumed to be within the vicinity of the site.

- Hazardous material remediation is not included other than for the allowance included on Project 5 when the Fuel Farm is demolished.

SITEWORK

- Pavement is estimated as 20" soil cement, 8" CTB base, 4" asphalt drainable base and 18" PCC pavement.

- Pavement markings are included.

- Allowances have been added to account for storm drainage requirements.

- The area of the existing FBO to be filled under Project 3A is difficult to grade properly. Significant work will be required to develop this site, hence the higher grading price.

- All excess dirt and rock material to be wasted on site.

- The estimate does not include provisions for undercut and removal of any unsuitable soil material or rock excavation.

- The estimate for Project 4 – Centralized Deicing Pad includes a trench drain along one side of the pad to capture the spent deicing fluid. No diversion valves, diversion structures, pump stations or other mechanical and electrical devices have been included in the estimate as the method of conveyance is not known at this time.

- The tunnel that has been included for Project 4 is assumed to be two (2) barrels wide to allow for the perimeter road as well as Louis Carruthers Drive to be accommodated. Due to the length of the tunnel, it is assumed to have a mechanical air handling system installed to move the air inside the tunnel. Most tunnel design standards require this for tunnels that are 550 feet in length or longer. This tunnel is assumed to be significantly longer than that. It is not known what utilities are located in the Louis Carruthers Drive corridor, but the pricing will be able to accommodate a water line, electrical lines, telephone lines and a gas line. As longer as a sewer is not too deep, then this could be accommodated as well for this price. It is assumed that the tunnel will be lighted as well as have a dry standpipe fire suppression system. Between the inclusions and the design evolution soft cost, we believe that the tunnel costs have been accounted for in our estimate.

ESTIMATE SUMMARY

Project Title	Master Plan Update		
Location	Memphis International Airport		
Submittal Stage	Airfield Projects		
Client Project No.		**Revision**	
Original Date	20-Apr-09	**Revision Date**	
Assumed Bid Opening Date		**CI Project No.**	2466.08.2
Project Manager	DJH	**Checked by**	CSG

Summary

	Description		Total
1	Project 1 - Realign Taxiway M6	$	3,506,100
2	Project 2 - Taxiway C Extension/Taxiway J Realignment	$	9,445,313
3A	Project 3A - Runway 18C Departure Hold Pad	$	4,321,178
3B	Project 3B - Runway 18C Departure Hold Pad	$	1,922,992
4	Project 4 - Centralized Deicing Pad	$	36,600,379
5A	Project 5A - Replacement of Taxiway T	$	14,894,363
5B	Project 5B - Replacement of Taxiway P	$	13,373,311

ESTIMATE DETAIL

Project Title	Master Plan Update		
Location	Memphis International Airport		
Submittal Stage	Airfield Projects		
Project No.	1	**Revision**	
Original Date	20-Apr-09	**Revision Date**	
Assumed Bid Opening Date		**CI Project No.**	2466.08.2
Project Manager	DJH	**Checked by**	CSG

Project 1 - Realign Taxiway M6

DESCRIPTION	Quantity	Unit	Unit Price	Total Price
Mobilization (5%)	1	LS	$ 117,500.00	$ 117,500
Temporary Construction Items (3%)	1	LS	$ 70,500.00	$ 70,500
Demolish Existing T/W M6	6,950	SY	$ 18.00	$ 125,100
Grade New T/W M6	13,600	SY	$ 10.00	$ 136,000
Storm Drainage Allowance	1	AL	$ 35,000.00	$ 35,000
Underdrains	2,500	LF	$ 20.00	$ 50,000
Subgrade Preparation	13,600	SY	$ 3.00	$ 40,800
Soil/Cement (20")	13,600	SY	$ 7.00	$ 95,200
Cement Treated Base (8")	13,600	SY	$ 20.00	$ 272,000
Asphalt Drainable Base (4")	8,700	SY	$ 15.00	$ 130,500
Portland Cement Pavement (20")	8,700	SY	$ 100.00	$ 870,000
Asphalt Base - Shoulders (3")	5,000	SY	$ 20.00	$ 100,000
Asphalt Surface - Shoulders (2")	5,000	SY	$ 18.00	$ 90,000
Pavement Grooving	6,900	SY	$ 3.00	$ 20,700
Pavement Marking	5,000	SF	$ 2.00	$ 10,000
Taxiway Edge Lights	65	EA	$ 2,300.00	$ 149,500
1x2" Concrete Encased Duct	1,500	LF	$ 15.00	$ 22,500
2x2" Concrete Encased Duct	250	LF	$ 25.00	$ 6,250
Taxiway Guidance Signs	4	EA	$ 5,000.00	$ 20,000
#8 5KV Cable	5,000	LF	$ 1.50	$ 7,500
#6 Bare Counterpoise	2,000	LF	$ 1.25	$ 2,500
Subtotal Opinion of Probable Construction Cost				***$ 2,371,550***
Design Contingency	10.0%			$ 237,155
Construction Contingency	10.0%			$ 237,155
Escalation	0.0%			$ -
Subtotal				**$ 2,845,860**
Owner Soft Costs				
Project Management	3.0%			$ 85,376
Construction Manager	6.0%			$ 170,752
Planning and Preconstruction	0.2%			$ 5,692
Architectural / Engineering Design	8.0%			$ 227,669
Architectural / Engineering Construction Adn	2.0%			$ 56,917
Airport Staff	1.7%			$ 48,380
Materials Testing	1.4%			$ 39,842
Plan Check Services	0.1%			$ 2,846
Cost Estimating and Scheduling	0.3%			$ 8,538
Other	0.5%			$ 14,229
Artwork	0.0%			$ -
Opinion of Probable Construction Cost				**$ 3,506,100**

Project Title	Master Plan Update		
Location	Memphis International Airport		
Submittal Stage	Airfield Projects		
Project No.	2	**Revision**	
Original Date	20-Apr-09	**Revision Date**	
Assumed Bid Opening Date		**CI Project No.**	2466.08.2
Project Manager	DJH	**Checked by**	CSG

Project 2 - Taxiway C Extension/Taxiway J Realignment

DESCRIPTION	Quantity	Unit	Unit Price		Total Price	
Mobilization (5%)	1	LS	$	302,000.00	$	302,000
Temporary Construction Items (3%)	1	LS	$	181,200.00	$	181,200
Grade New T/W C Ext. & J Realignment	44,500	SY	$	10.00	$	445,000
Storm Drainage Allowance	1	AL	$	100,000.00	$	100,000
Underdrains	7,000	LF	$	20.00	$	140,000
Subgrade Preparation	44,500	SY	$	3.00	$	133,500
Soil/Cement (20")	44,500	SY	$	7.00	$	311,500
Cement Treated Base (8")	44,500	SY	$	20.00	$	890,000
Asphalt Drainable Base (4")	27,500	SY	$	15.00	$	412,500
Portland Cement Pavement (20")	27,500	SY	$	85.00	$	2,337,500
Asphalt Base - Shoulders (3")	17,100	SY	$	20.00	$	342,000
Asphalt Surface - Shoulders (2")	17,100	SY	$	18.00	$	307,800
Pavement Marking	10,000	SF	$	2.00	$	20,000
Taxiway Edge Lights	130	EA	$	2,300.00	$	299,000
1x2" Concrete Encased Duct	5,000	LF	$	15.00	$	75,000
2x2" Concrete Encased Duct	800	LF	$	25.00	$	20,000
Taxiway Guidance Signs	8	EA	$	5,000.00	$	40,000
#8 5KV Cable	15,000	LF	$	1.50	$	22,500
#6 Bare Counterpoise	7,500	LF	$	1.25	$	9,375
Subtotal Opinion of Probable Construction Cost					***$***	***6,388,875***
Design Contingency	10.0%				$	638,888
Construction Contingency	10.0%				$	638,888
Escalation	0.0%				$	-
Subtotal					**$**	**7,666,650**
Owner Soft Costs						
Project Management	3.0%				$	230,000
Construction Manager	6.0%				$	459,999
Planning and Preconstruction	0.2%				$	15,333
Architectural / Engineering Design	8.0%				$	613,332
Architectural / Engineering Construction Adr	2.0%				$	153,333
Airport Staff	1.7%				$	130,333
Materials Testing	1.4%				$	107,333
Plan Check Services	0.1%				$	7,667
Cost Estimating and Scheduling	0.3%				$	23,000
Other	0.5%				$	38,333
Artwork	0.0%				$	-
Opinion of Probable Construction Cost					**$**	**9,445,313**

Project Title	Master Plan Update		
Location	Memphis International Airport		
Submittal Stage	Airfield Projects		
Project No.	3A	**Revision**	
Original Date	20-Apr-09	**Revision Date**	
Assumed Bid Opening Date		**CI Project No.**	2466.08.2
Project Manager	DJH	**Checked by**	CSG

Project 3A - Runway 18C Departure Hold Pad

DESCRIPTION	Quantity	Unit	Unit Price		Total Price	
Mobilization (5%)	1	LS	$	132,500.00	$	132,500
Temporary Construction Items (3%)	1	LS	$	79,500.00	$	79,500
Demolish Existing FBO Facilities	1	LS	$	150,000.00	$	150,000
Grade Runway 18C Departure Hold Pad	12,150	SY	$	30.00	$	364,500
Storm Drainage Allowance	1	AL	$	100,000.00	$	100,000
Underdrains	2,500	LF	$	20.00	$	50,000
Subgrade Preparation	12,150	SY	$	3.00	$	36,450
Soil/Cement (20")	12,150	SY	$	7.00	$	85,050
Cement Treated Base (8")	12,150	SY	$	20.00	$	243,000
Asphalt Drainable Base (4")	12,150	SY	$	15.00	$	182,250
Portland Cement Pavement (20")	12,150	SY	$	100.00	$	1,215,000
Asphalt Base - Shoulders (3")	3,500	SY	$	25.00	$	87,500
Asphalt Surface - Shoulders (2")	3,500	SY	$	23.00	$	80,500
Pavement Marking	3,000	SF	$	2.00	$	6,000
Taxiway Edge Lights	25	EA	$	2,300.00	$	57,500
1x2" Concrete Encased Duct	1,500	LF	$	15.00	$	22,500
2x2" Concrete Encased Duct	400	LF	$	25.00	$	10,000
Taxiway Guidance Signs	2	EA	$	5,000.00	$	10,000
#8 5KV Cable	5,000	LF	$	1.50	$	7,500
#6 Bare Counterpoise	2,500	LF	$	1.25	$	3,125
Subtotal Opinion of Probable Construction Cost					***$***	***2,922,875***
Design Contingency	10.0%				$	292,288
Construction Contingency	10.0%				$	292,288
Escalation	0.0%				$	-
Subtotal					**$**	**3,507,450**
Owner Soft Costs						
Project Management	3.0%				$	105,224
Construction Manager	6.0%				$	210,447
Planning and Preconstruction	0.2%				$	7,015
Architectural / Engineering Design	8.0%				$	280,596
Architectural / Engineering Construction Ad	2.0%				$	70,149
Airport Staff	1.7%				$	59,627
Materials Testing	1.4%				$	49,104
Plan Check Services	0.1%				$	3,507
Cost Estimating and Scheduling	0.3%				$	10,522
Other	0.5%				$	17,537
Artwork	0.0%				$	-
Opinion of Probable Construction Cost					**$**	**4,321,178**

Project Title	Master Plan Update		
Location	Memphis International Airport		
Submittal Stage	Airfield Projects		
Project No.	3A	**Revision**	
Original Date	20-Apr-09	**Revision Date**	
Assumed Bid Opening Date		**CI Project No.**	2466.08.2
Project Manager	DJH	**Checked by**	CSG

Project 3B - Runway 18C Departure Hold Pad

DESCRIPTION	Quantity	Unit	Unit Price		Total Price	
Mobilization (5%)	1	LS	$	60,200.00	$	60,200
Temporary Construction Items (3%)	1	LS	$	36,100.00	$	36,100
Demolish Existing FBO Facilities	1	LS	$	150,000.00	$	150,000
Grade Runway 18C Departure Hold Pad	5,000	SY	$	10.00	$	50,000
Storm Drainage Allowance	1	AL	$	10,000.00	$	10,000
Underdrains	2,500	LF	$	20.00	$	50,000
Subgrade Preparation	5,000	SY	$	3.00	$	15,000
Soil/Cement (20")	5,000	SY	$	7.00	$	35,000
Cement Treated Base (8")	5,000	SY	$	20.00	$	100,000
Asphalt Drainable Base (4")	5,000	SY	$	15.00	$	75,000
Portland Cement Pavement (20")	5,000	SY	$	100.00	$	500,000
Asphalt Base - Shoulders (3")	2,800	SY	$	25.00	$	70,000
Asphalt Surface - Shoulders (2")	2,800	SY	$	23.00	$	64,400
Pavement Marking	2,000	SF	$	2.00	$	4,000
Taxiway Edge Lights	18	EA	$	2,300.00	$	41,400
1x2" Concrete Encased Duct	1,000	LF	$	15.00	$	15,000
2x2" Concrete Encased Duct	300	LF	$	25.00	$	7,500
Taxiway Guidance Signs	2	EA	$	5,000.00	$	10,000
#8 5KV Cable	3,500	LF	$	1.50	$	5,250
#6 Bare Counterpoise	1,500	LF	$	1.25	$	1,875
Subtotal Opinion of Probable Construction Cost					***$***	***1,300,725***
Design Contingency	10.0%				$	130,073
Construction Contingency	10.0%				$	130,073
Escalation	0.0%				$	-
Subtotal					**$**	**1,560,870**
Owner Soft Costs						
Project Management	3.0%				$	46,826
Construction Manager	6.0%				$	93,652
Planning and Preconstruction	0.2%				$	3,122
Architectural / Engineering Design	8.0%				$	124,870
Architectural / Engineering Construction Ad	2.0%				$	31,217
Airport Staff	1.7%				$	26,535
Materials Testing	1.4%				$	21,852
Plan Check Services	0.1%				$	1,561
Cost Estimating and Scheduling	0.3%				$	4,683
Other	0.5%				$	7,804
Artwork	0.0%				$	-
Opinion of Probable Construction Cost					**$**	**1,922,992**

Project Title	Master Plan Update		
Location	Memphis International Airport		
Submittal Stage	Airfield Projects		
Project No.	4.00	**Revision**	
Original Date	20-Apr-09	**Revision Date**	
Assumed Bid Opening Date		**CI Project No.**	2466.08.2
Project Manager	DJH	**Checked by**	CSG

Project 4 - Centralized Deicing Pad

DESCRIPTION	Quantity	Unit	Unit Price	Total Price
Mobilization (5%)	1	LS	$ 1,145,000.00	$ 1,145,000
Temporary Construction Items (3%)	1	LS	$ 687,000.00	$ 687,000
Tunnel - Louis Carruthers Drive	1100	LF	$ 10,000.00	$ 11,000,000
Grade Runway Centralized Deicing Pad	76,650	SY	$ 10.00	$ 766,500
Storm Drainage Allowance	1	AL	$ 300,000.00	$ 300,000
Underdrains	5,000	LF	$ 20.00	$ 100,000
Subgrade Preparation	76,650	SY	$ 3.00	$ 229,950
Soil/Cement (20")	76,650	SY	$ 7.00	$ 536,550
Cement Treated Base (8")	76,650	SY	$ 20.00	$ 1,533,000
Asphalt Drainable Base (4")	76,650	SY	$ 15.00	$ 1,149,750
Portland Cement Pavement (20")	76,650	SY	$ 85.00	$ 6,515,250
Trench Drain	1,150	LF	$ 300.00	$ 345,000
Asphalt Base - Shoulders (3")	5,000	SY	$ 25.00	$ 125,000
Asphalt Surface - Shoulders (2")	5,000	SY	$ 23.00	$ 115,000
Pavement Marking	3,000	SF	$ 2.00	$ 6,000
Taxiway Edge Lights	30	EA	$ 2,300.00	$ 69,000
1x2" Concrete Encased Duct	5,000	LF	$ 15.00	$ 75,000
2x2" Concrete Encased Duct	400	LF	$ 25.00	$ 10,000
Taxiway Guidance Signs	4	EA	$ 5,000.00	$ 20,000
#8 5KV Cable	15,000	LF	$ 1.50	$ 22,500
#6 Bare Counterpoise	5,000	LF	$ 1.25	$ 6,250
Subtotal Opinion of Probable Construction Cost				**$ 24,756,750**
Design Contingency	10.0%			$ 2,475,675
Construction Contingency	10.0%			$ 2,475,675
Escalation	0.0%			$ -
Subtotal				**$ 29,708,100**
Owner Soft Costs				
Project Management	3.0%			$ 891,243
Construction Manager	6.0%			$ 1,782,486
Planning and Preconstruction	0.2%			$ 59,416
Architectural / Engineering Design	8.0%			$ 2,376,648
Architectural / Engineering Construction Adı	2.0%			$ 594,162
Airport Staff	1.7%			$ 505,038
Materials Testing	1.4%			$ 415,913
Plan Check Services	0.1%			$ 29,708
Cost Estimating and Scheduling	0.3%			$ 89,124
Other	0.5%			$ 148,541
Artwork	0.0%			$ -
Opinion of Probable Construction Cost				**$ 36,600,379**

Project Title	Master Plan Update		
Location	Memphis International Airport		
Submittal Stage	Airfield Projects		
Project No.	5A	**Revision**	
Original Date	20-Apr-09	**Revision Date**	
Assumed Bid Opening Date		**CI Project No.**	2466.08.2
Project Manager	DJH	**Checked by**	CSG

Project 5A - Replacement of Taxiway T

Mobilization (5%)	1	LS	$	466,250.00	$	466,250
Temporary Construction Items (3%)	1	LS	$	279,750.00	$	279,750
Demolish Existing T/W T	58,400	SY	$	18.00	$	1,051,200
Demolish Existing Fuel Farm	1	LS	$	500,000.00	$	500,000
Environmental Mitigation Contingency	1	AL	$	100,000.00	$	100,000
Underdrains	10,000	LF	$	20.00	$	200,000
Subgrade Preparation	58,400	SY	$	3.00	$	175,200
Soil/Cement (20")	58,400	SY	$	7.00	$	408,800
Cement Treated Base (8")	58,400	SY	$	20.00	$	1,168,000
Asphalt Drainable Base (4")	44,000	SY	$	15.00	$	660,000
Portland Cement Pavement (20")	44,000	SY	$	85.00	$	3,740,000
Asphalt Base - Shoulders (3")	14,400	SY	$	20.00	$	288,000
Asphalt Surface - Shoulders (2")	14,400	SY	$	18.00	$	259,200
Pavement Marking	8,500	SF	$	2.00	$	17,000
Taxiway Edge Lights	225	EA	$	2,300.00	$	517,500
1x2" Concrete Encased Duct	8,500	LF	$	15.00	$	127,500
2x2" Concrete Encased Duct	800	LF	$	25.00	$	20,000
Taxiway Guidance Signs	8	EA	$	5,000.00	$	40,000
#8 5KV Cable	25,000	LF	$	1.50	$	37,500
#6 Bare Counterpoise	15,000	LF	$	1.25	$	18,750
Subtotal Opinion of Probable Construction Cost					**$**	**10,074,650**
Design Contingency	10.0%				$	1,007,465
Construction Contingency	10.0%				$	1,007,465
Escalation	0.0%				$	-
Subtotal					**$**	**12,089,580**
Owner Soft Costs						
Project Management	3.0%				$	362,687
Construction Manager	6.0%				$	725,375
Planning and Preconstruction	0.2%				$	24,179
Architectural / Engineering Design	8.0%				$	967,166
Architectural / Engineering Construction Adr	2.0%				$	241,792
Airport Staff	1.7%				$	205,523
Materials Testing	1.4%				$	169,254
Plan Check Services	0.1%				$	12,090
Cost Estimating and Scheduling	0.3%				$	36,269
Other	0.5%				$	60,448
Artwork	0.0%				$	-
Opinion of Probable Construction Cost					**$**	**14,894,363**

Project Title	Master Plan Update		
Location	Memphis International Airport		
Submittal Stage	Airfield Projects		
Project No.	5B	**Revision**	
Original Date	20-Apr-09	**Revision Date**	
Assumed Bid Opening Date		**CI Project No.**	2466.08.2
Project Manager	DJH	**Checked by**	CSG

Project 5B - Replacement of Taxiway P

Mobilization (5%)	1	LS	$	447,850.00	$	447,850
Temporary Construction Items (3%)	1	LS	$	268,700.00	$	268,700
Demolish Existing T/W T	56,500	SY	$	18.00	$	1,017,000
Underdrains	10,000	LF	$	20.00	$	200,000
Subgrade Preparation	52,500	SY	$	3.00	$	157,500
Soil/Cement (20")	52,500	SY	$	7.00	$	367,500
Cement Treated Base (8")	52,500	SY	$	20.00	$	1,050,000
Asphalt Drainable Base (4")	42,500	SY	$	15.00	$	637,500
Portland Cement Pavement (20")	42,500	SY	$	85.00	$	3,612,500
Asphalt Base - Shoulders (3")	14,000	SY	$	20.00	$	280,000
Asphalt Surface - Shoulders (2")	14,000	SY	$	18.00	$	252,000
Pavement Marking	8,500	SF	$	2.00	$	17,000
Taxiway Edge Lights	215	EA	$	2,300.00	$	494,500
1x2" Concrete Encased Duct	8,500	LF	$	15.00	$	127,500
2x2" Concrete Encased Duct	800	LF	$	25.00	$	20,000
Taxiway Guidance Signs	8	EA	$	5,000.00	$	40,000
#8 5KV Cable	25,000	LF	$	1.50	$	37,500
#6 Bare Counterpoise	15,000	LF	$	1.25	$	18,750
Subtotal Opinion of Probable Construction Cost					***$***	***9,045,800***
Design Contingency	10.0%				$	904,580
Construction Contingency	10.0%				$	904,580
Escalation	0.0%				$	-
Subtotal					**$**	**10,854,960**
Owner Soft Costs						
Project Management	3.0%				$	325,649
Construction Manager	6.0%				$	651,298
Planning and Preconstruction	0.2%				$	21,710
Architectural / Engineering Design	8.0%				$	868,397
Architectural / Engineering Construction Adr	2.0%				$	217,099
Airport Staff	1.7%				$	184,534
Materials Testing	1.4%				$	151,969
Plan Check Services	0.1%				$	10,855
Cost Estimating and Scheduling	0.3%				$	32,565
Other	0.5%				$	54,275
Artwork	0.0%				$	-
Opinion of Probable Construction Cost					**$**	**13,373,311**

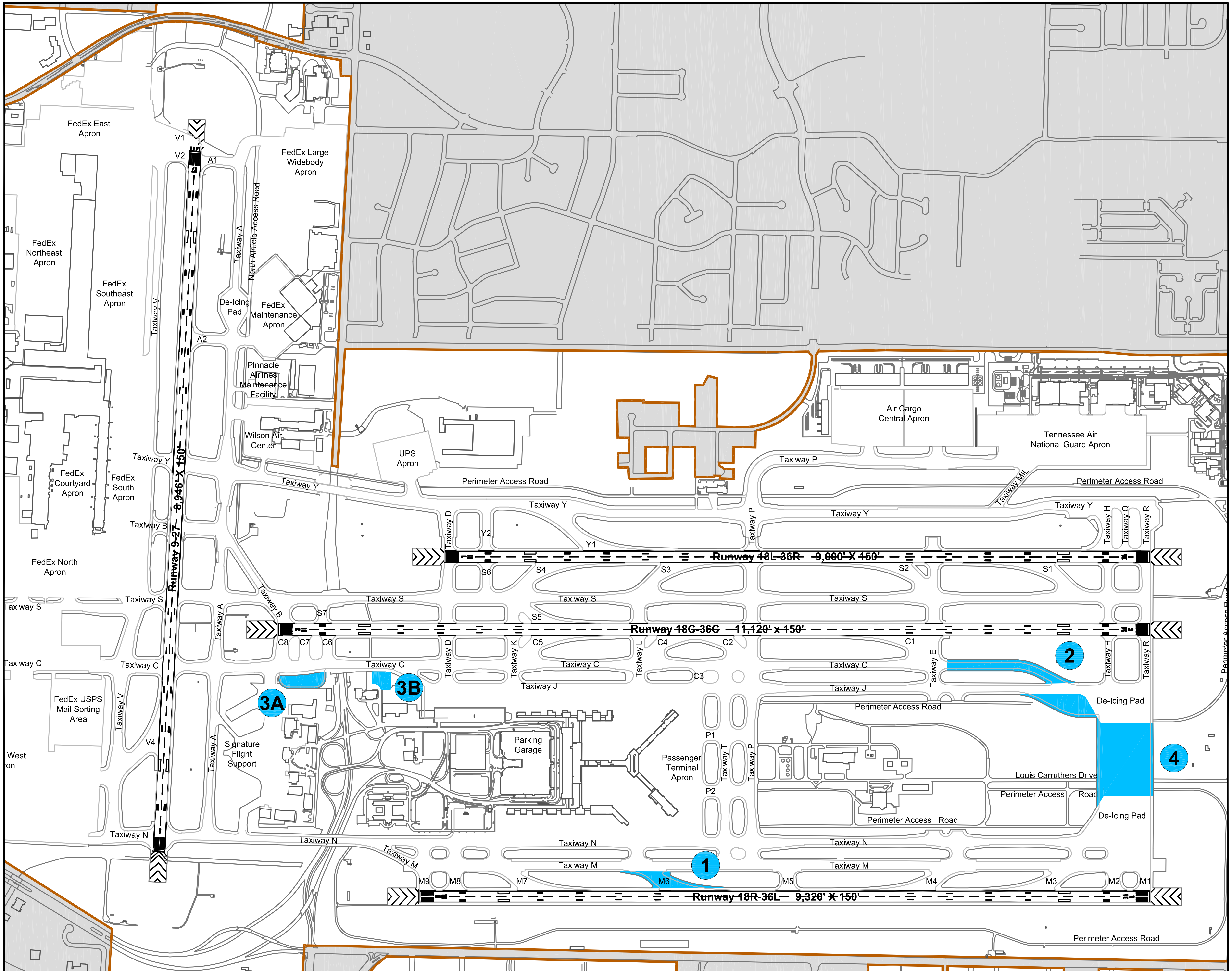
EXHIBITS

Exhibit A
Document List

EXHIBIT A – DOCUMENT LIST

- The estimate reflects the drawings listed herein.

Drawing No.	Description	Date
	Jacobs Consultancy Plans	
2-1	Planning Period Airfield Projects	April 2009
2-2	Ultimate Airfield Projects	April 2009



LEGEND

- Airport property line
- 1 Angled exit Taxiway M6
- 2 Taxiway C Extension/Taxiway J realignment
- 3A Runway 18C departure hold pad
- 3B Runway 18C departure hold pad
- 4 Centralized deicing pad

N

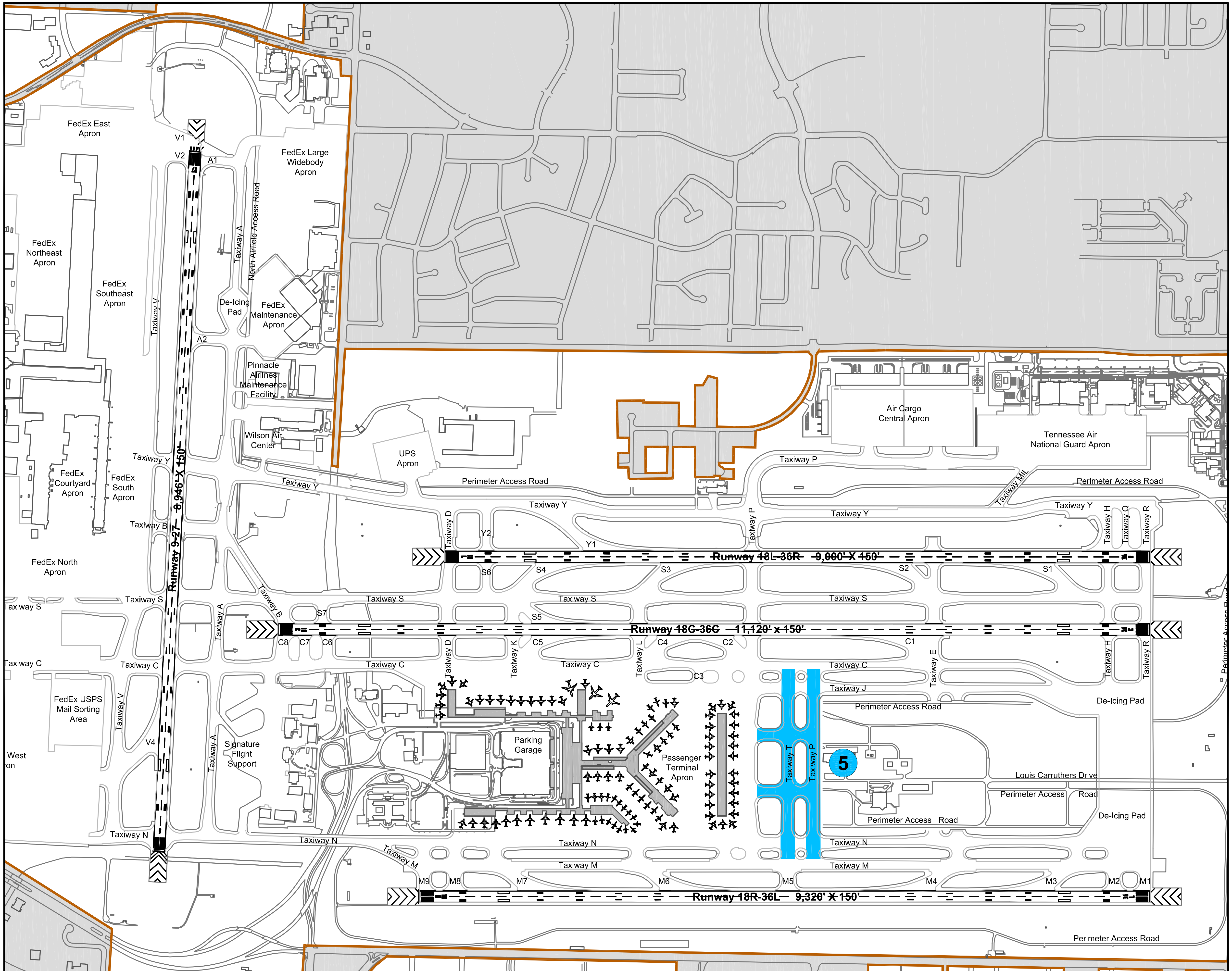
0' 600' 1,200' 2,400'

DRAFT

Figure 2-1

PLANNING PERIOD AIRFIELD PROJECTS
Master Plan Update
Memphis International Airport
April 2009

JACOBS CONSULTANCY



LEGEND

Airport property line

5 Replacement of Taxiways T and P

N

0' 600' 1,200' 2,400'

DRAFT

Figure 2-2

ULTIMATE AIRFIELD PROJECTS
Master Plan Update
Memphis International Airport
April 2009

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FINAL WORKING PAPER

TERMINAL DEVELOPMENT ALTERNATIVES
MASTER PLAN UPDATE
Memphis International Airport

Prepared for

Memphis-Shelby County Airport Authority
Memphis, Tennessee

January 2010

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Memphis International Airport

Prepared for

Memphis-Shelby County Airport Authority
Memphis, Tennessee

January 2010

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TERMINAL DEVELOPMENT ALTERNATIVES

INTRODUCTION

Phase I of the Master Plan Update, undertaken by the Memphis-Shelby County Airport Authority (the Authority) for Memphis International Airport (the Airport) included a comprehensive inventory of existing conditions within the passenger terminal complex (including a standalone report on building systems), forecasts of future aviation demand for passenger airline traffic, and demand/capacity analyses that led to physical facility requirements required to support anticipated traffic levels over the 20-year planning period.

Throughout Phase I, the implications of the announced but yet-to-be-culminated merger between Delta Air Lines and Northwest Airlines were considered as part of each task. Northwest Airlines operates its third-largest domestic connecting hub at the Airport and served more than 80% of total enplaned passengers in 2007. At the time the inventory was compiled, Northwest Airlines offered the only nonstop international flights from the Airport and, combined with Delta Air Lines, occupied 74 of the 86 gates.

The Phase I facility requirements identified the need to upgrade, expand, and modernize the passenger terminal complex—consisting of a Main Terminal building and three concourses—to enable the Airport to accommodate future air travel demand at desired levels of passenger service for the 20-year planning period and beyond. To that end, a detailed alternatives analysis was undertaken at the outset of Phase II of the Master Plan Update to develop, analyze, evaluate, and identify a preferred plan for future terminal development. This Working Paper describes the background, approach, alternatives, and the preferred plan identified during the study.

Approach

The development and selection of the preferred development alternative was handled through four interactive workshops, during which Authority staff provided real-time feedback to the Consultant Team (the Team) and collaborated on planning options and challenges. The agenda for each workshop was as follows:

- **Workshop #1 (November 11, 2008) –** Review of Phase I findings and past terminal planning efforts; establishment of terminal planning objectives; discussion of preliminary long-term development concepts
- **Workshop #2 (December 16, 2008) –** Identification of "building block" projects; discussion of baseline alternatives and long-term vision concepts; presentation of preliminary Federal Inspection Service (FIS) facility designs

- **Workshop #3 (February 17, 2009) –** Presentation of refined baseline alternatives, long-term vision concepts, and FIS facility plans; discussion of cost estimates, financial capacity, and cost per enplaned passenger projections; selection of preferred baseline alternative and long-term vision concept

- **Workshop #4 (March 18, 2009) –** Description of individual components of the preferred plan; presentation of refined FIS facility and main terminal renovation plans; confirmation of phasing plan for terminal development

The Team was led by Jacobs Consultancy and supported by Allen & Hoshall (building systems), Architectural Alliance (architecture), Clark Dixon (architecture), Connico (cost estimating), and the Authority's Seismic Risk Assessment team (seismic/structural engineering).

Planning Guidelines

Terminal development alternatives were prepared and evaluated using the following planning objectives and guidelines:

- **Protect the Hub –** Pursue development projects that maintain and enhance the Airport's strategic position as a hub for connecting traffic.

- **Minimize Capital Costs –** Create a terminal development program that is affordable to the Authority and its key tenants and maintains the Airport's low cost per enplaned passenger as compared with peer and competitor airports.

- **Maintain Existing Building –** Avoid, wherever possible, removing gates and supporting facilities already in place and functioning.

- **Enable Non-disruptive Construction –** Develop a program that recognizes the importance of maintaining full and uninterrupted Airport operations during the construction of new projects.

- **Avoid Lost Investment –** Ensure that projects within the planning period are consistent with a long-term vision for passenger terminal development to avoid incurring sunk costs in the future.

Planning Activity Levels

Recognizing uncertainties associated with long-range aviation demand forecasting, three planning activity levels (PALs) were identified to represent future levels of activity at which key terminal improvements would be necessary. Because activity levels could deviate from calendar-based forecasts for any number of reasons, the use of PAL "triggers" allows for facilities planning that is realistically tied to future activity levels as they occur, rather than arbitrary milestone years. For this Master Plan Update, PAL 1, PAL 2, and PAL 3 generally correspond to aviation activity forecasts for 2012, 2017, and 2027, respectively. Passenger airline activity associated with each PAL is summarized in Table 1.

Table 1

SUMMARY OF FORECAST PASSENGER ACTIVITY
Master Plan Update
Memphis International Airport

	Historical		Forecast		
			PAL 1	PAL 2	PAL 3
	(2006)	(2007)	(2012)	(2017)	(2027)
Enplaned passengers					
Local	2,267,000	2,362,000	2,691,000	3,044,000	3,876,000
Connecting	3,053,000	2,995,000	3,259,000	3,401,000	3,740,000
Total	5,320,000	5,357,000	5,950,000	6,445,000	7,616,000
Aircraft operations	201,170	197,748	210,900	215,200	243,100

Sources: Historical—Memphis-Shelby County Airport Authority records.
Forecast—Jacobs Consultancy, July 2008.

REQUIREMENTS AND CHALLENGES

The focus of the alternatives analysis was to address the following requirements and facility challenges.

Aircraft Gates

A total of 103 gates will be required at the end of the planning period, based on a conservative assumption that gates will continue to be used on an exclusive or preferential use basis as is currently practiced. Gate requirements were translated to required linear frontage along the terminal building to avoid aircraft and gate specifics. Table 2 presents the required frontage at each PAL. Despite the evolving fleet mix (i.e., small narrowbody aircraft being replaced with large regional jets) anticipated over the planning period, the average gate width remains relatively constant at each PAL.

Table 2

AIRCRAFT GATE REQUIREMENTS
Master Plan Update
Memphis International Airport

		Estimated requirement *(a)*			
	Existing	Baseline (2007)	PAL 1 (2012)	PAL 2 (2017)	PAL 3 (2027)
Total gates	86	86	87	92	103
Linear frontage (feet)	9,800	10,000	9,990 *(b)*	10,600	11,700
Average gate width (feet)	114	116	115	115	114

(a) Assumes continuation of existing exclusive or preferential use gate leasing policies throughout planning period.
(b) Decrease in required frontage, while total gate requirement increases, is due to forecast of decreasing aircraft size.

Source: Jacobs Consultancy, November 2008.

Main Terminal Building

The Main Terminal building, which consists of three primary sections—Terminals A, B, and C—is appropriately-sized to handle future passenger demand. However, a number of "hotspots" were identified as needing improvement during the planning period. These include:

- Disproportionate volume of passengers in Terminal B
- Insufficient number of lanes and queuing space at Terminal B security checkpoint (PAL 1)
- Circulation cross-flows in Terminal B ticket lobby in front of the security checkpoint
- Insufficiently-sized baggage claim lobbies in Terminals A and C (PAL 3)
- Constrained and poorly-located vertical circulation cores in terminal lobbies
- Narrow ground-level passageway between baggage claim lobbies

In addition to the constrained areas listed above, there is abundant underutilized and/or vacant space on the mezzanine level of Terminals A and C. Further, it is assumed that an in-line baggage security screening system, which has already undergone preliminary design and engineering independent of the Master Plan Update, will be implemented during PAL 2. This in-line system would be a three-story structure located south of the Main Terminal building but north of the secure passenger connector walkways on both the east and west sides of the complex.

FIS Facility

The Federal Inspection Service (FIS) facility, located at the end of the southwestern leg of Concourse B, provides primary and secondary Immigration and Customs screening of passengers, baggage claims, baggage re-check areas for connecting passengers, and passenger and checked baggage security screening facilities. The existing facility, which can process approximately 400 arriving passengers per hour, experiences congestion and provides diminished levels of service at the queuing area for primary Immigration screening and at the passenger and baggage security screening area when multiple flights arrive simultaneously. Forecast growth in international traffic and Authority objectives for enhanced levels of service will require a facility capable of parking four international aircraft, including two widebody aircraft, and processing approximately 800 passengers per hour.

In addition, the remote location of the FIS facility is cumbersome for terminating international passengers, as they must re-check their baggage and be re-screened at the passenger security checkpoint before walking the length of Concourse B to the Main Terminal building, where they must again claim their bags. Ideally, these passengers would be able to exit the FIS facility directly without needing to claim their baggage twice. The baggage re-check requirement also imposes a burden on the airline, which must double handle this baggage.

Building Systems

A comprehensive assessment of the current condition, capacity, and age of mechanical, electrical, and plumbing systems within the Main Terminal building and concourses was prepared concurrently with the inventory during Phase I of the Master Plan Update. This assessment, coupled with anecdotal information from Authority staff, concluded that several basic building systems (1) are currently operating at or above their functional capacities; (2) have components that require heavy maintenance, overhaul, or replacement; and/or (3) will restrict future additions to the building without simultaneously upgrading the capacity of the system in question.

Seismic Vulnerabilities

A seismic risk assessment was conducted concurrently with Phase I of the Master Plan Update to evaluate the vulnerabilities of the passenger terminal building to a potential seismic event. The Main Terminal building and concourses, much of which dates from the late 1960s, was not constructed considering seismic factors and therefore is vulnerable to both minor and major structural failures. Areas of particular concern include the columns and glazing in the main terminal lobbies, the joints between structural sections of the concourses, and the connection between the elevated curbside roadway deck and the columns that support it.

Curbsides

The terminal curbside is configured in a two-level arrangement, with departing passengers dropped off on the upper level outside the ticketing lobbies and arriving passengers picked up on the ground level adjacent to the baggage claim lobbies. The upper-level roadway has two separate roadway sections while the ground-level roadway has three separate roadway sections. The inner roadways on both the upper and lower levels, each three lanes wide, are prone to double parking and limit the ability of through traffic to flow freely. The throughput capacity of both levels is adequate through PAL 2. However, curbside frontage in front of Terminal B is scarce during the peak periods on both the upper and lower levels. Therefore, while overall curbside length is adequate, additional frontage to support Terminal B is required at PAL 2.

Level of Service Considerations

Level-of-service (LOS) considerations take on a wide range of meaning given that various users of the Airport all have differing priorities and concerns. To the traveling public, providing a good LOS could include minimizing walking distances, mitigating areas of congestion, providing a variety of services and amenities, and making the terminal as intuitive as possible. To an airline or concessionaire, providing a good LOS could include avoiding operational constraints, reducing delays, and enhancing revenue. Lastly, to the greater Memphis community, providing a good LOS could include promoting business development, enhancing tourism, generating employment for local residents, and linking the City to the rest of the country and world. The terminal development alternatives considered were prepared with these three LOS perceptions in mind.

Airfield Interactions

Aircraft parking along the west side of Concourse A and the east side of Concourse C must pushback from their parking positions onto active north-south Taxiways N and J, respectively. On the west side, Taxiway N is essential for aircraft, principally FedEx, using Runway 18R-36L and parking on aprons located north of Winchester Road.

Because of the proximity Concourse A, Taxiway N was limited to aircraft within Airplane Design Group∗ (ADG) III and smaller, which excludes the majority of the FedEx fleet. In mid-2009, the Authority removed roadway markings on the pavement, thereby permitting ADG IV operations between Taxiways M9 and T on Taxiway N. FAA approval is pending. On the east side of the terminal, Taxiway J is used exclusively by aircraft parking at Concourse C and is not used for major north-south airfield circulation.

In addition, there are two single-taxilane alleyways between Concourse B and Concourses A and C that provide access to aircraft gates (approximately 13 on the east side and 20 on the west side). These taxilanes do not result in excessive head-to-head taxiing conflicts or operational delays because all of the gates are controlled by Delta

∗Airplane Design Group (ADG) is a categorization of aircraft according to their wingspans and tail heights. Aircraft in ADG III have wingspans between 79 and 117 feet and tail heights between 30 and 44 feet.

Air Lines, which can assign gates and manage schedules to mitigate the potential issues. However, these taxilanes are an efficiency deterrent and would become more problematic if multiple airlines were using the gates on the interior of the alleys.

CONCEPT DEVELOPMENT

The Airport's existing Main Terminal building and concourses, as they stand today, are largely the product of an architectural vision established in the 1960s and built out over the past several decades. What was once an ultimate vision for the terminal has now been physically realized, necessitating the development of a new long-term terminal vision to guide the development program for the next 20-years and beyond. Establishing this vision was the first step to identifying physical development alternatives.

Preliminary Long-term Visions

Five preliminary long-term visions were developed to identify the range of viable conceptual layouts for passenger terminal facilities at the Airport. Figure 1 graphically depicts and describes the key features, pros, and cons associated with each vision.

Of these five preliminary long-term visions, Concepts 1, 3, and 5 were discarded from further consideration based on the unsuitability of each to addressing the requirements and issues as well as Authority input and feedback at Workshop #1. Concept 1 would require high investment costs, remove a substantial number of existing aircraft gates, and displace existing aviation support facilities in the south midfield. Concept 3 would be extremely disruptive to existing operations and difficult to construct, negate past investment in the existing terminal complex, and adversely affect recent landside improvements. Lastly, Concept 5 would create a dead-end alleyway between concourses, provide lengthy walking distances for passengers, and negate past investment in Concourse B.

Both long-term visions carried forward reflect reasonable evolution of the existing passenger terminal complex. Concept 2 respects the existing terminal geometry while also improving airfield operations and providing the ability to expand modularly in the future. Concept 4 continues the existing terminal geometry while improving passenger level-of-service through expanded holdroom, circulation, and concession space on Concourse B.

Building Block Projects

The facility requirements for the passenger terminal were unique in that there were few significant demand-driven requirements. Instead, the requirements were for minor facility expansions over the planning period. To begin developing a program to meet these unique circumstances, a variety of "building block" projects that resolve specific facility shortfalls were developed. Each of these projects addresses a particular requirement or issue and can be combined in several different permutations to form overall development concepts.

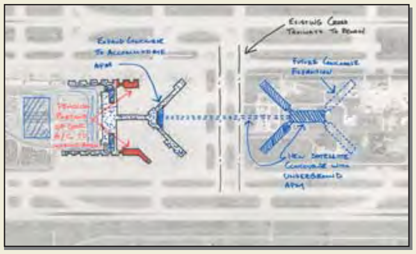
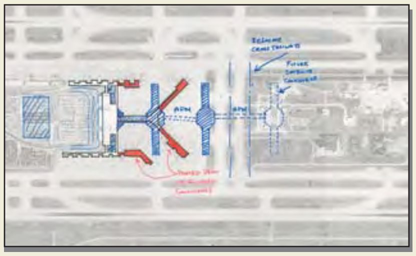
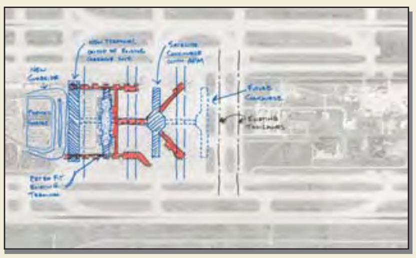
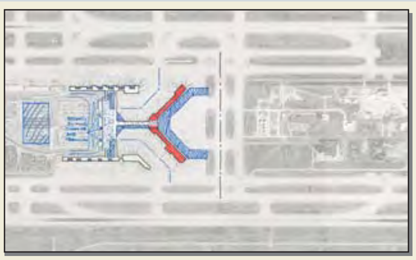
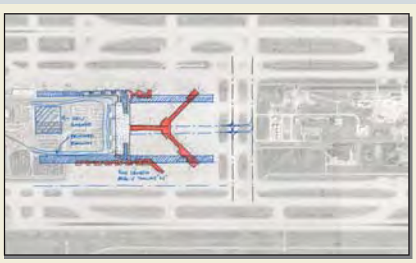
	KEY ELEMENTS	PROS	CONS
CONCEPT 1 	• Develop new concourse in south midfield • Provide Automated People Mover System between existing terminal and new south concourse • Demolish southern ends of Concourses A and C • Update recommended terminal plan presented in 1996 Master Plan	• Ease of phasing • Improved aircraft operations in terminal area • Flexibility to accommodate multiple operational scenarios	• High capital costs • Increased walking distances • Adverse effects on existing facilities in south midfield • Potential environmental mitigation
CONCEPT 2 	• Develop new concourse to south of existing terminal • Provide Automated People Mover System between existing terminal and new south concourse • Relocate cross-field taxiways • Demolish southern ends of Concourses A and C • Reconstruct Concourse B in alignment perpendicular to airfield	• Ease of phasing • Improved aircraft operations in terminal area • Flexibility to accommodate multiple operational scenarios	• High capital costs • Significant construction and phasing challenges • Adverse effects on existing facilities in south midfield • Potential environmental mitigation
CONCEPT 3 	• Construct new Main Terminal building and curbsides/access • Convert existing Main Terminal to passenger concourse use • Demolish existing concourses • Develop new concourse to replace existing Concourse B • Provide Automated People Mover System between existing terminal and new south concourse	• New terminal complex at completion • Improved aircraft operations in terminal area • Flexibility to accommodate multiple operational scenarios • Reduced renovation and retrofit investment	• High capital costs • Adverse effects on existing curbside and parking facilities • Loss of architectural heritage of existing Main Terminal building
CONCEPT 4 	• Enlarge and renovate Main Terminal • Widen and extend southern legs of Concourse B • Enlarge seating and concession space in Concourses A and C	• Ease of phasing • Improved aircraft operations in terminal area • Significant Automated People Mover System investment avoided • Improved levels-of-service	• Limited potential for future expansion • Limited flexibility to adapt to multiple operational scenarios
CONCEPT 5 	• Demolish Concourse B • Rebuild and expand Concourses A and C to the north and south	• Ease of phasing • Maintains existing cross-field taxiways • Minimized impacts to existing facilities	• Creates lengthy alleyway between concourses • Lack of flexibility to adapt to multiple operational scenarios • Limited potential for future expansion • Longer walking distances for passengers

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Figure 1

PRELIMINARY LONG-TERM VISIONS

Terminal Development Alternatives
Master Plan Update
Memphis International Airport

November 2009

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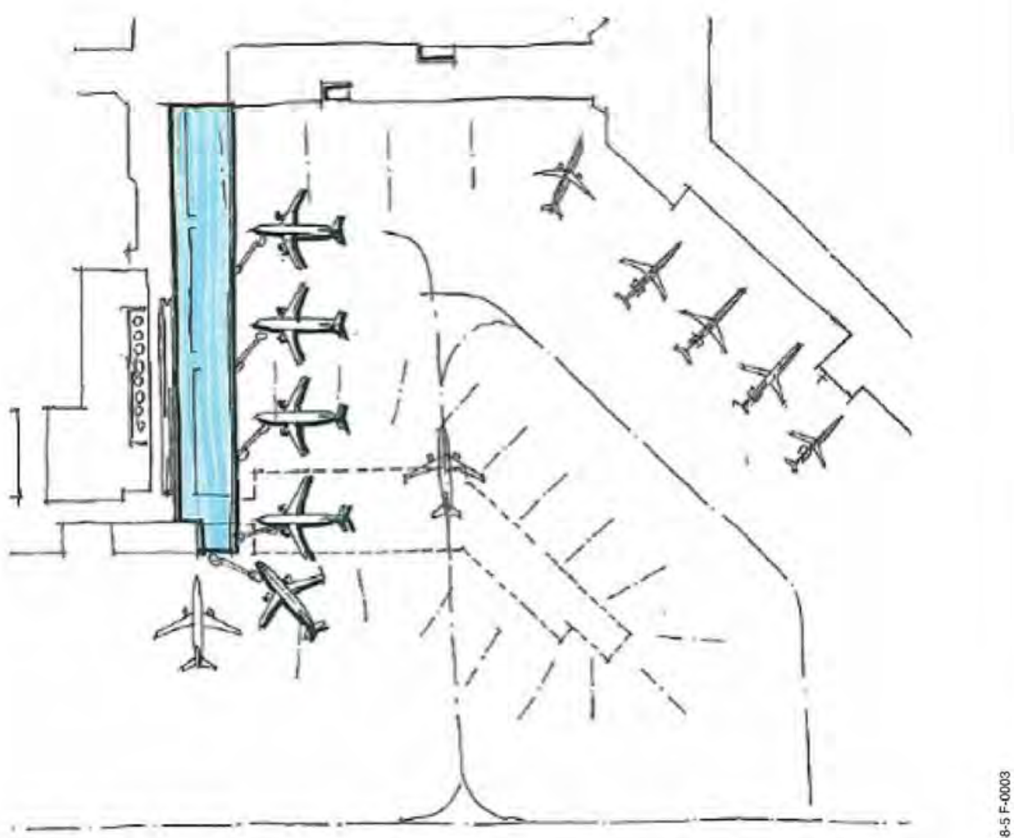
Appendix A contains illustrations and descriptions of over thirty projects that were reviewed with the Authority at Workshop #2. Each of the proposed projects addressed one or more of the followings requirements or challenges:

- Additional aircraft gates, passenger holdrooms, and airline operations space
- Improved interactions between the passenger terminal and airfield
- Relocated FIS facility and international arrivals facility
- Improved passenger level-of-service, including both expanded circulation space and reduction in unassisted walking distance

As an example, Figure 2 depicts a building block project that would remove the southern end of Concourse A and expand the Main Terminal building to the south. This would enable approximately five narrowbody aircraft parking positions to be located on the south face of the Main Terminal building at close proximity to the passenger security screening checkpoints and adjacent concessions. This project would also remove the existing single taxilane alleyway between Concourses A and B.

Figure 2
SAMPLE BUILDING BLOCK PROJECT
Master Plan Update
Memphis International Airport



TERMINAL DEVELOPMENT ALTERNATIVES

Three terminal development alternatives for the 20-year planning period, termed "baseline" alternatives, were prepared using the building block projects. The baseline alternatives contain projects that are required to accommodate forecast requirements but do not address the comprehensive list of facility and level-of-service issues previously discussed. Each baseline alternative was paired to a differing proposed long-term vision, termed "concept", for which there were also three: Concepts 2 and 4 plus a hybrid concept, which combined certain aspects of the two selected long-term visions into an additional distinct concept. The long-term vision concepts contain not only the projects from the corresponding baseline alternative but also additional projects to improve level-of-service and other issues. Variations of baseline alternatives that proposed projects incompatible with future long-term visions (i.e., near-term investments that become "throw-away" in the future) were dismissed. The baseline alternatives and long-term vision concepts are illustrated on Figure 3.

Baseline A and Concept 2

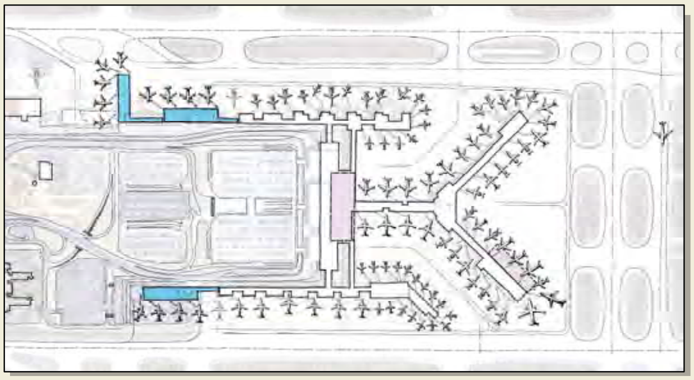
The Baseline A alternative concentrates future terminal development to the north ends of Concourses A and C. This alternative respects the existing terminal geometry, maintains flexibility for future development, and minimizes disruption to existing terminal operations by concentrating construction in areas not currently used for aviation or terminal purposes. All components of the Baseline A alternative are also part of Concept 2, its paired long-term vision concept.

Concept 2 reconfigures the existing passenger concourses located south of the main terminal building by (1) realigning the legs of Concourse B to be perpendicular the runways; (2) adding gates along the south face of the main terminal; (3) adding a satellite concourse to the south of the realigned Concourse B; and (4) removing gates B1 – B8 to improve corridor circulation. This concept, in addition to meeting the need for gates, also removes the single-taxilane alleyways to improve airfield operations and aircraft flows, enhances passenger level-of-service throughout all concourses, and increases the number of high value and close-in aircraft parking positions.

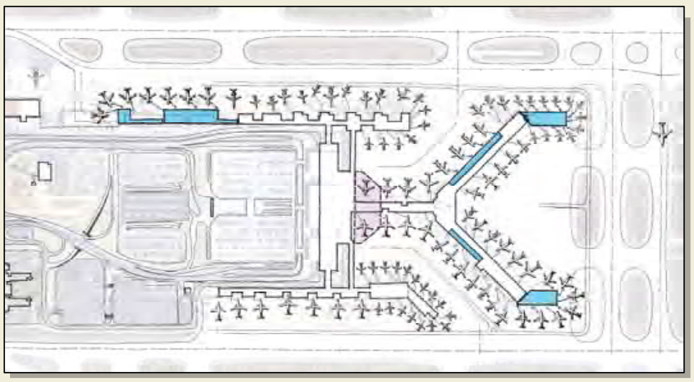
Baseline B and Concept 4

The Baseline B alternative expands aircraft gates through extensions to the southern ends of the legs of Concourse B and the north end of Concourse C. It is proposed that one of the Concourse B extensions be designed for commuter aircraft operations to enhance commuter/mainline connections. In addition, a portion of the legs of Concourse B would be widened to improve corridor circulation for the added passenger volumes expected to pass through there. This alternative continues the existing terminal geometry, minimizes impacts to airfield operations, and increases the number of gates at the "hub" on Concourse B. All components of the Baseline B alternative are also part of Concept 4, its paired long-term vision concept.

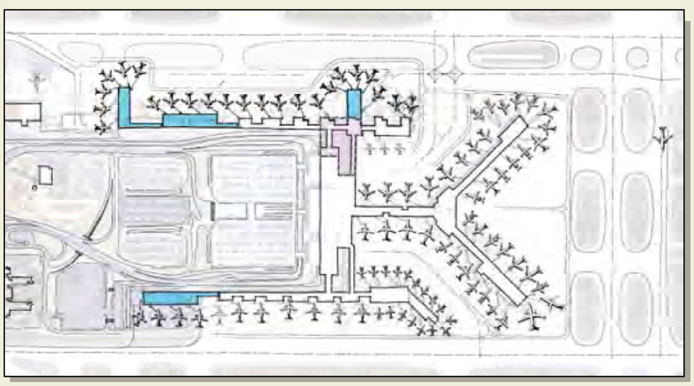
BASELINE ALTERNATIVES



BASELINE A

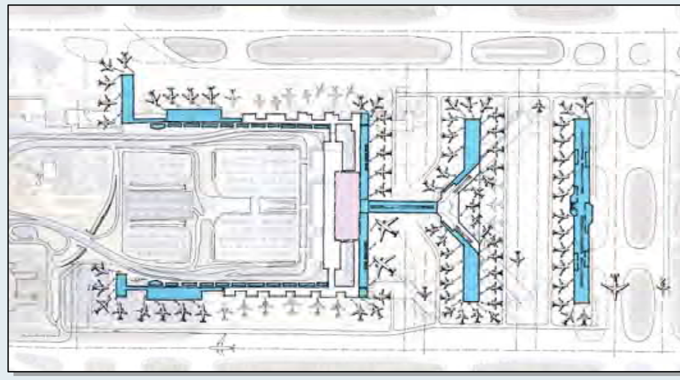


BASELINE B

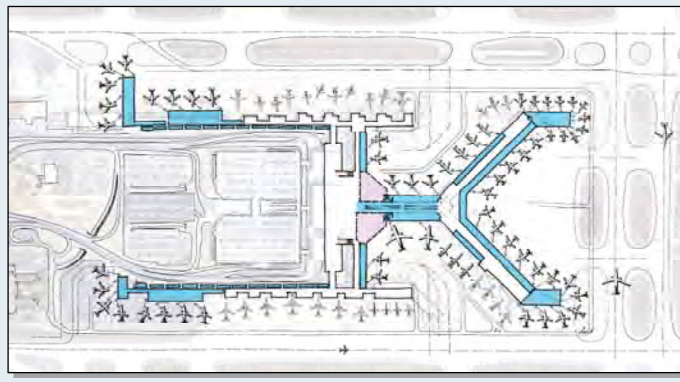


BASELINE C

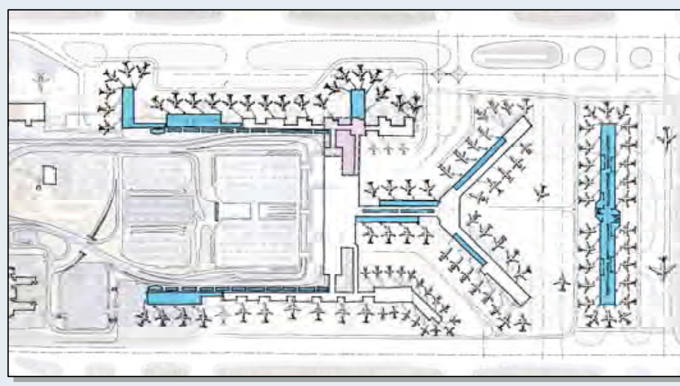
LONG-TERM VISION CONCEPTS



CONCEPT 2



CONCEPT 4



CONCEPT HYBRID

MEM548-5 F-0004

LEGEND

- Existing
- Planned new construction
- FIS facility

N

1,360 0 680 1,360

Graphic Scale in Feet

Figure 3

BASELINE ALTERNATIVES AND LONG-TERM VISION CONCEPTS

Master Plan Update
Memphis International Airport
November 2009

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Concept 4 furthers the development of the existing terminal geometry by (1) widening the entirety of the legs of Concourse B to the south; (2) removing portions of the southern ends of Concourses A and C; (3) adding gates along the south face of the main terminal; and (4) widening the section of Concourse B between the main terminal and rotunda to expand corridor circulation and holdroom space; (5) extending Concourse A to the north; and (6) enlarging a pavilion to the north of Concourse C that was part of the Baseline B alternative. This concept improves airfield operations through partial removal of the single-taxilane alleyways and minimizes disruptions to existing terminal operations during construction. However, Concept 4 provides limited follow-on expansion opportunities, as the existing site becomes fully developed at completion of the concept.

Baseline C and Concept Hybrid

The Baseline C alternative is similar to the Baseline A alternative with the exception of a second pavilion to be constructed on Concourse C, near Gates C12A and C12B. This pavilion, which marginally increases gate frontage, does provide additional flexibility for aircraft parking layouts and allows the three aircraft gates on the south face of Concourse C to be removed. Removal of these three gates enables an additional taxilane and helps alleviate the congestion-prone single-taxilane alleyway. The Baseline C alternative avoids disruption to Concourse B, maximizes development of Concourse C, and preserves transition to not just its paired long-term vision, Concept Hybrid, but also to either Concept 2 or Concept 4. All components of the Baseline C alternative are part of Concept Hybrid.

Concept Hybrid positions the Airport for expansion beyond the planning period, much like Concept 2, while avoiding many of the negatives associated with Concept 2. Concept Hybrid, in addition to the projects completed as part of Baseline C, would construct a satellite concourse to the south of the existing Concourse B. This concourse would be aligned in an east-west orientation at the location of Taxiway T and would be connected to the Concourse B rotunda by an underground connector capable of accommodating moving walkways, utility conduits, and, in the future, a ride system. Also, to accommodate the increased passenger flows to the satellite, the section of Concourse B between the main terminal and rotunda would be widened to expand corridor circulation and holdroom space. Concept Hybrid minimizes impacts to Concourse B during construction, improves airfield operations and taxilane flows, and provides significantly more frontage for aircraft gates than Concept 2 or Concept 4.

FIS Facility

The determined requirements for the FIS facility included doubling of existing throughput capacity and improved proximity to the Main Terminal building to improve the level-of-service for passengers completing their travels in Memphis. In order to process approximately 800 passengers per hour, the expanded FIS facility would occupy approximately 80,000 square feet of terminal space for queuing, processing, baggage claim, baggage re-check, and supporting office and administrative spaces. Three locations were considered for the FIS facility, as follows:

- **Mezzanine Level of Terminal B –** Depicted in conjunction with Baseline A **–** Concept 2 on Figure 3, an FIS facility at this location would consolidate all passenger processing functions on a single level to the south of the Terminal B glass atrium.

- **Apron Level at Junction of Concourse and Terminal B –** Depicted in conjunction with Baseline B – Concept 4 on Figure 3, an FIS facility at this location would contain all passenger processing functions on a single level to the south of the outbound baggage make-up room in Terminal B.

- **Mezzanine Level at Junction of Concourse and Terminal C –** Depicted in conjunction with Baseline C – Concept Hybrid on Figure 3, an FIS facility at this location would contain passenger processing functions on a new mezzanine level above Concourse C as well as in the unused hotel space on the mezzanine level of Terminal C.

While each FIS facility location was depicted on Figure 3 with a specific baseline – long-term vision combination, the pairing was arbitrary for graphic purposes. Any of the FIS locations could be paired with any of the terminal alternatives as part of a preferred terminal plan.

Depending on the preferred location of the FIS facility and selected baseline alternative, parking for international aircraft could be located in several locations around the passenger terminal complex.

Previous planning studies undertaken by the Authority have considered expanding the existing FIS facility in its current location, doubling its size and processing capability. This expansion, shown on Figure 3 in conjunction with Baseline A – Concept 2, was reviewed as a part of this analysis but ultimately dismissed because it maintains the FIS facility at a remote location that is cumbersome for terminating passengers.

TERMINAL ALTERNATIVES EVALUATION

The three baseline alternative/long-term vision concept combinations were presented to Authority staff at Workshop #3 for consideration and feedback. To facilitate decision-making, information regarding cost estimates and a high-level phasing plan and constructability estimate were also prepared, as described below.

- **Cost Estimates –** Rough order-of-magnitude cost estimates were prepared for each of the three baseline alternatives and three long-term vision concepts. These estimates included costs for additional aircraft gates, concourse expansions, interior renovations (replacing ceiling tiles, carpeting, lighting, and re-painting as appropriate), Main Terminal building renovations (common to all alternatives), and the FIS facility (deemed to be best suited to the long term vision concept under study), building systems upgrades, and seismic retrofits. These cost estimates, which are summarized in Table 3, and described in detail in Appendix B, show that the costs for the baseline alternatives range between $414 and $451 million dollars. Costs for the long-term vision concepts range between $811 million and slightly more than $1 billion and are inclusive of the project costs in the corresponding baseline alternative.

- **Phasing Plan and Constructability Estimate –** Phasing plans for both the baseline alternatives and the long-term vision concepts were prepared to determine how many construction phases would be required to implement new terminal facilities while maintaining the required number of aircraft gates throughout construction. Baseline A and C alternatives are easier to construct than the Baseline B alternative, as the extensions on Concourse B displace the existing gates located on ends of the concourse. Concept 2 is the most difficult long-term vision concept to construct, as it displaces the entirety of both legs of Concourse B and requires significant temporary facilities and multiple discrete construction phases. Concept Hybrid is the easiest long-term vision concept to implement, as the satellite concourse can be constructed without substantial impact to Concourse B or other operational areas of the terminal.

Table 3

ESTIMATED COSTS FOR BASELINE ALTERNATIVES AND LONG-TERM VISION CONCEPTS

Master Plan Update
Memphis International Airport

	Cost estimates (in $ millions) *(a)*			
	Construction	General conditions *(b)*	Owner soft costs *(c)*	Total
Baseline Alternatives				
Baseline A	$251.3	$ 97.0	$ 81.8	$ 430.1
Baseline B	259.9	100.3	84.6	444.8
Baseline C	263.6	101.7	85.8	451.1
Long-term Vision Concepts *(d)*				
Concept 2	$604.1	$233.1	$196.8	$1,034.0
Concept 4	473.9	182.8	154.3	811.0
Concept Hybrid	527.8	203.7	172.0	903.5

(a) Costs presented in 2008 dollars.
(b) Includes markups for general conditions, contractors' fees, design and construction contingencies, and payment and performance bonds.
(c) Includes markups for project and construction management, design fees, construction administration, materials testing, and other associated services.
(d) Includes projects that were included in the paired Baseline Alternative (i.e. Concept 2 includes the cost of all projects that are part of Baseline A).

Source: Connico, May 2009.

During Workshop #3, the Authority and the Team determined that the Baseline C alternative best satisfied the requirements and challenges at the beginning of the alternatives analysis. This alternative focuses investment on Concourses A and C. The pavilion at Gates C12A and C12B also provides additional terminal space to support the parking of large aircraft for international operations. The location of this pavilion makes the FIS facility located on the mezzanine level of Terminal and Concourse C the preferred site of the three considered.

Concept Hybrid, the corresponding long-term vision, also was preferred over other options as it provides an opportunity to expand beyond the 20-year gate requirement without building a completely separate terminal complex. Concept Hybrid allows for existing Concourse B to remain without materially affecting the number of aircraft gates it supports.

PREFERRED PLAN

The following paragraphs describe the projects, phasing, and costs associated with the preferred development plan for the overall terminal complex, new FIS facility, and main terminal building. Though not specifically described in the following sections, the plan also includes seismic upgrades as described in Appendix D. The Baseline C alternative and Concept Hybrid long-term vision were refined after Workshop #3 based on Authority feedback to arrive at the plan described below.

Terminal Complex

The Baseline C alternative was determined to be the preferred plan for future overall development of the Airport's passenger terminal complex. Concept Hybrid was determined to be the preferred long-term vision. The preferred 20-year plan is depicted on Figure 4 and the preferred long-term vision concept is depicted on Figure 5. Altogether, the preferred plan would provide 11,725 feet of frontage for aircraft parking (11,700 feet is forecast as being required in the 20-year planning period) that could be increased to 14,900 feet through construction of the preferred long-term vision concept. Projects comprising the preferred plan would be constructed as described in the following paragraphs.

PAL 1: 2008-2012 (Figure 6). During PAL 1, Concourse C would be extended to the north, providing 610 feet of additional gate frontage with passenger holdrooms and amenities on the second level and airline operations space on the ground level. While not explicitly required to meet the forecast demand for gates, this addition provides the Airport with greater flexibility to reconstruct the aprons surrounding the terminal.∗ In addition, the northern portion of Concourse C (north of Gates C14A and C14B) would undergo interior renovations during PAL 1, replacing ceiling tiles, carpeting, lighting, and re-painting as appropriate.

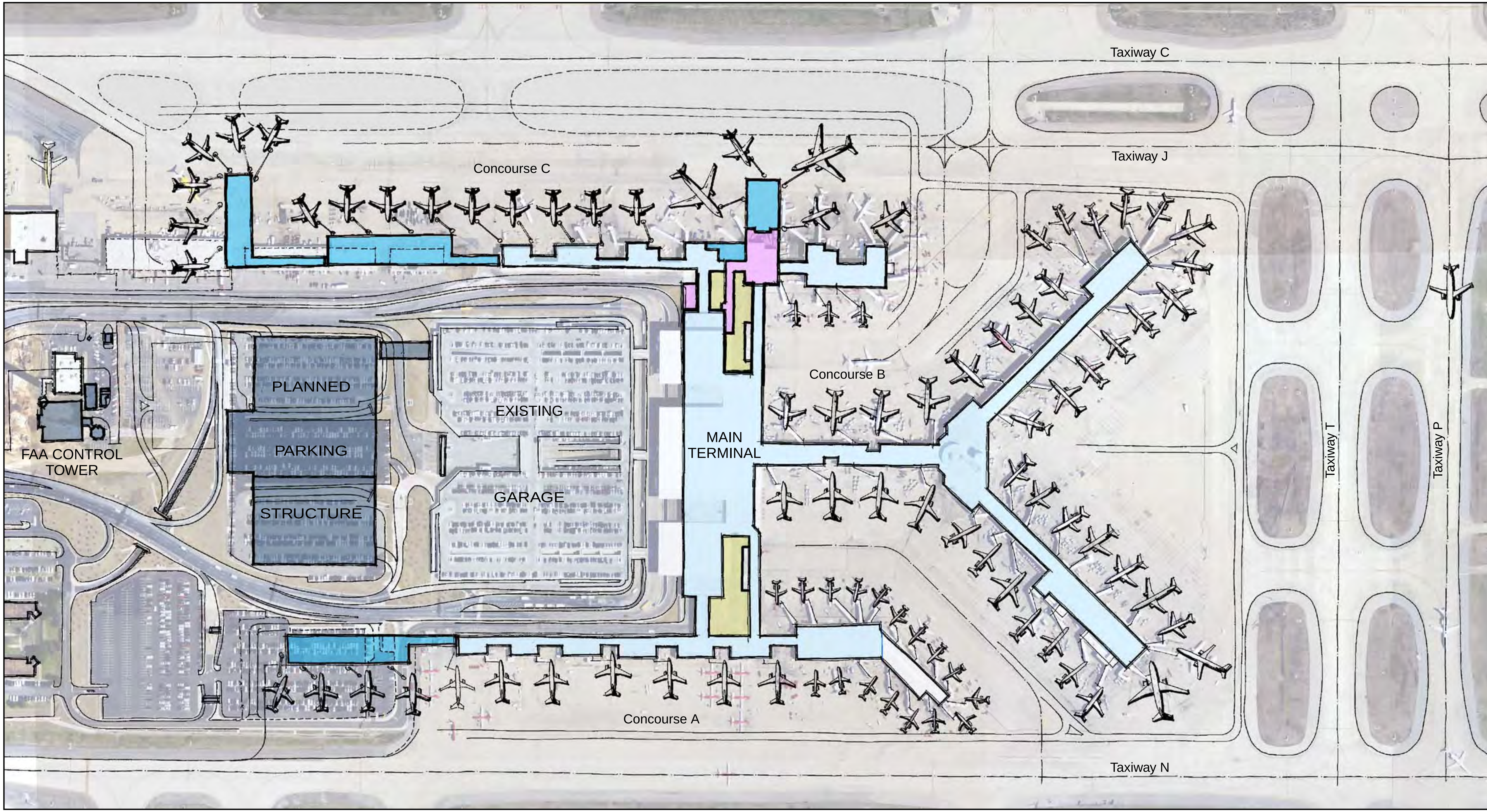
∗The Authority is pursuing a program to reconstruct the apron areas surrounding the passenger terminal outside of the Master Plan Update.

PAL 2: 2013-2017 (Figure 7). During PAL 2, expansion of aircraft gates to the north end of Concourse C will continue through construction of a pavilion, aligned perpendicular to the runways, providing 760 feet of additional gate frontage. A second pavilion will be constructed off of what is currently the passenger holdroom for Gates C12A and C12B of similar size to the pavilion on the north. This pavilion, in addition to providing 325 feet of additional gate frontage, new passenger holdrooms, and expanded airline operations space, would also provide new international arrivals gates and accommodate the parking of both narrow and widebody aircraft. A "fill in" of the concourse between the new pavilion and the holdrooms to the north (Gates C14A and C14B) would also be constructed to provide space for additional passenger amenities at the concourse level and baggage handling space at the apron level. Lastly, the three gates on the south face of Concourse C (Gates C1, C2, and C3) would be removed and the apron service road moved north of its existing location to allow for an additional taxilane, easing the demand for the existing single-taxilane between Concourses B and C. The gate removal and ensuing taxilane construction results in the loss of 370 feet of gate frontage.

In addition, construction of a new FIS facility, operationally and functionally split between a new mezzanine level on Concourse C and the ground level of Terminal C, would be implemented during PAL 2. Accompanying the FIS facility are a variety of interior renovations to the Main Terminal building (Terminals B and C) as well as renovations to the southern portion of Concourse C. Both the new FIS facility and improvements to the Main Terminal building are described in greater detail in subsequent paragraphs.

PAL 3: 2018-2027 (Figure 8). During PAL 3, Concourse A will be extended to the north, providing 600 feet of additional gate frontage, passenger holdrooms and amenities, and airline operations space. In addition, interior renovations would be undertaken for the entirety of Concourses A and B with the exception of the regional jet facility at the southern end of Concourse A. Improvement projects and renovations would also occur to the main terminal building (Terminal A) during PAL 3.

Preferred Long-term Vision (Figure 5). The concept for long-term development beyond the 20-year planning period includes not only the projects identified in the preferred plan but also other projects and improvements, as shown on Figure 5. These include construction of a satellite concourse to the south of Concourse B that would provide an additional 3,175 feet of frontage and be connected to the existing terminal, initially, via an underground pedestrian connector to the Concourse B rotunda. The connector would be sized to permit future installation of a ride system. To improve passenger level-of-service, (1) additional holdroom and passenger circulation space would be constructed within Concourse B between the Main Terminal building and the rotunda; (2) a portion of the legs of Concourse B would be widened; and (3) moving walkways would be added to the east face of Concourse A and the west face of Concourse C to reduce walking distances. Lastly, a secure pedestrian bridge would be constructed connecting the northern ends of Concourses A and C.



LEGEND

- Existing
- New construction
- FIS facility
- Interior renovations
- In-line baggage system
- Ongoing Airport projects

N

150 0 150 300

Graphic Scale in Feet

Figure 4

PREFERRED PLAN

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Memphis International Airport
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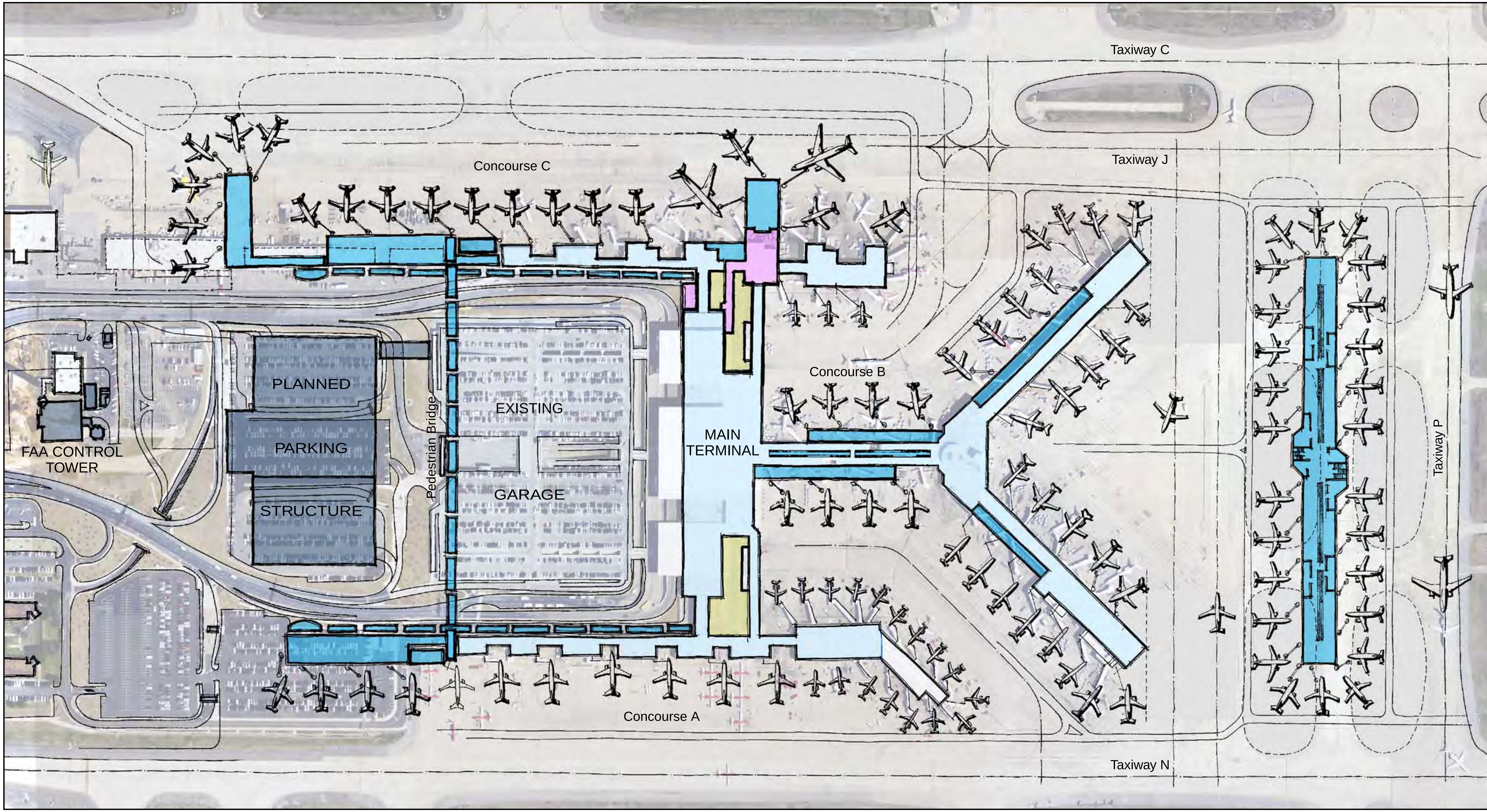

LEGEND

- Existing
- New construction
- FIS facility
- Interior renovations
- In-line baggage system
- Ongoing Airport projects

N

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Graphic Scale in Feet

Figure 5

PREFERRED LONG TERM VISION

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Memphis International Airport
November 2009

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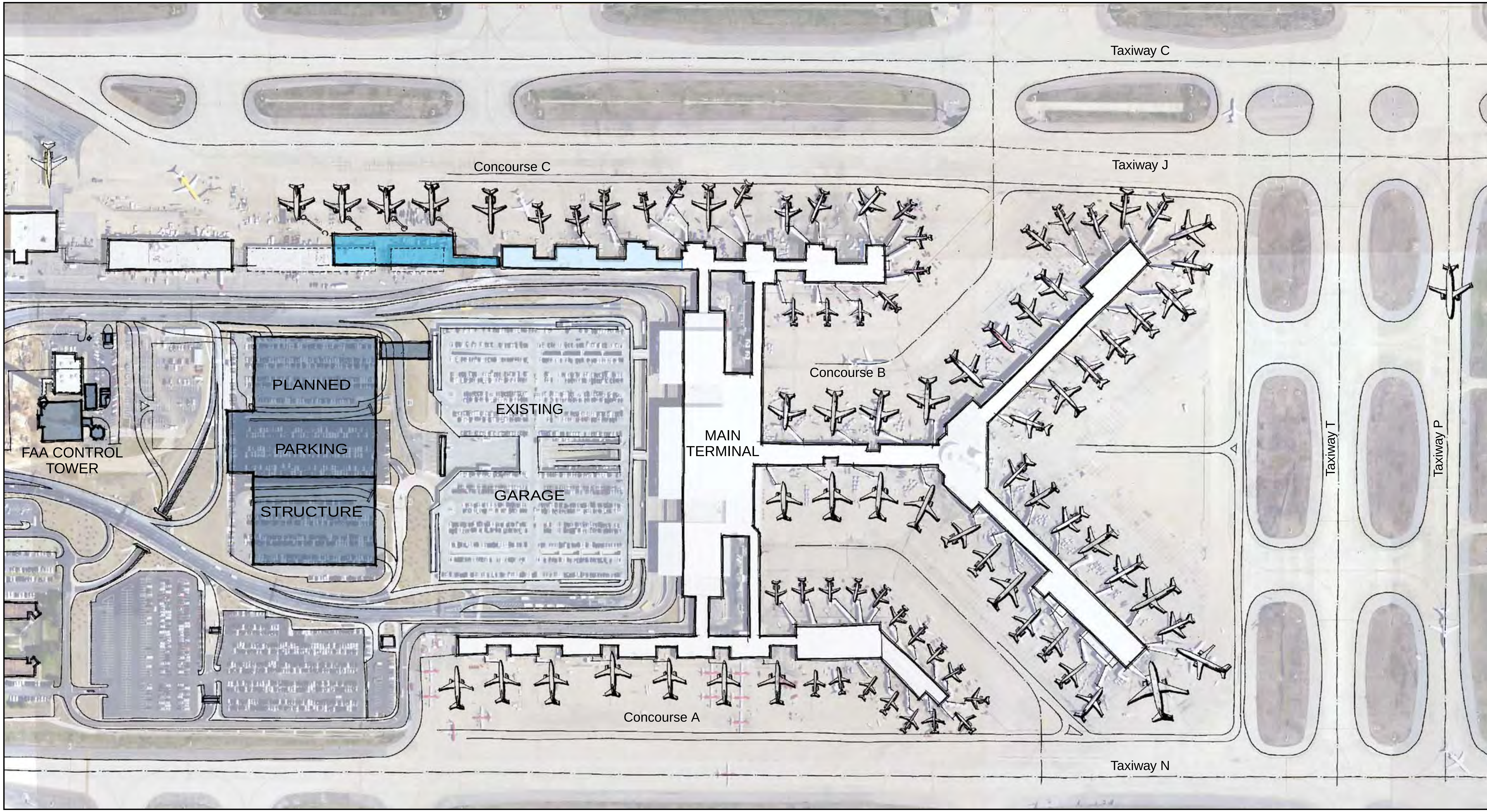

LEGEND

- Existing
- New construction
- Interior renovations
- Ongoing Airport projects

N

150 0 150 300
Graphic Scale in Feet

Figure 6
PREFERRED PLAN—PAL 1

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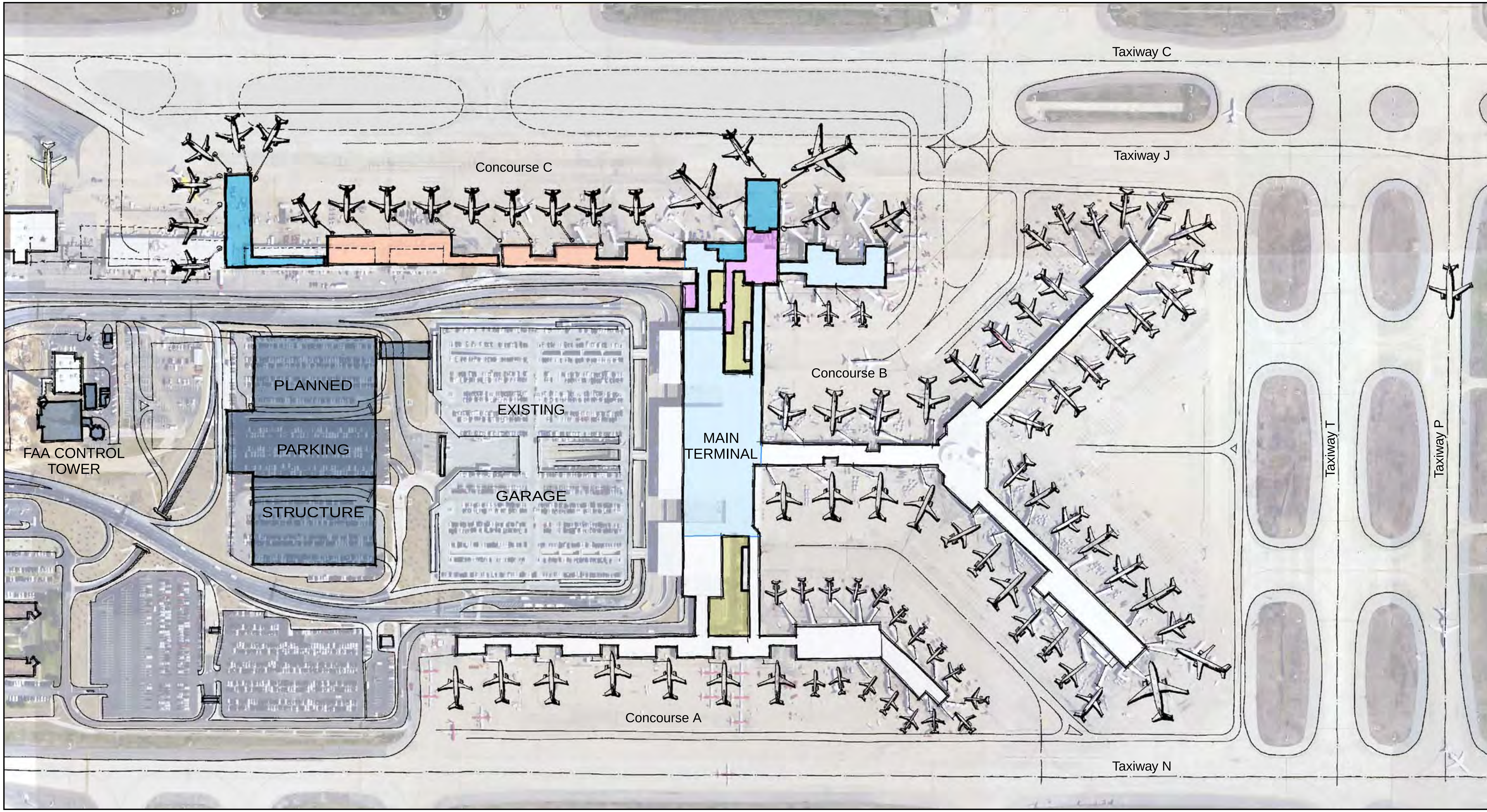

LEGEND

- Existing
- Completed in prior PAL
- Completed in this PAL
- Renovated in this PAL
- FIS facility (completed in this PAL)
- In-line baggage system
- Ongoing Airport projects

N

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Graphic Scale in Feet

Figure 7

PREFERRED CONCEPT—PAL 2

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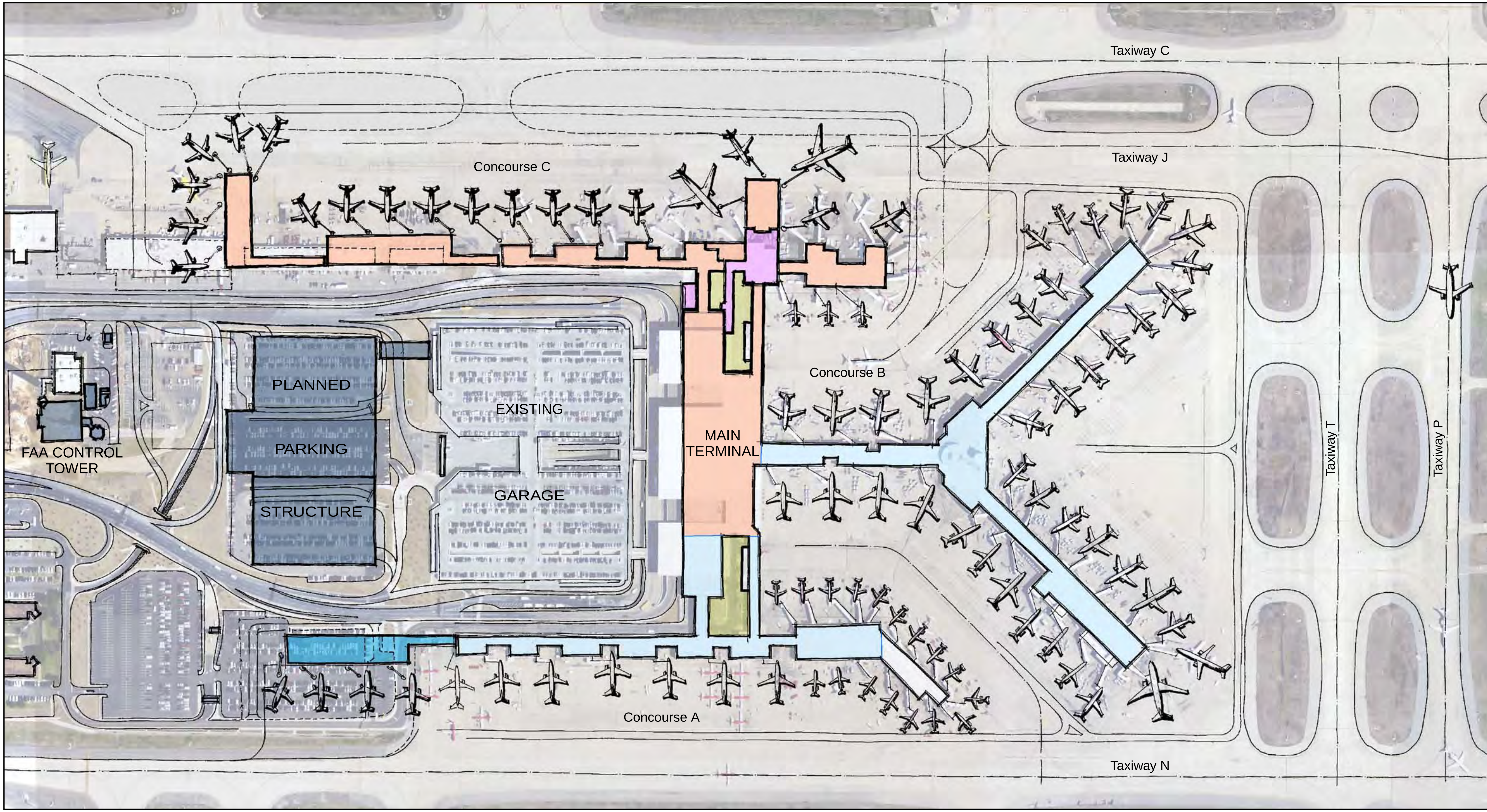

LEGEND

- Existing
- Completed in prior PAL
- Completed in this PAL
- Renovated in this PAL
- FIS facility (completed in prior PAL)
- In-line baggage system
- Ongoing Airport projects

N

150 0 150 300

Graphic Scale in Feet

Figure 8

PREFERRED PLAN—PAL 3

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FIS Facility

As previously discussed, the preferred location for an enlarged FIS facility is located at the junction of Terminal C and Concourse C. The preferred FIS facility, depicted on Figure 9 and planned to be implemented during PAL 2, allows for the parking of four international aircraft around the pavilion. Passengers exiting the aircraft would be collected in sterile corridors around the perimeter of the pavilion and transferred to a new mezzanine level constructed above a portion of existing Concourse C for primary Immigration inspection. Once cleared, passengers would proceed along a connector hallway to a two-level "down" escalator descending to a baggage claim area with two sloped-plate baggage claim devices. After claiming their baggage, passengers would proceed either to secondary Customs screening, if required, or directly exit the FIS facility. Connecting passengers would re-check their baggage at a ground-level baggage re-check area and then make their way upstairs to the existing Terminal C security checkpoint, which will be enlarged to accommodate not only international passengers but also normal domestic passengers currently using the checkpoint. Terminating passengers would exit the FIS facility along the north face of the Main Terminal building and into a new meeter/greeter hall.

This FIS facility makes active re-use of portions of the existing Main Terminal building to minimize new construction and overall costs. The baggage claim area would be located on the ground level of the existing Main Terminal building in space currently occupied by the Terminal C baggage claim and outbound baggage make-up area. The international baggage claim area could be partitioned such that one (or both) could be used for domestic operations during periods when international activity is light. Secondary Customs screening and baggage re-check facilities would be accommodated by extension of ground-level terminal space to the east onto the existing vehicle parking area (East Dock). A portion of the required administrative and office space supporting the FIS facility would be located on the mezzanine level of Terminal C in what is currently unoccupied space formerly used as a hotel.

It should be noted that the proposed routing of international passengers between the mezzanine and ground levels intersects space previously assumed as being reserved for the planned in-line baggage screening system. Preliminary discussions with the Authority's consultant for the baggage system indicate that the routing may be accommodated satisfactorily.

Main Terminal Building

A variety of moderate improvement projects were identified for the Main Terminal building to meet the facility requirements as well as address level-of-service issues. Proposed improvements and reconfigurations to the Main Terminal building are depicted on Figure 10 (ground level), Figure 11 (second level), and Figure 12 (mezzanine level). These figures also depict the proposed FIS facility that will be built at Terminal and Concourse C.

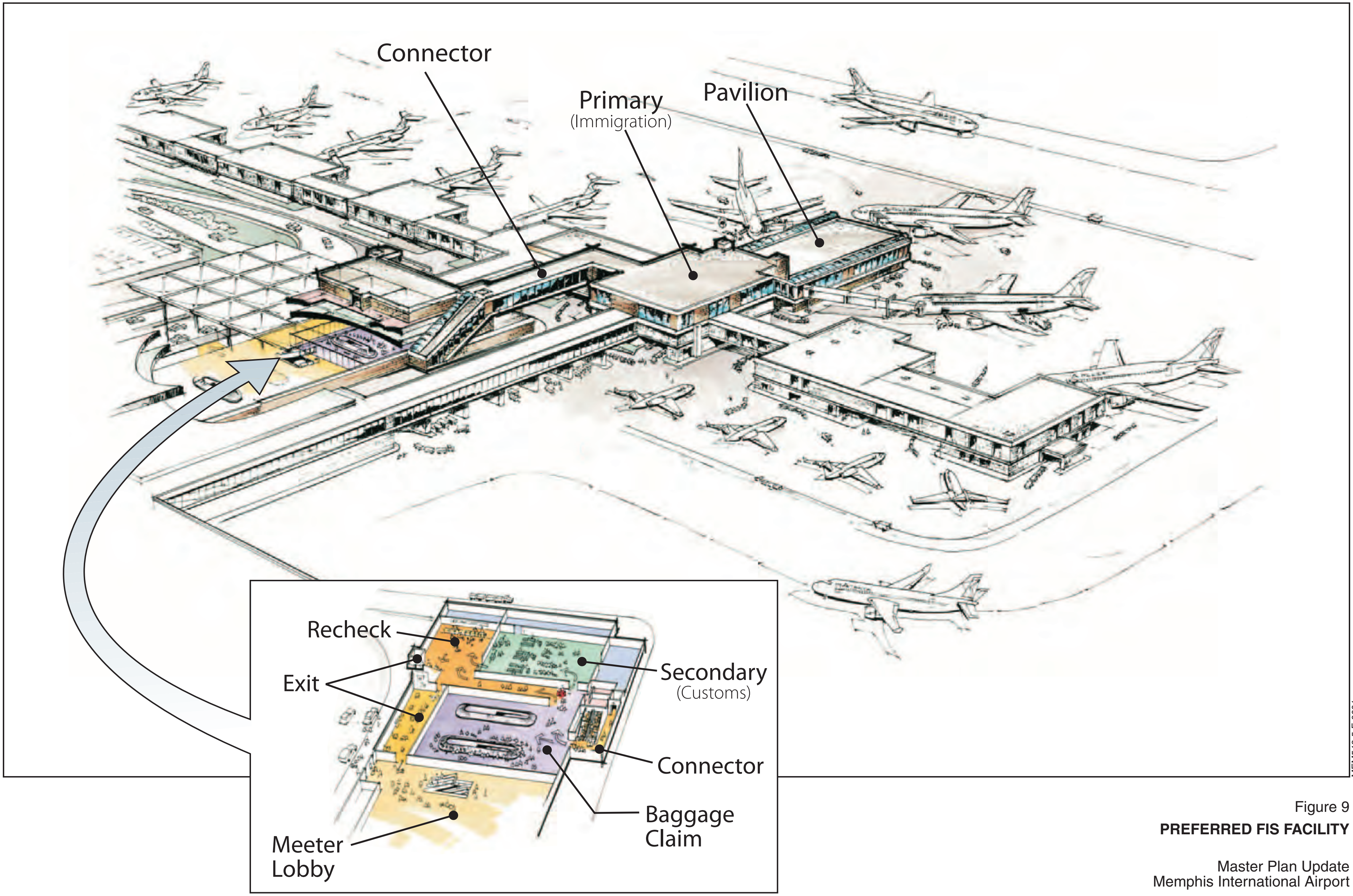

Figure 9

PREFERRED FIS FACILITY

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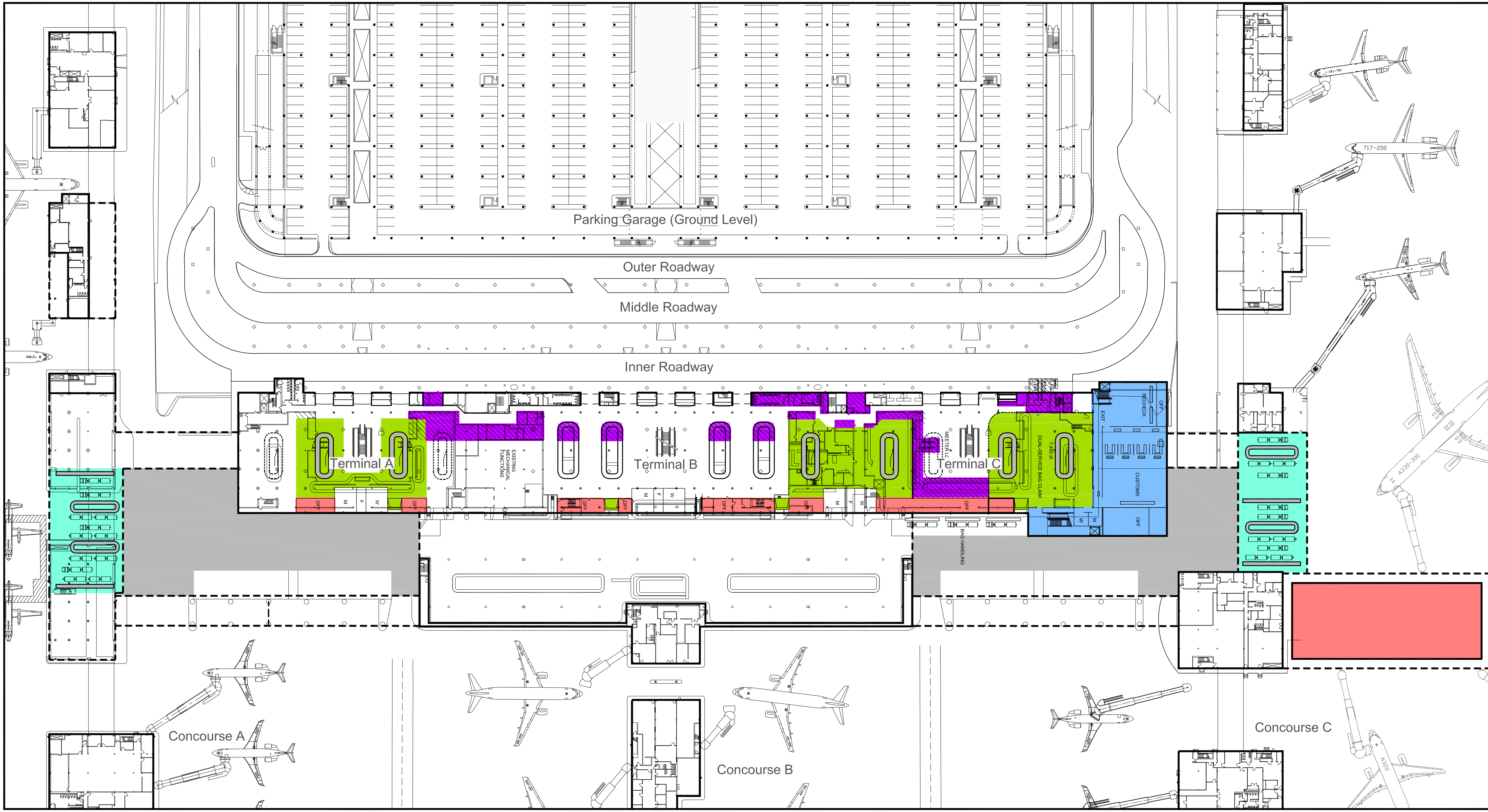

LEGEND

- Existing
- Airline space
- Baggage claim
- FIS facility
- In-line baggage system (by others)
- Outbound baggage make-up
- Public circulation
- Demolition

N

50 0 50 100

Graphic Scale in Feet

Figure 10

GROUND LEVEL
MAIN TERMINAL BUILDING

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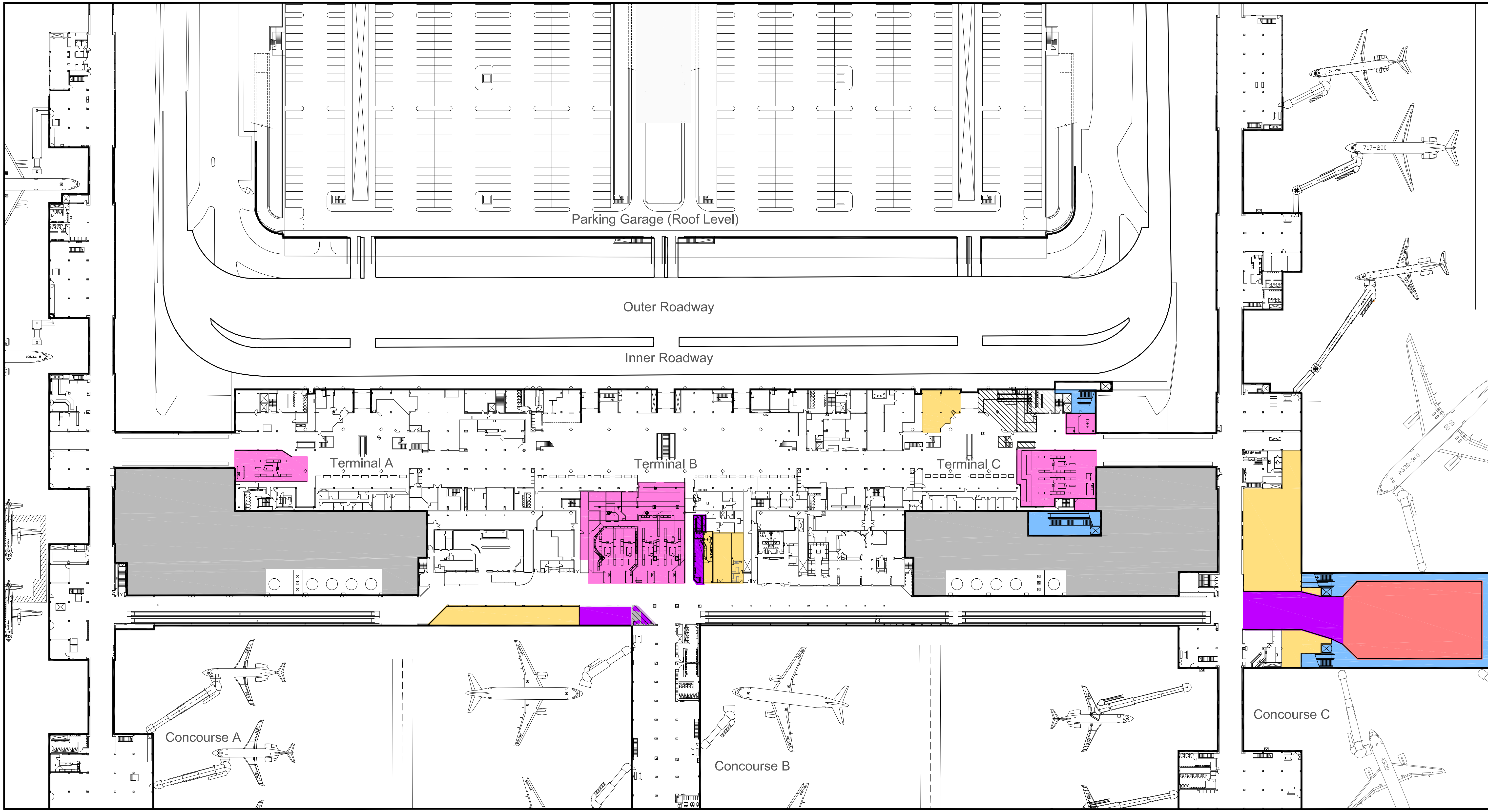

LEGEND

- Existing
- Airline space
- Concessions
- FIS facility
- In-line baggage system (by others)
- Public circulation
- Security checkpoint expansion
- Demolition

N

50 0 50 100
Graphic Scale in Feet

Figure 11
SECOND LEVEL
MAIN TERMINAL BUILDING

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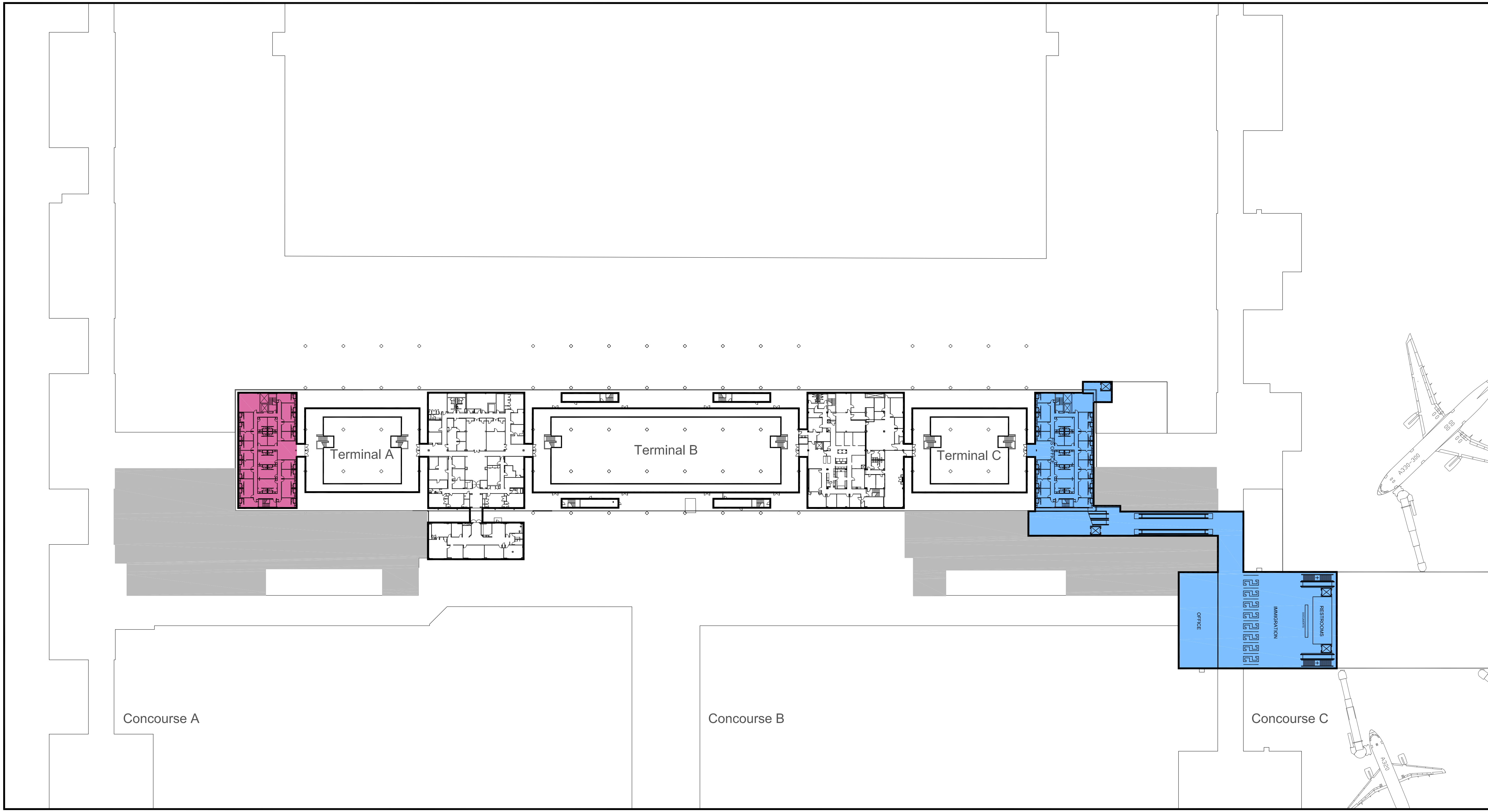

LEGEND

- Existing
- FIS facility
- In-line baggage system (by others)
- Office space
- Demolition

N

50 0 50 100

Graphic Scale in Feet

Figure 12

MEZZANINE LEVEL
MAIN TERMINAL BUILDING

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Selected projects, as noted below, on the second level of Terminal B would be implemented at PAL 1. Aside from these, renovations and improvements to Terminals B and C will occur at PAL 2 while projects in Terminal A will occur at PAL 3.

Key facility improvements on the ground level (Figure 10) include:

- Better circulation between baggage claim lobbies, achieved through wider and straighter corridors
- Enlarged baggage claim lobbies in Terminals A and C
- Relocated and expanded restroom facilities on the south side of each baggage claim lobby
- New meeter/greeter lobby in the area currently occupied by the Terminal C baggage claim to support both domestic and international arrivals
- Portions of the FIS facility at the east end of the terminal including baggage claim, secondary customs screening, connecting passenger baggage re-check, and office space
- Relocated and expanded baggage service offices on the south side of baggage claim lobbies
- Additional exit points to the arrivals curbside
- Relocated outbound baggage make-up areas that allow expanded passenger facilities within the main terminal

Key facility improvements on the second level (Figure 11) include:

- Enlarged security screening checkpoints in Terminals B and C (PAL 1)
- New concessions hub at junction of Terminal and Concourse C
- New escalator for terminating passengers to between Concourse B and the Terminal B baggage claim to reduce passenger circulation cross-flows in the Terminal B ticketing lobby (PAL 1)
- Relocated concessions adjacent to the expanded Terminal B security checkpoint (PAL 1)
- Access for connecting passengers leaving the FIS facility to the Terminal C security checkpoint

Key facility improvements on the mezzanine level (Figure 12) include:

- Development of portions of the FIS facility at the east end of the terminal, including primary inspection, circulation, and office space
- Relocated Authority office space in the area of Terminal A formerly occupied by a hotel

Building Systems

Improvements to the terminal's mechanical, electrical, and plumbing systems are required to support expansion and renovation projects that add floor space and more importantly building volume and replace aged equipment over the 20-year planning period when components reach the end of their useful lives. Maintaining the existing building systems in a state of good repair provides not only level-of-service benefits to passengers and tenants but also reductions in operating and maintenance costs. Appendix C details the equipment replacement schedule, organized by PAL, for the Main Terminal building, concourses, and central plant.

Seismic Retrofits

Seismic retrofit recommendations to the Main Terminal building and concourses are included in the preferred plan to address seismic vulnerabilities. The recommendations not only minimize the risk to public life and safety caused by potential structural failures but also minimize the potential downtime of key facilities following a seismic event and enable the Airport to regain functionality as quickly as possible. On the concourses, seismic recommendations include strengthening of foundations, installation of shearwalls, and bracing of plumbing and electrical conduits. Retrofits are timed to coincide with the aforementioned interior renovation work at various locations, during which ceilings, floorings, and other finishes will enable access to structural components of the building. These retrofits constitute an upgrade to approximately 75% of the current building code.

Within the Main Terminal building, seismic retrofits include strengthening of foundations, improving the flexibility of the "martini glass" columns, strengthening the connection between the columns and the ceiling, and bracing of masonry walls on the ground level. Detailed information regarding seismic retrofit projects and their phasing is provided in Appendix D.

Curbsides

Opportunities to expand both the upper- and lower-level curbsides are limited due to limited dimension between the Main Terminal and the existing parking garage. The existing curbside capacities can be improved to meet PAL 3 requirements at tolerable levels of service. By PAL 3, the vehicular activity levels on the upper level, particularly on the inner lanes at Terminal B, are expected to be at the undesirable level-of-service D or worse. This condition can be mitigated by restriping the current three outer lanes to provide a total of four lanes (two parking and two through-lanes) and having all upper-level traffic use the outer lanes exclusively. Even with the additional traffic volume from the inner lanes, the outer roadway is expected to operate at an acceptable level-of-service C. The area currently occupied by the inner lanes can be converted to public curbside use for passenger standing and movement to improve circulation in front of the terminal entrances.

On the lower-level, the alignment of columns supporting the upper-level roadway prohibits any of the three roadway sections from being expanded to four lanes. Therefore, it is recommended that the Authority maintain active and visible enforcement of vehicular and pedestrian flows and reduce the number of pedestrian crosswalks on the inner roadway to keep traffic moving. Further, the proposed additional exit points from the baggage claim lobbies to the curbside will help spread passengers over the entire length of available curb and help reduce peak demand in front of Terminal B.

While the above improvements will allow the current curbsides to remain functional throughout the planning period, it is recommended that curbside redesign and expansion be considered whenever, and as soon as, the existing parking garage is rebuilt or replaced.

Cost Estimates

Cost estimates for the preferred plan and preferred long-term vision are summarized in Table 4 and arranged by project type and PAL. As shown, the costs estimates include an allowance for general conditions and owner soft costs. The total cost of the preferred plan is $414 million, of which $242 million is the estimated construction cost and $172 million are added project soft costs. Projects implemented during PAL 2 are expected to comprise approximately half of the overall costs of the 20-year terminal development plan. The total cost of the preferred long-term vision is $848.6 million, inclusive of the costs of projects that are also a part of the preferred plan. Detailed assumptions and breakdowns of the projected costs of the terminal development program are provided in Appendix B.

Table 4

PREFERRED TERMINAL PLAN COST ESTIMATES
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	Cost estimates (in $ millions) *(a)*			
	Construction	General conditions *(b)*	Owner soft costs *(c)*	Total
PAL 1				
Facilities *(d)*	$ 31.7	$12.3	$10.3	$ 54.2
Interior renovations *(e)*	2.2	0.8	0.7	3.7
Main terminal renovations *(f)*	4.8	1.9	1.6	8.3
MEP system upgrades	9.2	3.6	3.0	15.7
Seismic retrofits	1.8	0.7	0.6	3.1
Subtotal	$ 49.6	$19.2	$16.1	$ 84.9
PAL 2				
Facilities *(d)*	$ 78.1	$30.2	$25.4	$133.7
Interior renovations *(e)*	3.5	1.3	1.1	5.9
Main terminal renovations *(f)*	16.8	6.5	5.4	28.7
Mechanical	5.1	2.0	1.7	8.8
Seismic	16.1	6.2	5.2	27.6
Subtotal	$119.7	$46.1	$38.9	$204.7
PAL 3				
Facilities *(d)*	$ 30.1	$11.7	$9.8	$ 51.6
Interior renovations *(e)*	12.4	4.8	4.0	21.3
Main terminal renovations *(f)*	4.0	1.5	1.3	6.9
Mechanical	9.9	3.8	3.2	16.9
Seismic	16.3	6.3	5.3	27.8
Subtotal	$ 72.7	$28.0	$23.6	$124.4
Preferred Plan Total	**$242.0**	**$93.3**	**$78.7**	**$414.0**
Preferred Long-term Vision *(g)*	**$495.9**	**$191.3**	**$161.5**	**$848.6**

(a) Costs presented in 2008 dollars.
(b) Includes markups for general conditions, contractors' fees, design and construction contingencies, and payment and performance bonds.
(c) Includes markups for project and construction management, design fees, construction administration, materials testing, and other associated services.
(d) Includes proposed FIS facility.
(e) Concourses only.
(f) Includes both facility improvements and interior renovations to the main terminal building.
(g) Includes projects included in the Preferred Plan.

Source: Connico, May 2009.

Appendix A

BUILDING BLOCK PROJECTS

BUILDING BLOCK PROJECT LISTING

Concourse A

A-1 Northward Extension of Concourse A
A-2 Concourse A Hammerhead
A-3 Concourse A Pavilions with Dual Taxilanes
A-4 Concourse A Pavilions with Single Taxilane
A-5 Regional Jet Facility at South End of Concourse A
A-6 Concourse A Gate Removal

Concourse B

B-1 Concourse B Trunk Gate Removal
B-2 Sterile Connectors along Trunk of Concourse B
B-3 Concourse B Trunk Holdroom Expansion with FIS
B-4 Concourse B Trunk Holdroom Expansion without FIS
B-5 Regional Jet Facility at Southeast Leg of Concourse B
B-6 Narrowbody Gates at Southwest Leg of Concourse B
B-7 Additional Extension to Southwest Leg of Concourse B
B-8 Realignment of Concourse B Legs at Rotunda
B-9 North-South Pier at Concourse B Rotunda
B-10 Widening of Southeast & Southwest Legs of Concourse B
B-11 Remote South Concourse

Concourse C

C-1 Northward Extension of Concourse C
C-2 Concourse C Hammerhead
C-3 Concourse C Pavilions with Dual Taxilanes
C-4 Concourse C Pavilions with Single Taxilane
C-5 Concourse C Gate Removal

Main Terminal Frontage and Overall Site

T-1 Narrowbody Gates at South Terminal Facade
T-2 Regional Jet Gates at South Terminal Façade

S-1 Cross-complex Connector

Federal Inspection Service (FIS) Facility

F-1 FIS Facility Expansion at Southwest Leg of Concourse B
F-2 FIS Facility at Concourse B Rotunda
F-3 FIS Facility at South End of Concourse A
F-4 FIS Facility at Concourse B and Terminal Junction
F-5 FIS Facility on West Side of Concourse A
F-6 FIS Facility on Mezzanine Level in Terminal B
F-7 FIS Facility in Transit Tunnel beneath Terminal
F-8 FIS Facility in Terminal A (Major Rebuild)
F-9 FIS Facility in Terminal A (Minor Rebuild)

PROJECT A-1 Northward Extension of Concourse A

PURPOSE

- Add four additional aircraft parking positions
- Construct passenger holdrooms, restrooms, concessions, and airline operations space to support new gates

DESCRIPTION

Extend Concourse A to the north in order to provide four additional aircraft parking positions. Extension to the north could include installation of moving walkways to mitigate walking distance increases to the main terminal.

ELEMENTS

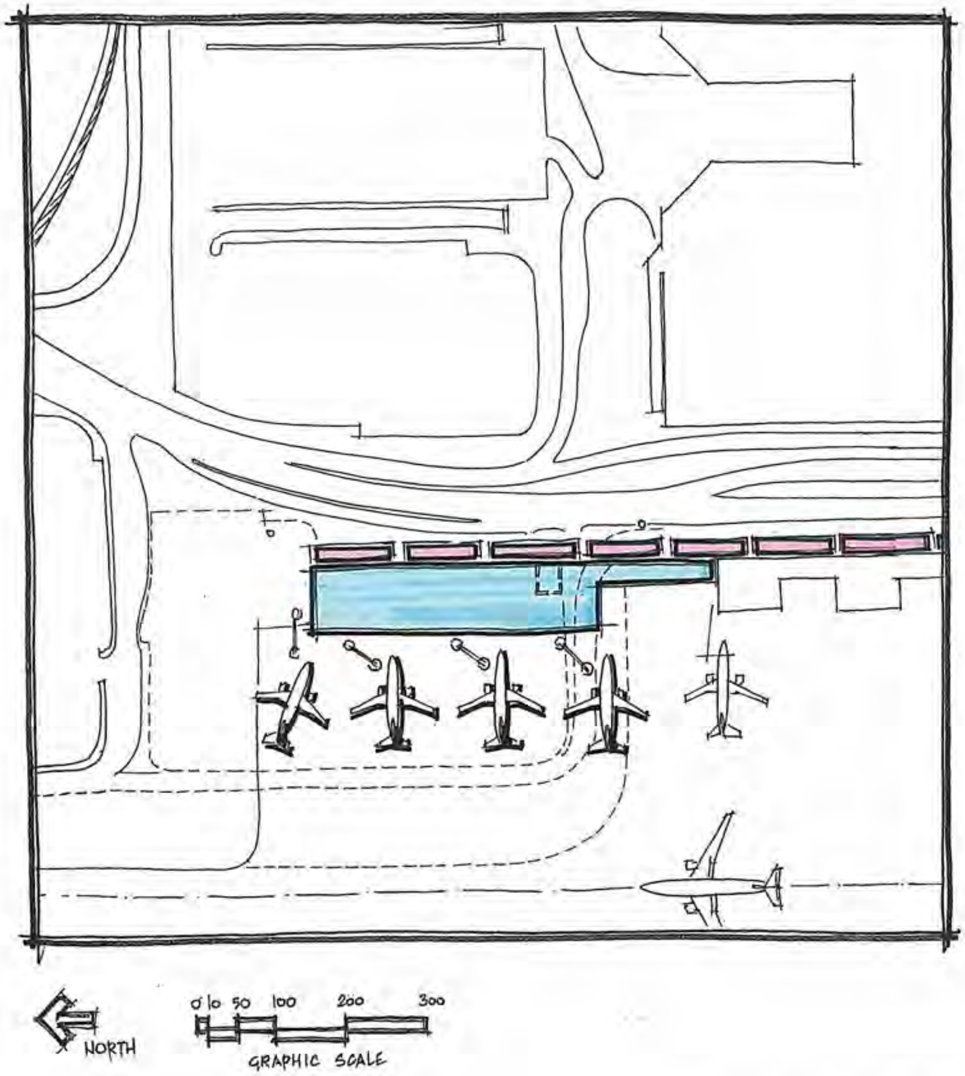
- Construct two-level building expansion (400 x 100 feet)
- Upper level—provide finished space for passenger holdrooms, two restroom blocks, and concession areas
- Lower level—provide shell space available to airlines for operations space
- Acquire and install four passenger loading bridges
- Construct additional aircraft apron as needed to accommodate aircraft and ground support equipment operations
- Install AOA fencing and security gates around new apron area
- Install seismic retrofits and MEP upgrades as appropriate

DEPENDENT PROJECTS

- None

LINEAR FRONTAGE (FEET)

- Frontage gained = 600
- Frontage lost = 0
- Net gain / (loss) = (600)



PROJECT **A-1**
Northward Extension of Concourse A

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PROJECT A-2 Concourse A Hammerhead

PURPOSE

- Add four aircraft parking positions
- Construct passenger holdrooms, restrooms, concessions, and airline operations space to support new gates

DESCRIPTION

Extend Concourse A north beyond extent of Project A-1 in order to provide additional aircraft parking positions. This project will include a connecting corridor and a "hammerhead" providing passenger gate areas and associated amenities.

ELEMENTS

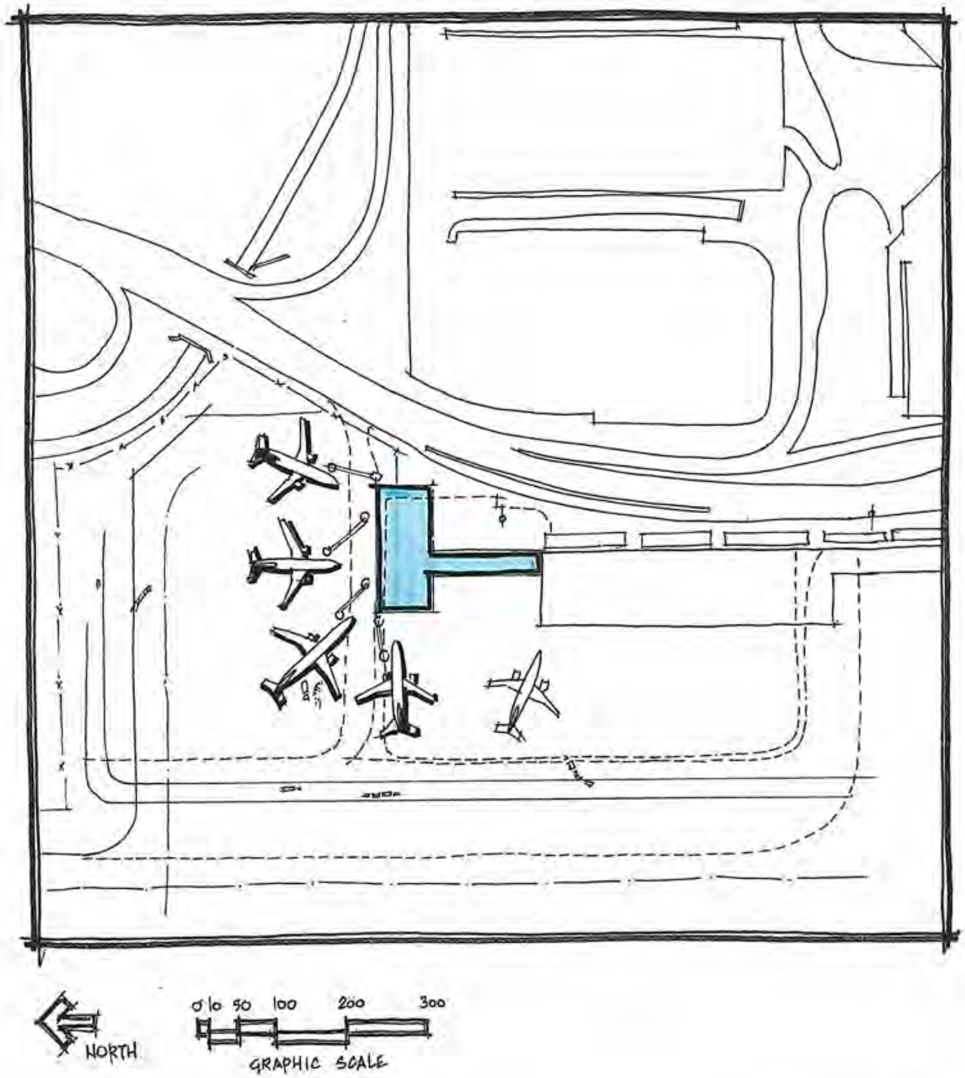
- Build a 150 x 30 foot circulation connector with moving walkways from the end of the existing concourse to the new gate area
- Build a 150 x 75 foot two-story concourse
- Upper level— provide finished space for passenger holdrooms, two restroom blocks, and one concession block to support seven aircraft (narrowbody) parking positions
- Lower level— provide shell space available to airlines for operations space
- Acquire and install four passenger loading bridges

DEPENDENT PROJECTS

- Project A-1—Northward extension of Concourse A

LINEAR FRONTAGE (FEET)

- Frontage gained = 560
- Frontage lost = 0
- Net gain / (loss) = 560



PROJECT A-3 **Concourse A Pavilions with Dual Taxilanes**

PURPOSE

- Build eight aircraft parking positions
- Construct passenger holdrooms, restrooms, concessions, and airline operations space to support new gates
- Improve level of service for passenger gates

DESCRIPTION

Expand density of aircraft parking positions along the west side of Concourse A by constructing pavilions that extrude out from the current facade. Aircraft parking positions would be provided on the north and south side of the pavilions and accessed via dual taxilanes between each set of pavilions. The concentration of gates around each pavilion would be accompanied with appropriate restroom and passenger amenities.

ELEMENTS

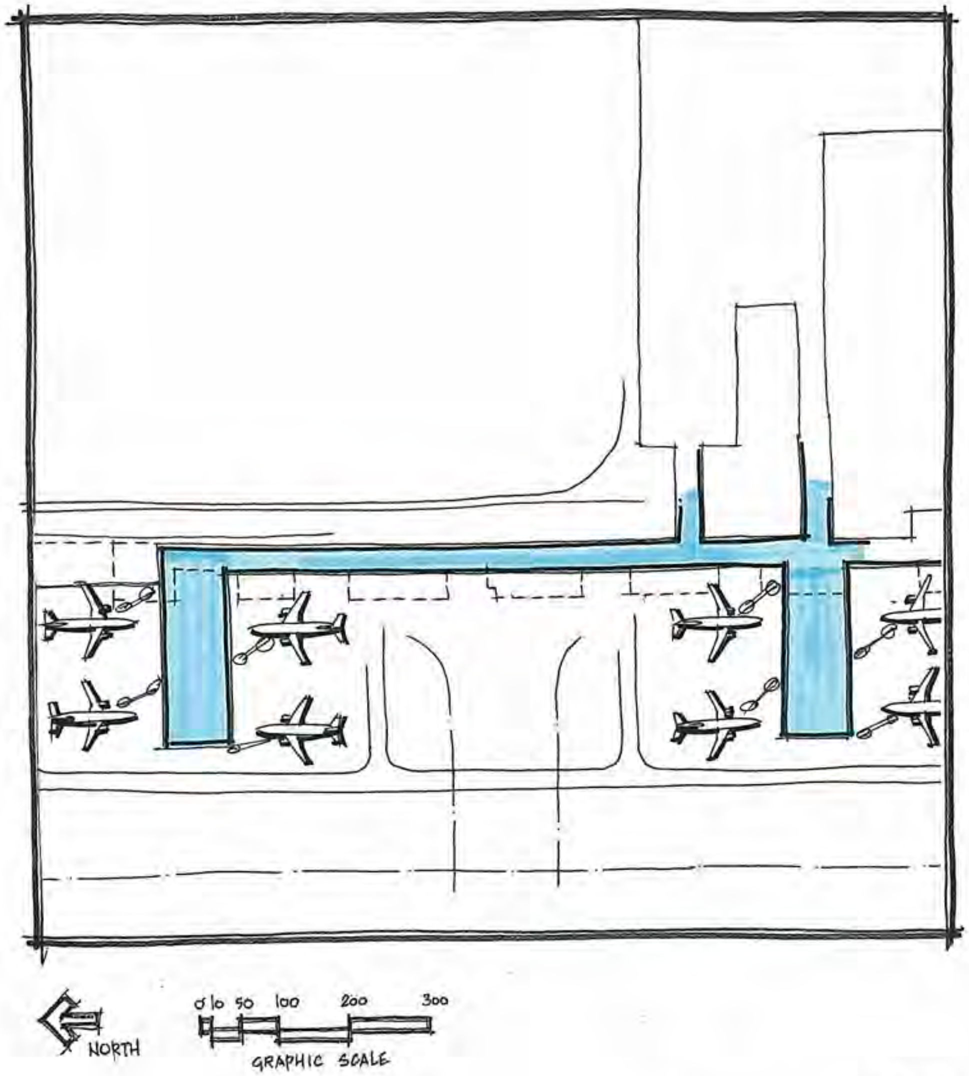
- Remove existing apron pavement as necessary to facilitate building construction
- Construct two two-story pavilions (100 x 200 feet) to extending from the west facade of Concourse A
- Upper level—new passenger circulation and boarding facilities with finishes commensurate with those elsewhere in the terminal
- Lower level—Airline operations space
- Provide two ADG III taxilanes between pavilions to facilitate aircraft movements utilizing existing apron pavement
- Install seismic retrofits and MEP upgrades as appropriate

DEPENDENT PROJECTS

- None

LINEAR FRONTAGE (FEET)

- Frontage gained = 1,080
- Frontage lost = 1,450
- Net gain / (loss) = (370)



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PROJECT A-4 **Concourse A Pavilions with Single Taxilane**

PURPOSE

- Build eight aircraft parking positions
- Construct passenger holdrooms, restrooms, concessions, and airline operations space to support new gates
- Improve level of service for passenger gates

DESCRIPTION

Expand density of aircraft parking positions along the west side of Concourse A by constructing pavilions that extrude out from the current facade. Aircraft parking positions would be provided on the north and south side of the pavilions and accessed via a single taxilane between each set of pavilions. The concentration of gates around each pavilion would be accompanied with appropriate restroom and passenger amenities.

ELEMENTS

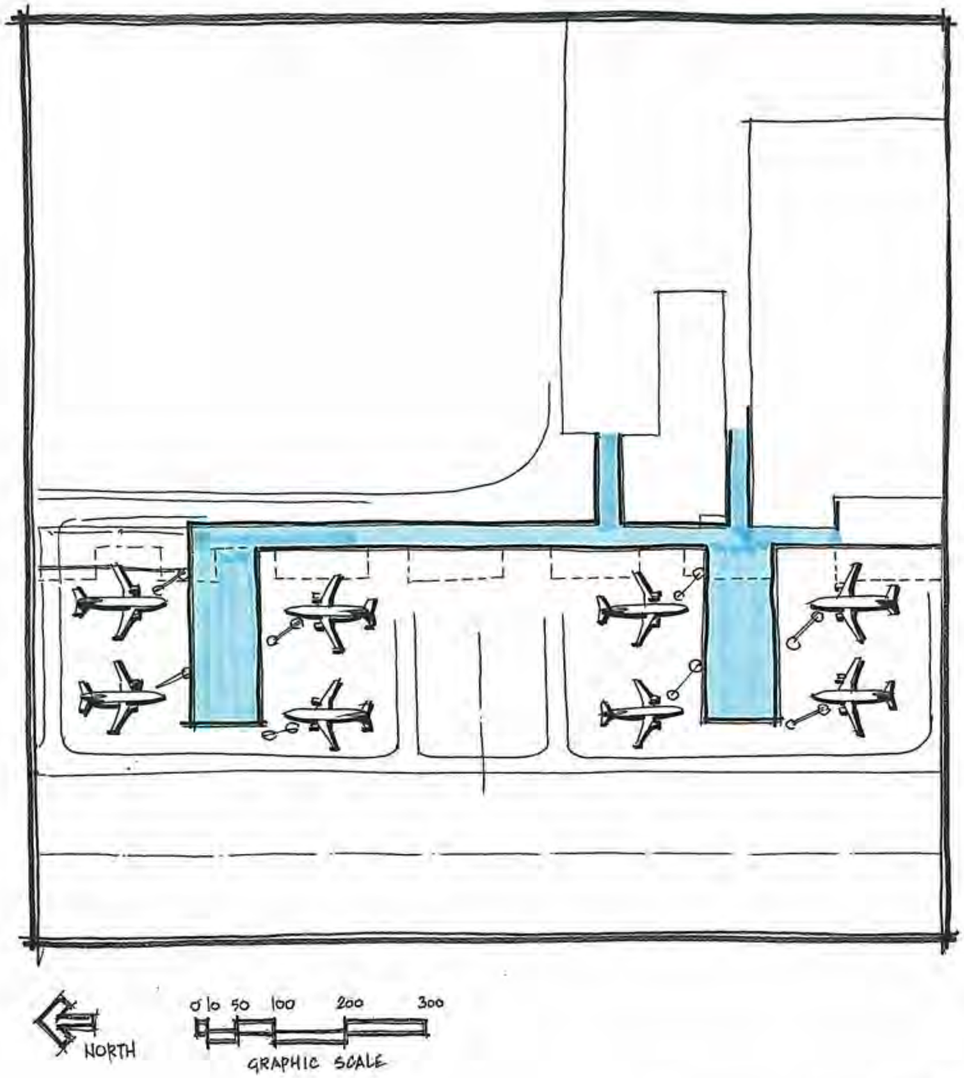
- Remove existing apron pavement as necessary to facilitate building construction
- Construct two two-story pavilions (100 x 200 feet) to extending from the west facade of Concourse A
- Upper level—new passenger circulation and boarding facilities with finishes commensurate with those elsewhere in the terminal
- Lower level—Airline operations space
- Provide an ADG III taxilane between pavilions to facilitate aircraft movements utilizing existing apron pavement
- Install seismic retrofits and MEP upgrades as appropriate

DEPENDENT PROJECTS

- None

LINEAR FRONTAGE (FEET)

- Frontage gained = 1,080
- Frontage lost = 1,450
- Net gain / (loss) = (370)



PROJECT A-4
Concourse A Pavilions with Single Taxilane

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PROJECT A-5 **Regional Jet Facility at South End of Concourse A**

PURPOSE

- Provide cluster of 15 regional jet aircraft parking positions at the south end of Concourse A
- Replace existing regional jet facility, which prevents dual taxilanes in the alley between Concourses A and B

DESCRIPTION

This project would create a cluster of regional jet gates at the south end of Concourse A on the ground level with finishes commensurate to the Airport's existing regional jet facility. These gates would be connected to the existing secure Concourse A-B connector via a vertical circulation. The second level, discussed in detail as Project F-3, would be converted to use as an FIS.

ELEMENTS

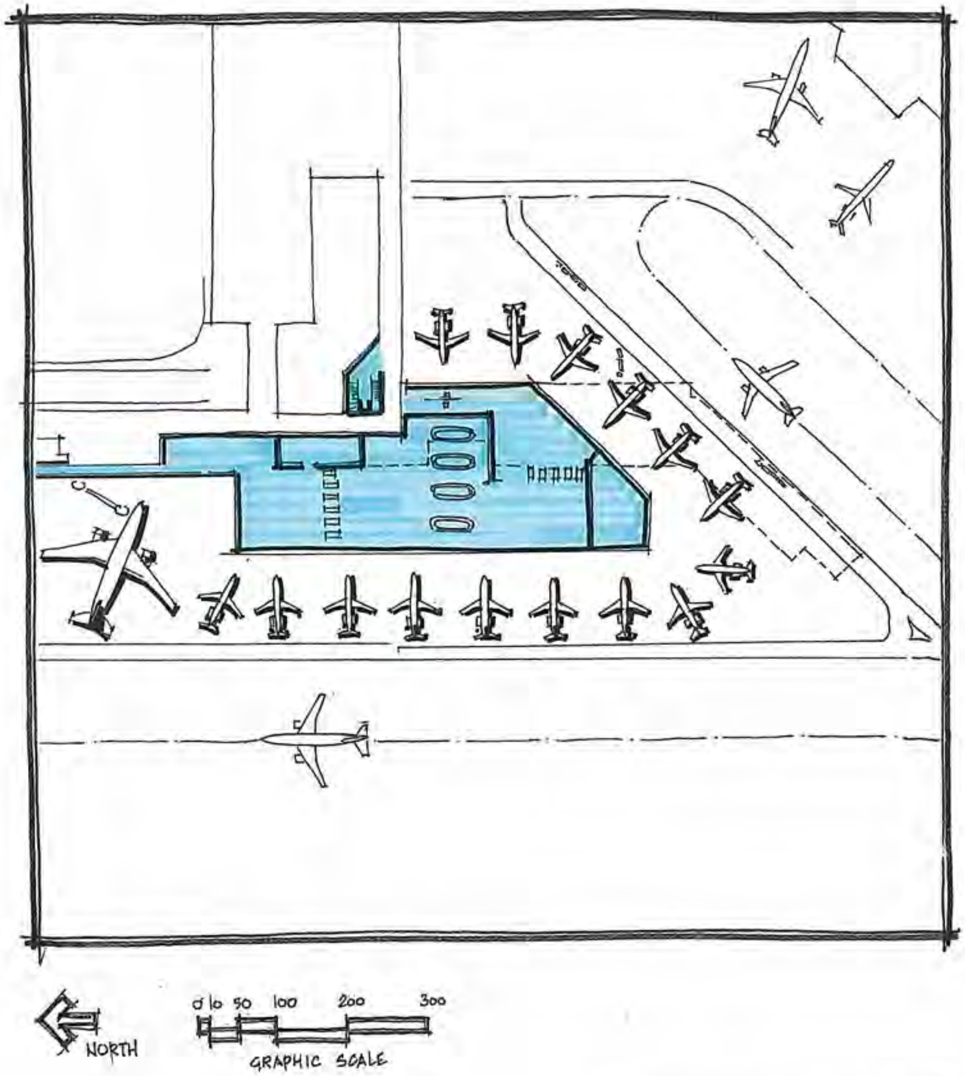
- Remove existing CRJ facility and south leg of Concourse A
- Construct a two-story replacement structure
- Lower level—new CRJ facility to support 15 aircraft parking positions
- Finish new CRJ facility with passenger holdrooms, restrooms, and concession areas commensurate with existing facility
- Install seismic retrofits and MEP upgrades as appropriate

DEPENDENT PROJECTS

- Project F-3—FIS Facility at South End of Concourse A

LINEAR FRONTAGE (FEET)

- Frontage gained = 1,380
- Frontage lost = 1,850
- Net gain / (loss) = (470)



PROJECT **A-5**
Regional Jet Facility at Sound End of Concourse A

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PROJECT A-6 **Concourse A Gate Removal**

PURPOSE

- Remove aircraft parking positions on the east and south facades of the existing Concourse A as well as the regional jet facility
- Provide a dual ADG III taxilane into the alley between Concourses A and B

DESCRIPTION

This project removes aircraft parking positions located on the south and east facades of Concourse A as well as two bays of the existing terminal building. Removing these gates allows for implementation of dual ADG III taxilanes into the alley between Concourses A and B.

ELEMENTS

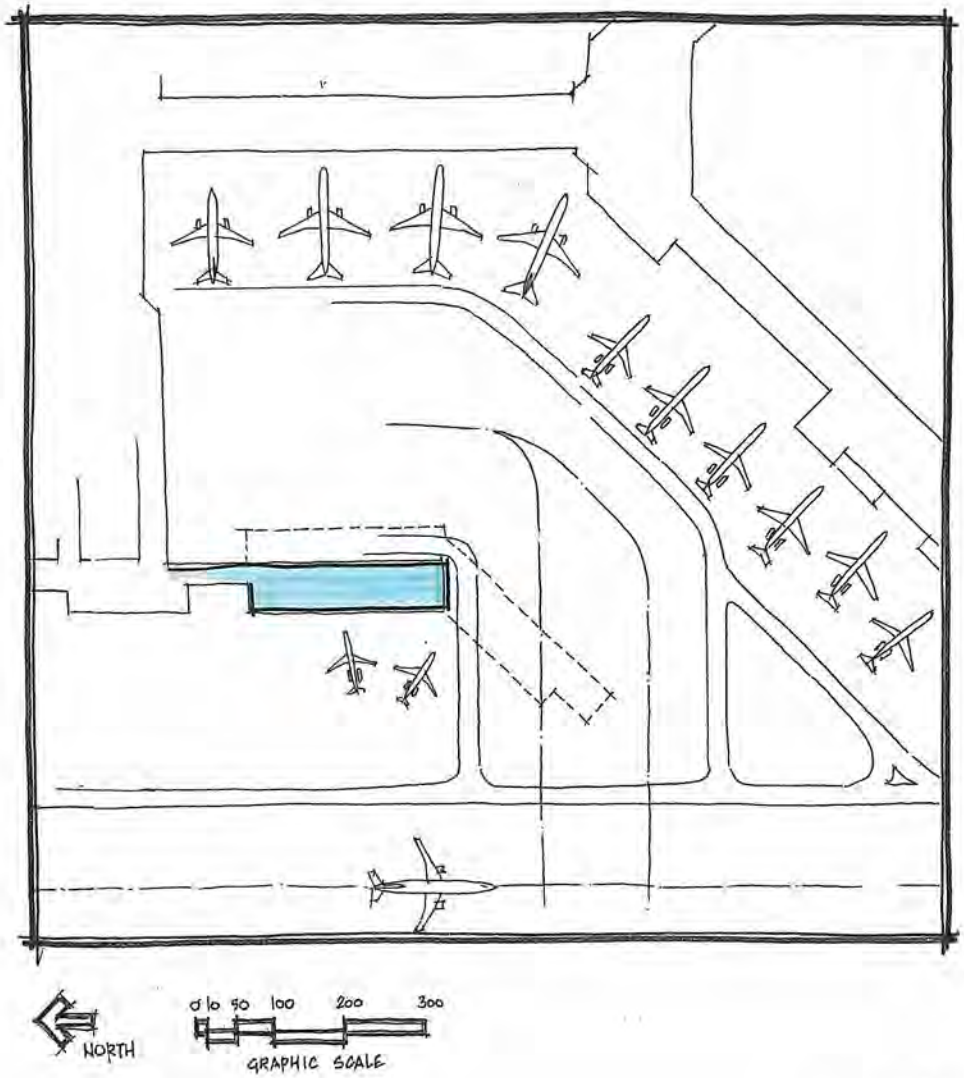
- Remove regional jet facility
- Remove two bays (270 x 40) on the east side of Concourse A
- Re-stripe aircraft parking apron for dual ADG III taxilanes
- Reconfigure aircraft parking positions on the west façade of Concourse A in order to optimize parking positions
- Install seismic retrofits and MEP upgrades as appropriate

DEPENDENT PROJECTS

- None

LINEAR FRONTAGE (FEET)

- Frontage gained = 0
- Frontage lost = 1,250
- Net gain / (loss) = (1,250)



PROJECT A-6
Concourse A Gate Removal

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PROJECT B-1 **Concourse B Trunk Gate Removal**

PURPOSE

- Improve the level of service of the circulation corridor by widening hallway and installing moving sidewalks
- Improve performance of single taxilane in alleyways by reducing number of aircraft parking positions at the end of the alleyways

DESCRIPTION

This project takes the existing circulation corridor and passenger holdrooms along the trunk section of Concourse B and converts the entire portion of the building to circulation space. This requires that gates B1 – B8 be removed and passenger holdrooms adapted to other uses. Circulation improvements would include the installation of moving walkways and wider floor space to facilitate passenger movements between the main terminal and Concourse B rotunda.

ELEMENTS

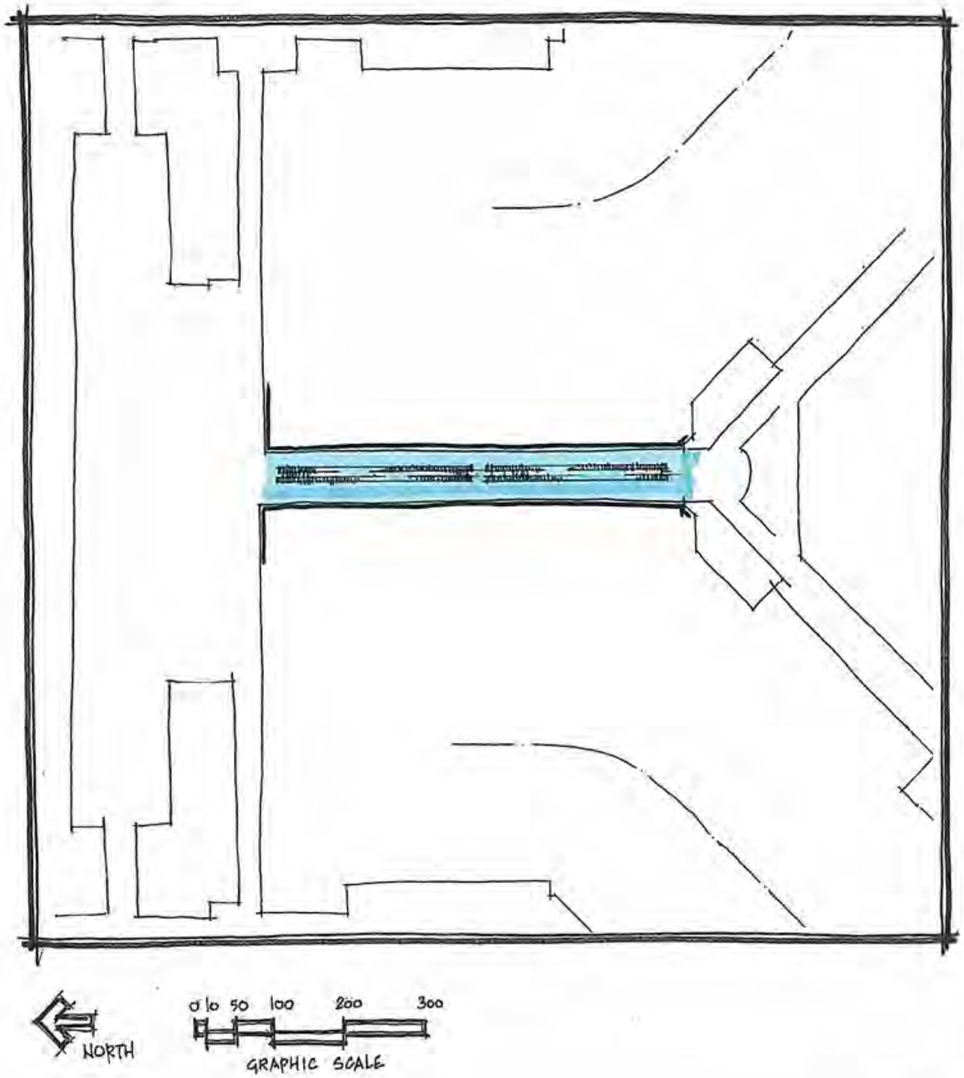
- Remove existing holdrooms and interior walls
- Remove eight passenger loading bridges
- Install moving walks and wider circulation corridor and finish commensurate with existing passenger terminal

DEPENDENT PROJECTS

- None

LINEAR FRONTAGE (FEET)

- Frontage gained = 0
- Frontage lost = 920
- Net gain / (loss) = (920)



PROJECT **B-1**
Concourse B Trunk Gate Removal

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PROJECT B-2 **Sterile Connectors along Trunk of Concourse B**

PURPOSE

- Provide segregated connectors between gates along the trunk of Concourse B to a proximate FIS facility

DESCRIPTION

This project would install a segregated connector (likely glass-walled) that allows deplaning passengers to access the FIS facility for clearance. These connectors could be installed to either side of Concourse B and funnel passengers into the ground-level FIS via vertical circulation areas.

ELEMENTS

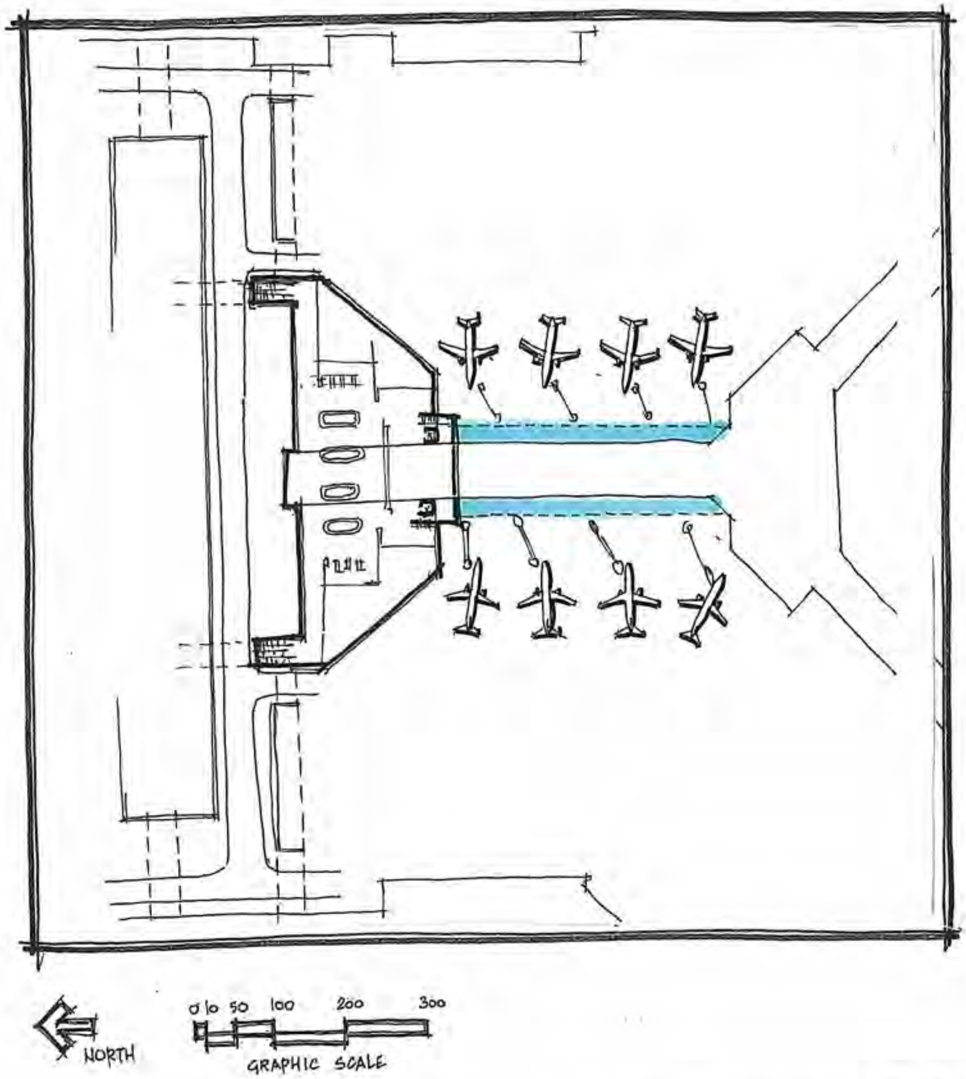
- Widen truck section of Concourse B to east and west by 10 feet to provide sterile corridors for Gates B1-8 leading to a FIS facility (see Project #7)
- Provide vertical circulation between the sterile corridors and the FIS facility, envisioned to be located on the lower level of the concourse
- Reconfigure passenger loading bridges as necessary
- Install seismic retrofits and MEP upgrades as appropriate

DEPENDENT PROJECTS

- Project F-4—FIS Facility at Concourse B and Terminal Junction

LINEAR FRONTAGE (FEET)

- Frontage gained = 0
- Frontage lost = 0
- Net gain / (loss) = 0



PROJECT **B-2**
Sterile Connectors along Trunk of Concourse B

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PROJECT B-3 **Concourse B Trunk Holdroom Expansion with FIS**

PURPOSE

- Provide additional passenger holdroom and amenity space for gates along trunk of Concourse B
- Accommodate larger aircraft and passenger loads for international flights at gates along trunk of Concourse B
- Expand circulation corridor and install moving walkways to better facilitate passengers transiting between the Concourse B rotunda and main terminal

DESCRIPTION

This project would expand the trunk of Concourse B to the east and west by adding holdroom capacity and passenger amenity space on the upper level and airline operations space on the lower level. This project would allow the current circulation corridor to be widened and improved through the installation of moving walkways. This project is envisioned to be undertaken with the construction of an FIS at the intersection of the terminal and Concourse B as described in Project F-3. Increasing the width of Concourse B in this vicinity may restrict the aircraft types that can park either along the trunk of Concourse B or the interior portions of Concourses A and C.

ELEMENTS

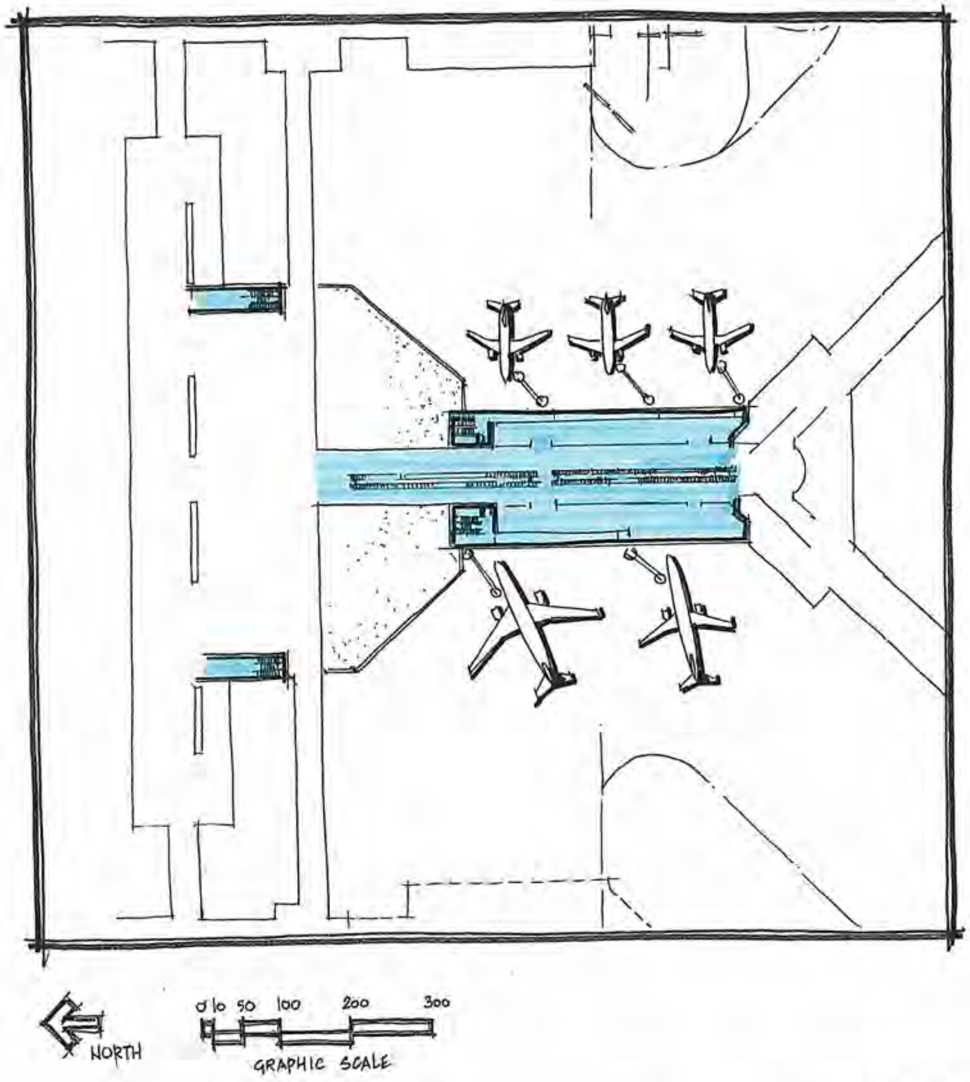
- Provide two-story widening to trunk section of Concourse B, addition two 250 x 60-foot additions to the east and west
- Upper level—new passenger circulation and boarding facilities with finishes commensurate with those elsewhere in the terminal
- Lower level—Airline operations space
- Reconfigure existing concourse and holdrooms to be entirely circulation space with bi-directional moving walks
- Remove and re-install eight passenger loading bridges
- Install seismic retrofits and MEP upgrades as appropriate

DEPENDENT PROJECTS

- Project B-2—Sterile Connectors along Trunk of Concourse B
- Project F-4—FIS Facility at Concourse B and Terminal Junction

LINEAR FRONTAGE (FEET)

- Frontage gained = 0
- Frontage lost = 400
- Net gain / (loss) = (400)



PROJECT **B-3**
Concourse B Trunk Holdroom Expansion with FIS

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PROJECT B-4 **Concourse B Trunk Holdroom Capacity without FIS**

PURPOSE

- Provide additional passenger holdroom and amenity space for gates along trunk of Concourse B
- Expand circulation corridor and install moving walkways to better facilitate passengers transiting between the Concourse B rotunda and main terminal

DESCRIPTION

This project would expand the trunk of Concourse B to the east and west by adding holdroom capacity and passenger amenity space on the upper level and airline operations space on the lower level. This project would allow the current circulation corridor to be widened and improved through the installation of moving walkways. This, while similar to Project B-3, is envisioned to be undertaken without the installation of an FIS and would simply add concourse space for domestic flights. Increasing the width of Concourse B in this vicinity may restrict the aircraft types that can park either along the trunk of Concourse B or the interior portions of Concourses A and C.

ELEMENTS

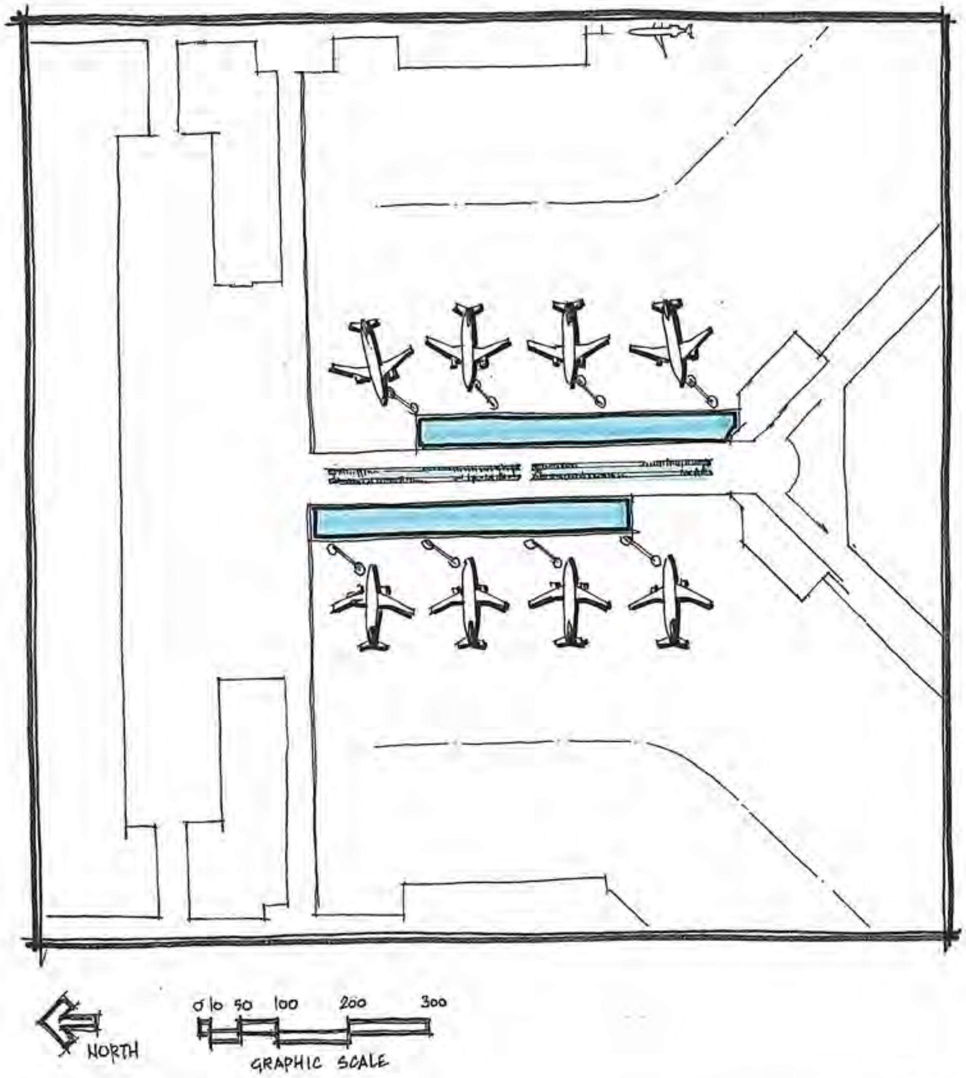
- Provide two-story widening to trunk section of Concourse B, addition two 250 x 60-foot additions to the east and west
- Upper level—new passenger circulation and boarding facilities with finishes commensurate with those elsewhere in the terminal
- Lower level—Airline operations space
- Reconfigure existing concourse and holdrooms to be entirely circulation space with bi-directional moving walks
- Remove and re-install eight passenger loading bridges
- Install seismic retrofits and MEP upgrades as appropriate

DEPENDENT PROJECTS

- None

LINEAR FRONTAGE (FEET)

- Frontage gained = 0
- Frontage lost = 0
- Net gain / (loss) = 0



PROJECT **B-4**
Concourse B Trunk Holdroom Expansion without FIS

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Memphis International Airport
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PROJECT B-5 **Regional Jet Facility at Southeast Leg of Concourse B**

PURPOSE

- Add a net total of seven regional jet parking positions to the southeast leg of Concourse B
- Construct passenger holdrooms, restrooms, and concessions areas to support new gates

DESCRIPTION

Expand aircraft parking positions by construction a regional jet facility to the end of the southeast leg of Concourse B. The concourse extension would be single-level and provide as many new gates as possible for each square foot of additional building space.

ELEMENTS

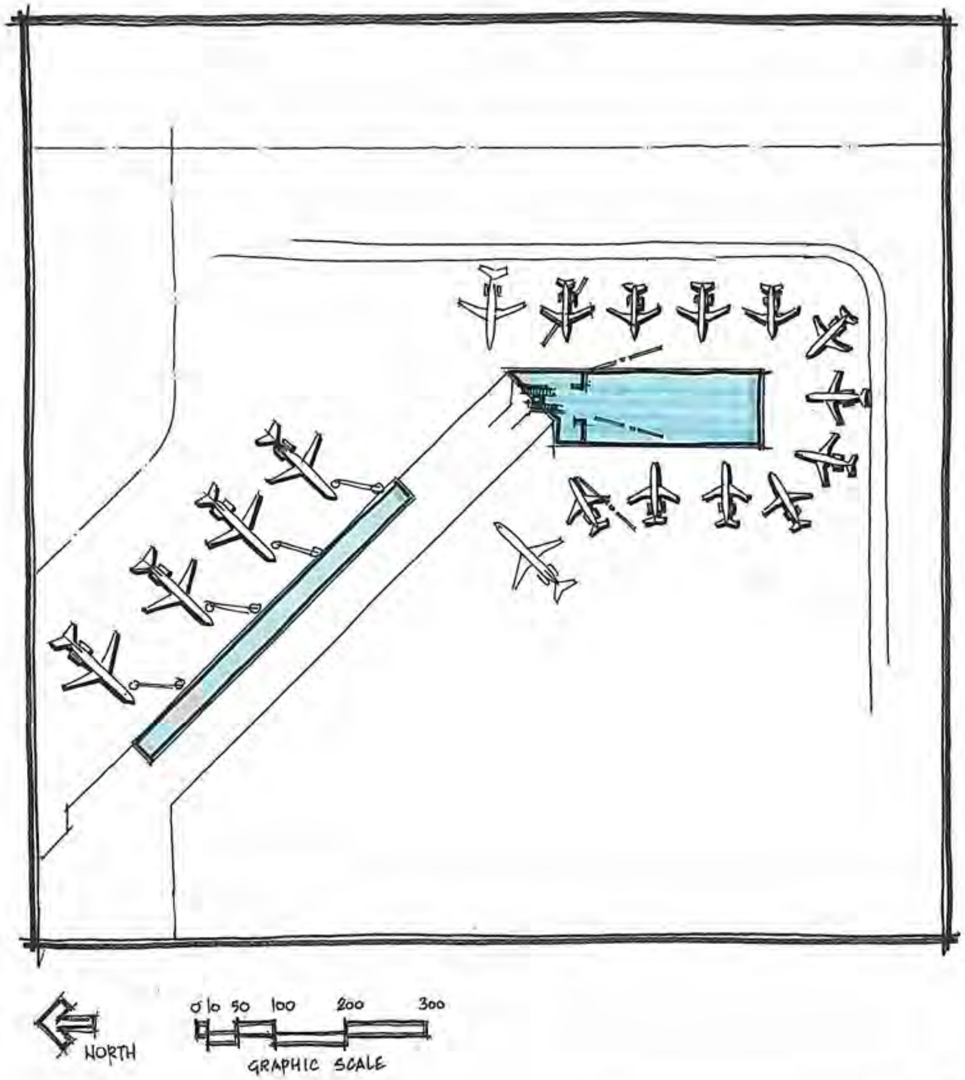
- Remove aircraft gates and south façade of existing concourse
- Construct a 200 x 100 foot single-level holdroom area, two restroom blocks, and one concessions area to support ten aircraft (regional jet) parking positions
- Install ten passenger loading bridges
- Expand apron areas and infill "islands" to support new aircraft gates
- Install seismic retrofits and MEP upgrades as appropriate

DEPENDENT PROJECTS

- None, although Projects B-1 through B-4 and B-10 that would improve the level of service in the corridors should be considered.

LINEAR FRONTAGE (FEET)

- Frontage gained = 860
- Frontage lost = 310
- Net gain / (loss) = 550



PROJECT **B-5**
Regional Jet Facility at Southeast Leg of Concourse B

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Memphis International Airport
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PROJECT B-6 **Narrowbody Gates at Southwest Leg of Concourse B**

PURPOSE

- Add a net total of three aircraft (narrowbody) parking positions to the southwestern leg of Concourse B
- Construct passenger holdrooms, restrooms, concessions, and airline operations space to support new gates

DESCRIPTION

Expand aircraft parking positions by constructing a mainline aircraft facility to the end of the southwest leg of Concourse B. The concourse extension would be two-level, providing passenger holdrooms, restrooms, and concessions on the upper level and airline operations space on the lower level.

ELEMENTS

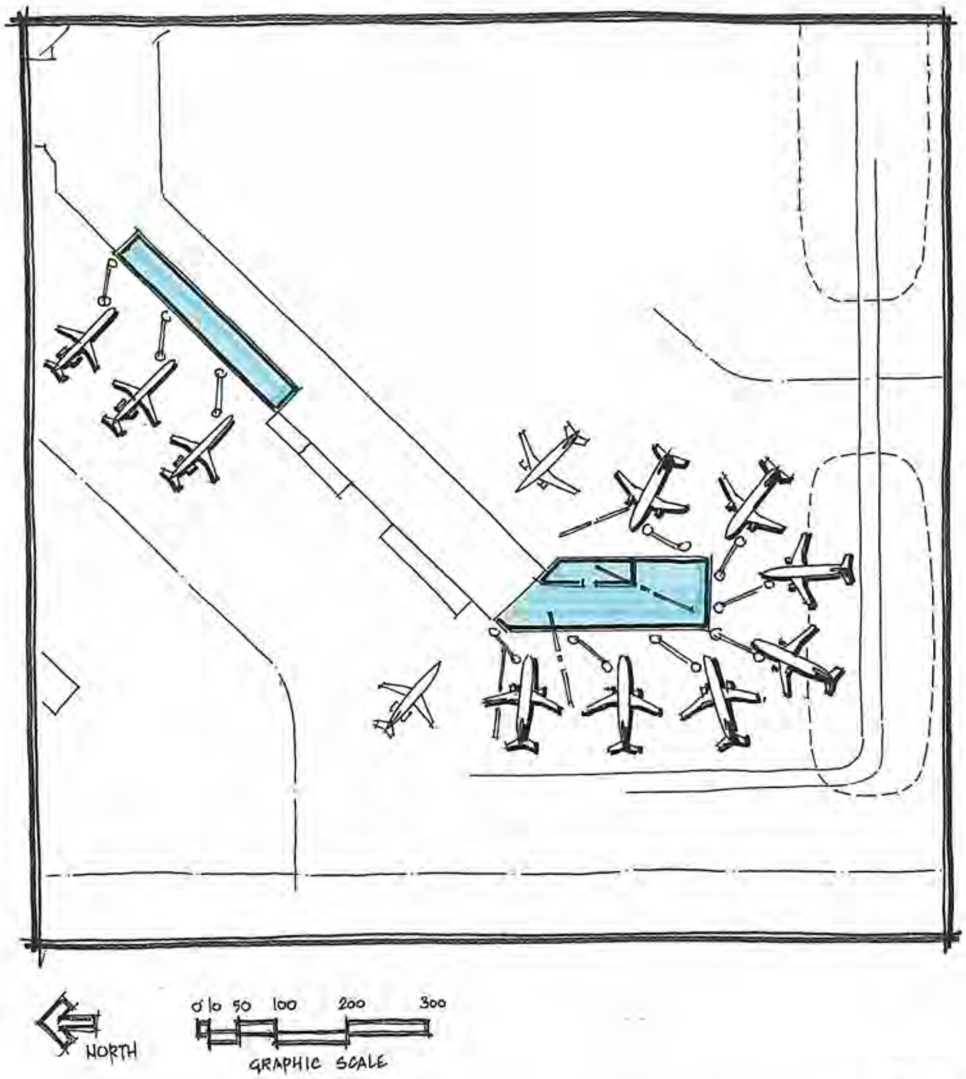
- Remove aircraft gates and south façade of existing concourse
- Construct a 250 x 100 foot two-level concourse extension
- Upper level— provide finished space for passenger holdrooms, two restroom blocks, and one concession block to support seven aircraft (narrowbody) parking positions
- Lower level— provide shell space available to airlines for operations space
- Install seven passenger loading bridges
- Expand apron areas and infill "islands" to support new aircraft gates
- Install seismic retrofits and MEP upgrades as appropriate

DEPENDENT PROJECTS

- None, although Projects B-1 through B-4 and B-10 that would improve the level of service in the corridors should be considered.

LINEAR FRONTAGE (FEET)

- Frontage gained = 740
- Frontage lost = 350
- Net gain / (loss) = 390



PROJECT **B-6**
Narrowbody Gates at Southwest Leg of Concourse B

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Memphis International Airport
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PROJECT B-7 Additional Extension to Southwest Leg of Concourse B

PURPOSE

- Provide additional aircraft parking positions to the south of Concourse B by further extending the concourse

DESCRIPTION

This project provides additional aircraft parking positions beyond what is shown in Projects B-5 and B-6 by extending the concourse farther to the south, requiring relocation of Taxiway T. The additional gate space is envisioned to be able to accommodate narrowbody aircraft. The extension also requires relocation of gates on the south façade of the concourse during construction.

ELEMENTS

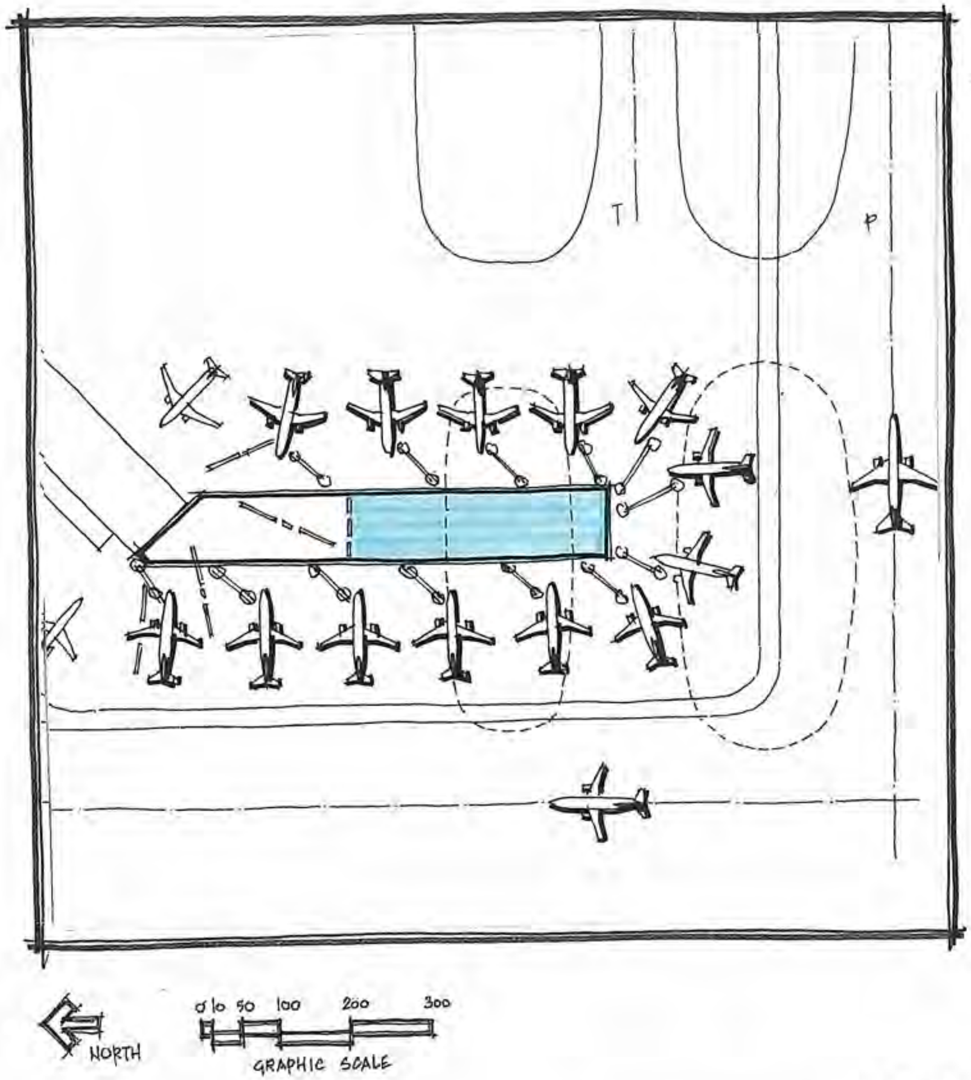
- Remove and relocate Taxiway T
- Construct two-story concourse extension (680 x 100 feet) to the south
- Upper level— provide finished space for passenger holdrooms, two restroom blocks, and one concession block to support seven aircraft (narrowbody) parking positions
- Lower level— provide shell space available to airlines for operations space
- Acquire and install four passenger loading bridges

DEPENDENT PROJECTS

- Project B-6—Narrowbody Gates at Southwest Leg of Concourse B

LINEAR FRONTAGE (FEET)

- Frontage gained = 1,030
- Frontage lost = 350
- Net gain / (loss) = 680



PROJECT **B-7**
Additional Extension to Southwest Leg of Concourse B

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PROJECT B-8 **Realignment of Concourse B Legs at Rotunda**

PURPOSE

- Improve passenger level of service realigning both legs of Concourse B in an east-west direction, permitting expansion of passenger holdrooms, amenities, and circulation corridors
- Provide two ADG III taxilanes through between the main terminal and the realigned concourse to easily facilitate aircraft movements

DESCRIPTION

This project reconfigures the legs of Concourse B in an east-west fashion to improve passenger level of service as well as airfield-terminal interactions. Reconfiguration of the legs allows for preservation of the existing rotunda area while reducing walking distances to gates on the Concourse B legs.

ELEMENTS

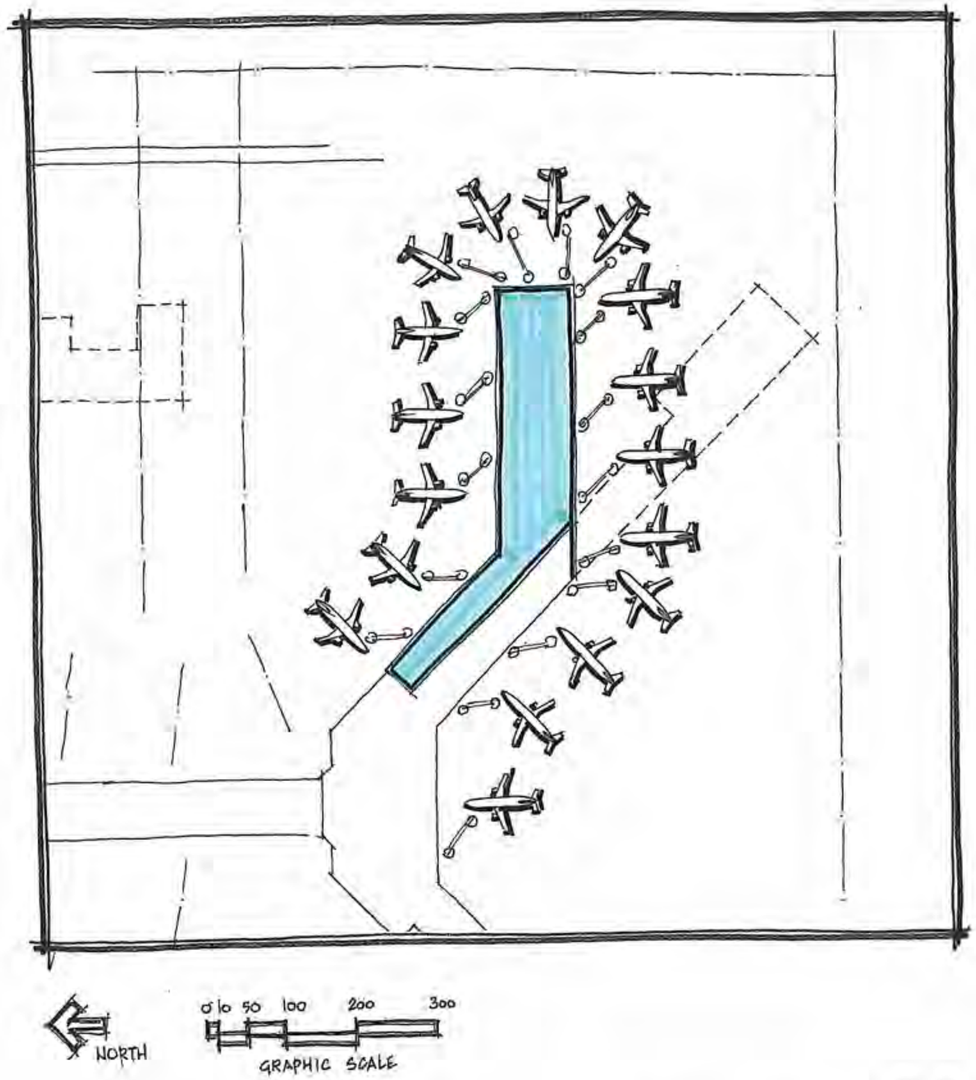
- Remove 400 feet of Concourse B and the east and west ends and repair aircraft pavements for aircraft use
- Construct two new two-story (400 x 120 feet) structures in an east-west orientation at the new concourse ends
- Upper level—new passenger circulation and boarding facilities with finishes commensurate with those elsewhere in the terminal
- Lower level—airline operations space
- Install 12 passenger loading bridges and concourse additions with associated aircraft services
- Provide allowance for adjustment of remaining existing aircraft parking positions
- Install seismic retrofits and MEP upgrades as appropriate

DEPENDENT PROJECTS

- Project T-1—Narrowbody Gates at South Terminal Façade or
- Project T-2—Regional Jet Gates at South Terminal Façade
- Projects B-1 through B-4 and B-10 that would improve the level of service in the corridors should be considered.

LINEAR FRONTAGE (FEET)

- Frontage gained = 3,140
- Frontage lost = 3,150
- Net gain / (loss) = (10)



PROJECT **B-8**
Realignment of Concourse B Legs at Rotunda

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PROJECT B-9 **North-South Pier at Concourse B Rotunda**

PURPOSE

- Provide additional aircraft parking positions by building a third leg from the Concourse B rotunda to the south

DESCRIPTION

This project adds a third leg to Concourse B, extending southward from the rotunda in order to add ten aircraft parking positions. The new two-story concourse would be capable of supporting narrowbody aircraft gates and upgraded passenger amenities like moving walkways.

ELEMENTS

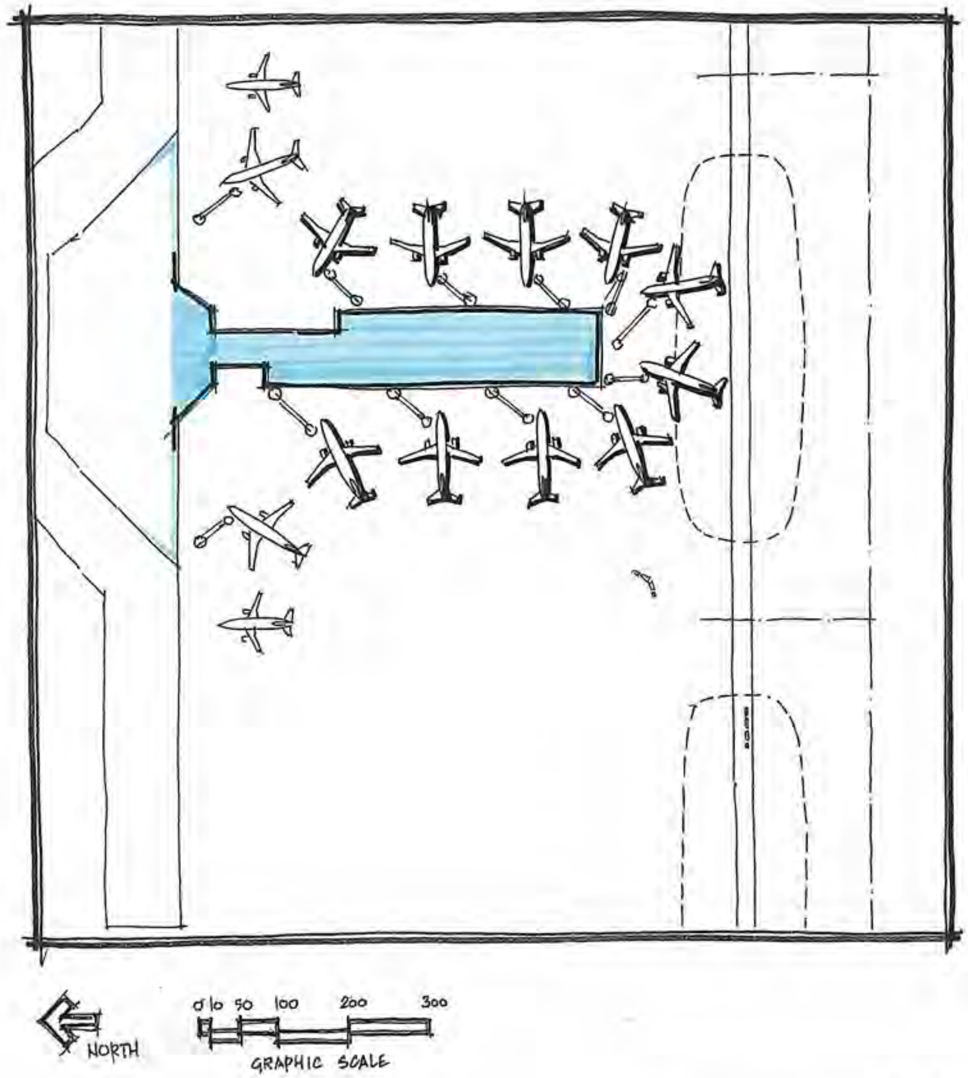
- Construct a third two-story pier at Concourse B in general alignment with the base of the concourse to provide ten new aircraft parking positions
- Upper level—new passenger circulation and boarding facilities with finishes commensurate with those elsewhere in the terminal
- Lower level—Airline operations space
- Construct circulation connectors (250 x 40 feet) to the west and east piers of Concourse B
- Install ten passenger loading bridges at the concourse additions with associated aircraft services
- Provide allowance for adjustment of remaining existing aircraft parking positions
- Install seismic retrofits and MEP upgrades as appropriate

DEPENDENT PROJECTS

- Project B-8—Realignment of Concourse B Legs at Rotunda

LINEAR FRONTAGE (FEET)

- Frontage gained = 1,320
- Frontage lost = 300
- Net gain / (loss) = 1,020



PROJECT **B-9**
North-South Pier at Concourse B Rotunda

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Memphis International Airport
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PROJECT B-10 **Widening of Southeast & Southwest Legs of Concourse B**

PURPOSE

- Improve passenger level of service by widening both legs of Concourse B, permitting expansion of passenger holdrooms, amenities, and circulation corridors
- Remove single-taxilane alleyways to improve airfield-terminal interactions

DESCRIPTION

This project increases the width of the legs of Concourse B in order to provide larger holdrooms and passenger circulation corridors. The increase in width is to be provided to the south of the existing concourse, requiring relocation and reconfiguration of existing parking positions.

ELEMENTS

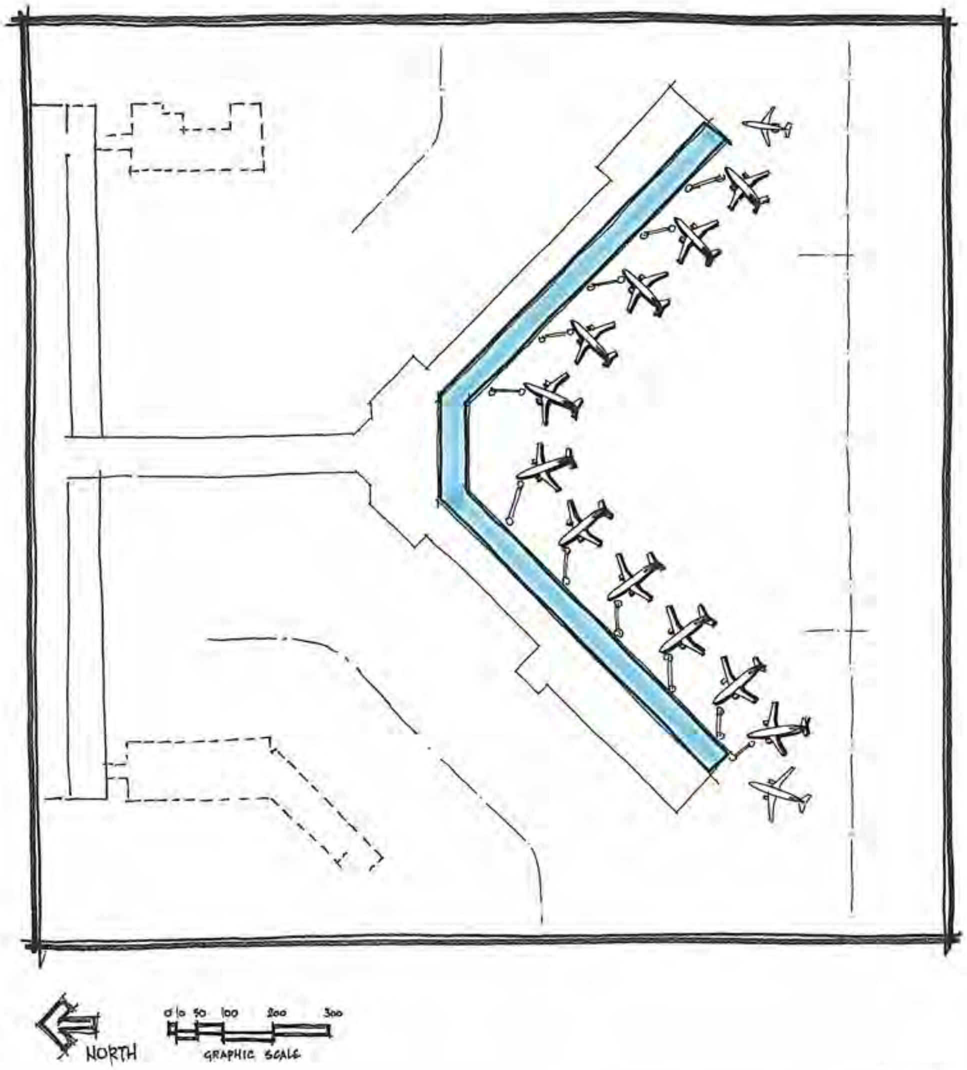
- Widen truck section of Concourse B to east and west by 10 feet to provide sterile corridors for Gates B1-8 leading to a FIS facility (see Project #7)
- Provide vertical circulation between the sterile corridors and the FIS facility, envisioned to be located on the lower level of the concourse
- Reconfigure passenger loading bridges as necessary
- Install seismic retrofits and MEP upgrades as appropriate

DEPENDENT PROJECTS

- None

LINEAR FRONTAGE (FEET)

- Frontage gained = 1,360
- Frontage lost = 1,500
- Net gain / (loss) = (140)



PROJECT **B-10**
Widening of Southeast & Southwest Legs of Concourse B

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PROJECT B-11 **Remote South Concourse**

PURPOSE

- Provide additional gates located remotely from the main terminal building
- Improve airfield-terminal interactions by providing two ADG III taxilanes that access either Taxiways J or N

DESCRIPTION

This project constructs a remote passenger concourse at the southern end of the existing terminal complex. The concourse would be connected to the existing Concourse B rotunda via either and underground walkway or a bridge. Moving walkways would assist passengers to move from the midpoint, adjacent to the connection to the tunnel or bridge, to either end with ease. The concourse is shown as double-loaded, although providing south façade gates would require demolition and relocation of Taxiway T.

ELEMENTS

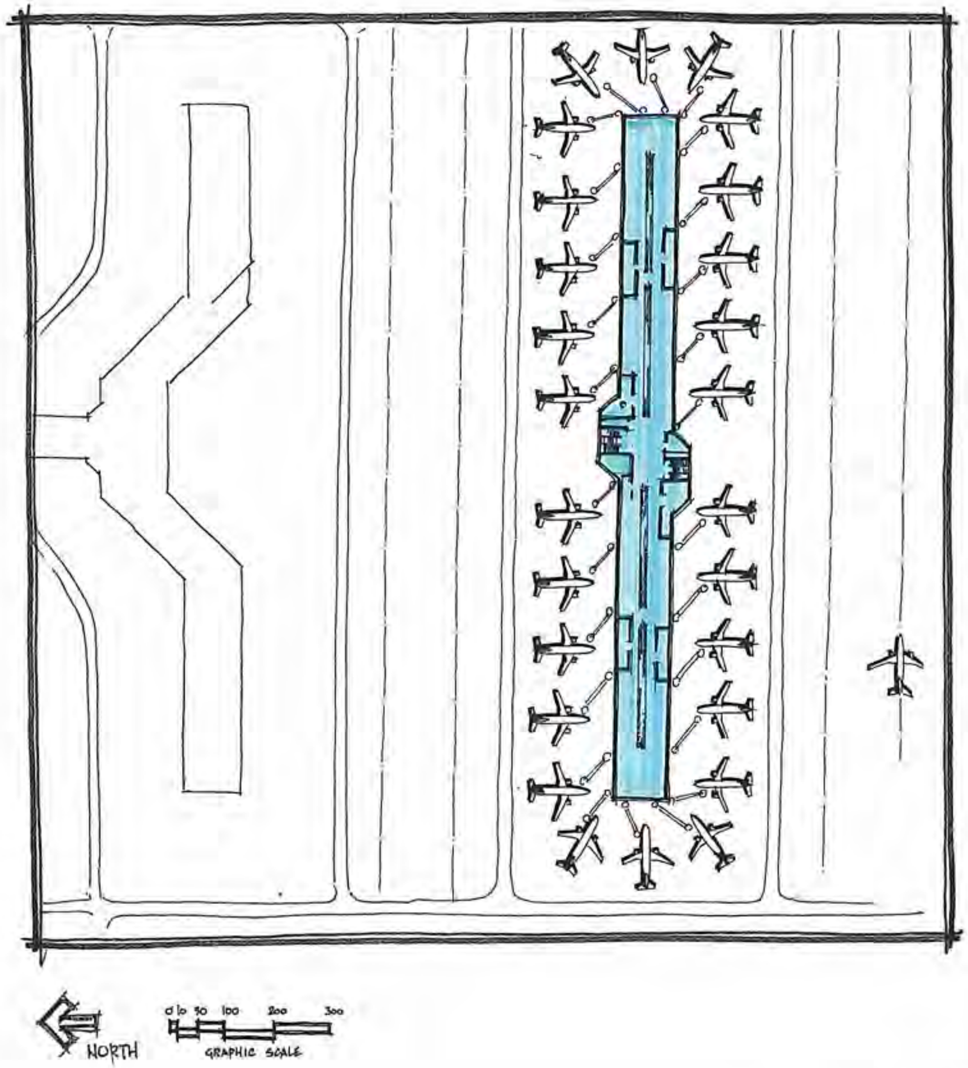
- Construct a new double-loaded two-story (1,300 x 120 feet) satellite terminal concourse to the north of Taxiway T
- Upper level—new passenger circulation with moving walks and boarding facilities with finishes commensurate with those elsewhere in the terminal
- Lower level—Airline operations space
- Provide a bridge or tunnel connection from mid-field concourse to new satellite concourse with moving walks (60 feet wide at minimum)
- Acquire and install approximately 26 passenger loading bridges
- Add and reconfigure aircraft parking apron as necessary to provide parking positions

DEPENDENT PROJECTS

- Project B-8—Realignment of Concourse B Legs at Rotunda

LINEAR FRONTAGE (FEET)

- Frontage gained = 1,950
- Frontage lost = 0
- Net gain / (loss) = 1,950



PROJECT **B-11**
Remote South Concourse

PROJECT C-1 **Northward Extension of Concourse C**

PURPOSE

- Add four additional aircraft parking positions
- Construct passenger holdrooms, restrooms, concessions, and airline operations space to support new gates

DESCRIPTION

Extend Concourse C to the north in order to provide four additional aircraft parking positions. Extension to the north could include installation of moving walkways to mitigate walking distance increases to the main terminal. This project, termed the "baseline" project, will provide sufficient gates to enable the Authority to undertake planned apron rehabilitation projects throughout the passenger terminal complex.

ELEMENTS

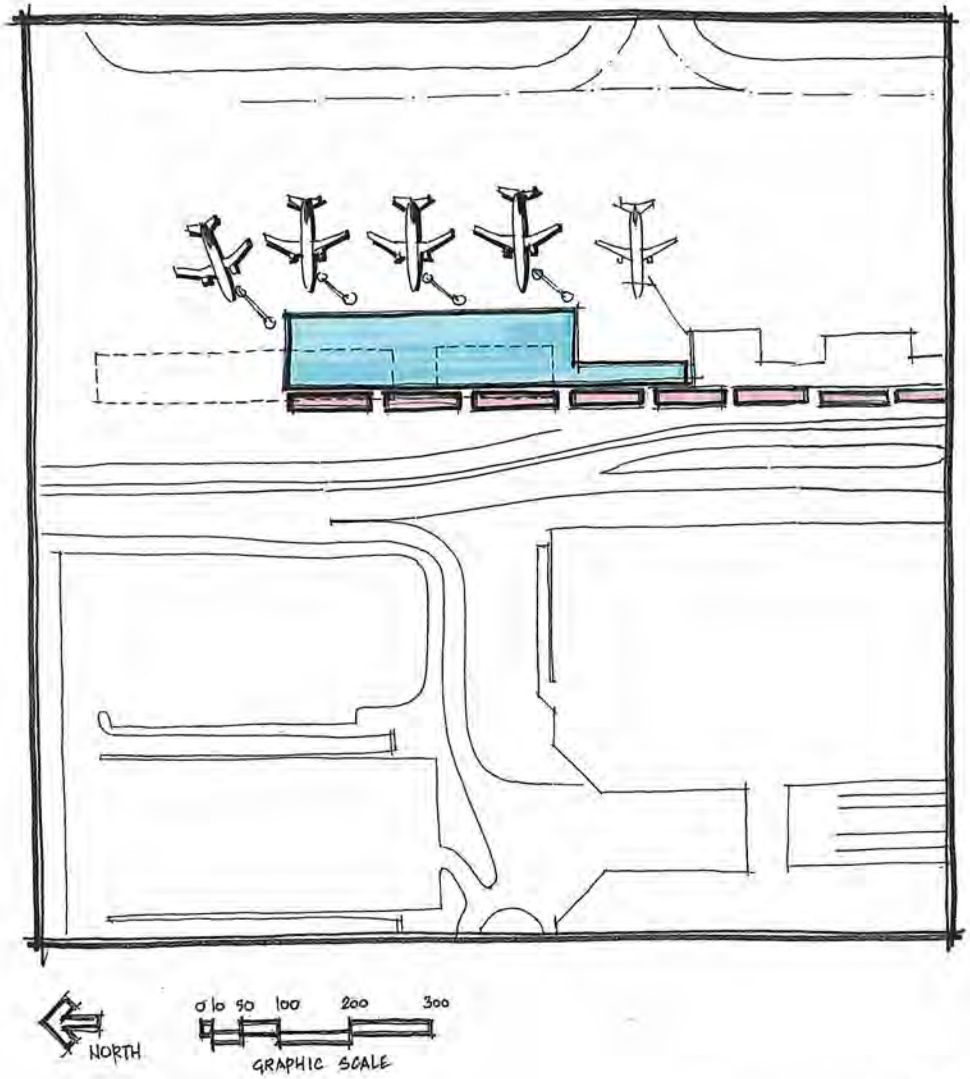
- Construct two-level building expansion (400 x 100 feet)
- Upper level—provide finished space for passenger holdrooms, two restroom blocks, and concession areas
- Lower level—provide shell space available to airlines for operations space
- Acquire and install four passenger loading bridges
- Construct additional aircraft apron as needed to accommodate aircraft and ground support equipment operations
- Install AOA fencing and security gates around new apron area
- Install seismic retrofits and MEP upgrades as appropriate

DEPENDENT PROJECTS

- None

LINEAR FRONTAGE (FEET)

- Frontage gained = 610
- Frontage lost = 0
- Net gain / (loss) = 610



PROJECT **C-1**
Northward Extension of Concourse C

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Memphis International Airport
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PROJECT C-2 **Concourse C Hammerhead**

PURPOSE

- Add four aircraft parking positions
- Construct passenger holdrooms, restrooms, concessions, and airline operations space to support new gates

DESCRIPTION

Extend Concourse C north beyond extent of Project C-1 in order to provide additional aircraft parking positions. This project will include a connecting corridor and a "hammerhead" providing passenger gate areas and associated amenities. There are two versions of this project: the "partial," which has a truncated hammerhead; and the "full," which has a full-length hammerhead (pictured). Figures for both are presented below.

ELEMENTS

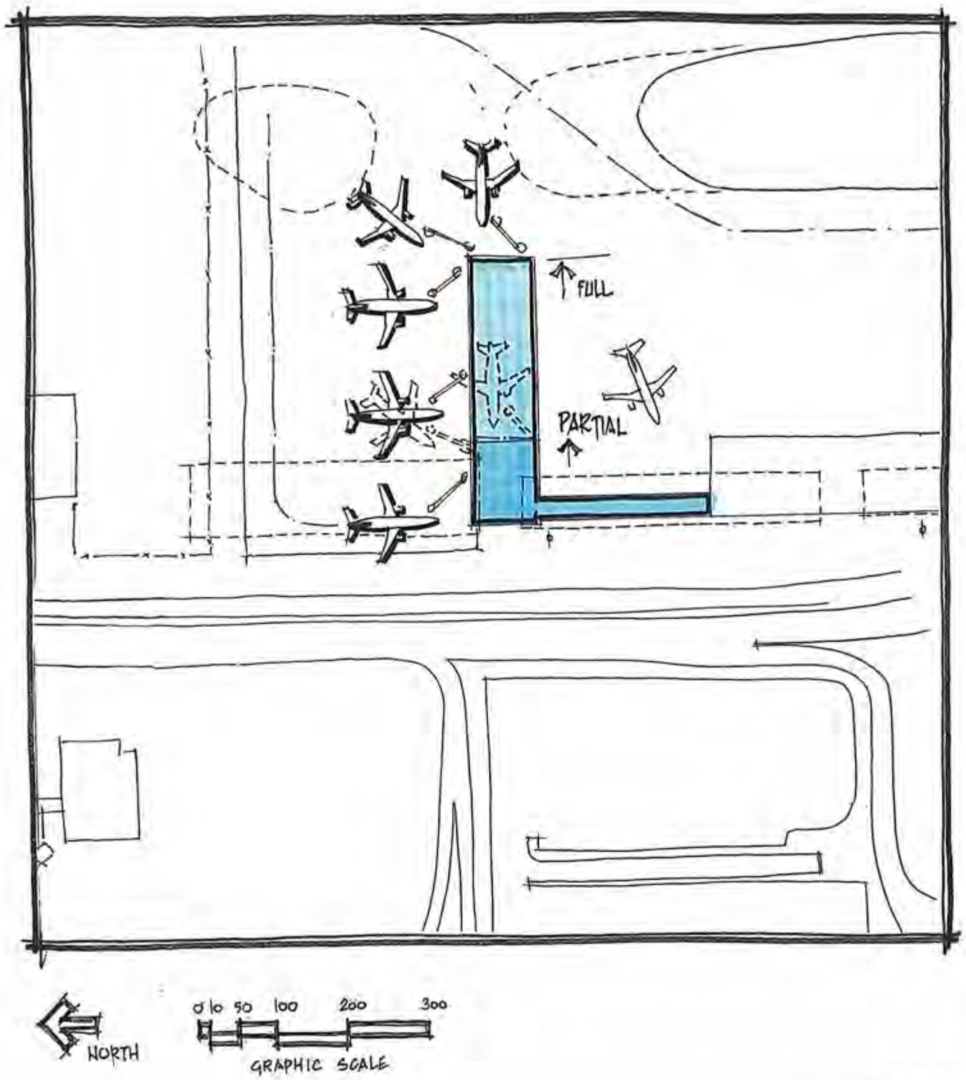
- Build a 250 x 30 foot circulation connector with moving walkways from the end of the existing concourse to the new gate area
- Build a 350 x 75 foot two-story concourse (100 x 75 foot for partial)
- Acquire and install 5 passenger loading bridges (3 for partial)
- Upper level— provide finished space for passenger holdrooms, two restroom blocks, and one concession block to support seven aircraft (narrowbody) parking positions
- Lower level— provide shell space available to airlines for operations space

DEPENDENT PROJECTS

- Project A-1—Northward extension of Concourse A is a prerequisite

LINEAR FRONTAGE (FEET)

- Frontage gained = 440 / 670
- Frontage lost = 0
- Net gain / (loss) = 440 / 670



PROJECT **C-2**
Concourse C Hammerhead

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PROJECT C-3 Concourse C Pavilions with Dual Taxilanes

PURPOSE

- Build 14 aircraft parking positions
- Construct passenger holdrooms, restrooms, concessions, and airline operations space to support new gates
- Improve level of service for passenger gates

DESCRIPTION

Expand density of aircraft parking positions along the east side of Concourse C by constructing pavilions that extrude out from the current facade. Aircraft parking positions would be provided on the north and south side of the pavilions and accessed via dual taxilanes between each set of pavilions. The concentration of gates around each pavilion would be accompanied with appropriate restroom and passenger amenities.

ELEMENTS

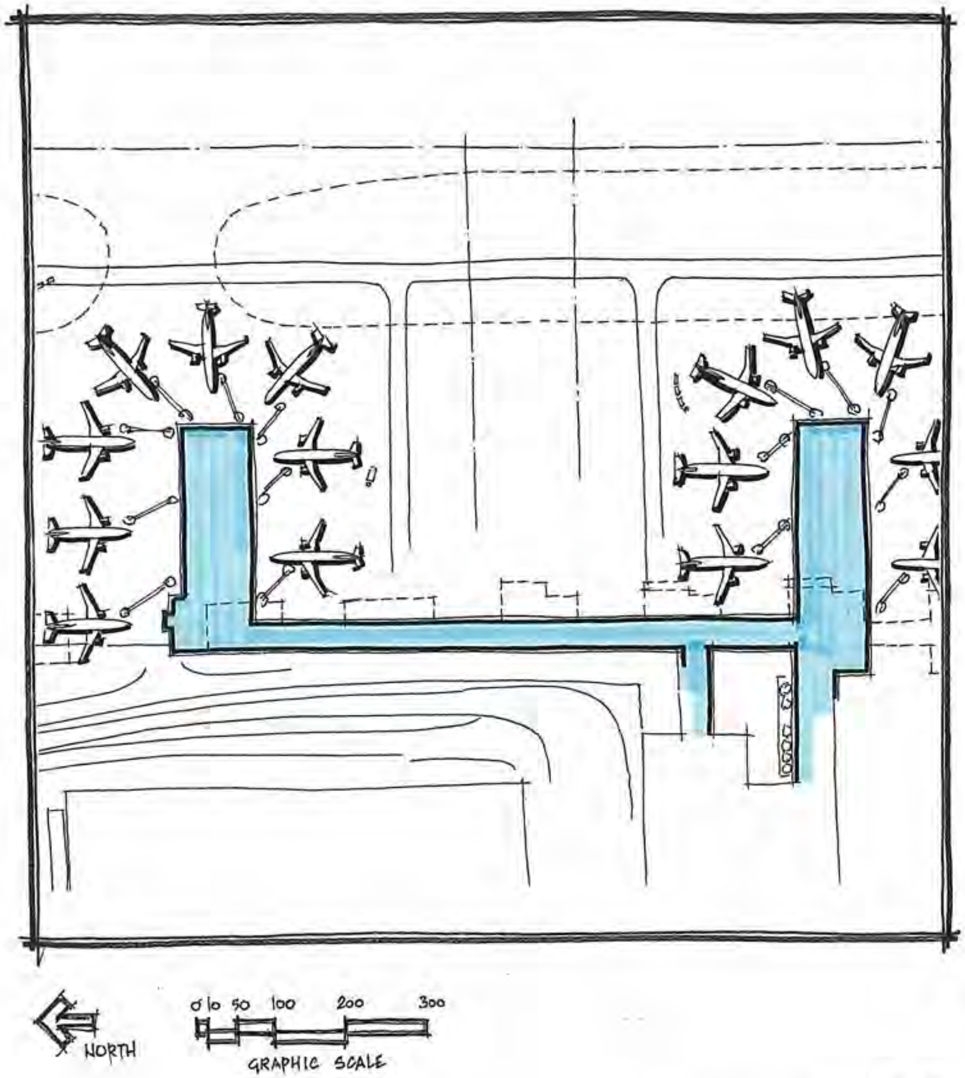
- Remove existing apron pavement as necessary to facilitate building construction
- Construct two two-story pavilions (100 x 250 feet) to extending from the west facade of Concourse C
- Upper level—new passenger circulation and boarding facilities with finishes commensurate with those elsewhere in the terminal
- Lower level—Airline operations space
- Provide two ADG III taxilanes between pavilions to facilitate aircraft movements utilizing existing apron pavement
- Install seismic retrofits and MEP upgrades as appropriate

DEPENDENT PROJECTS

- None

LINEAR FRONTAGE (FEET)

- Frontage gained = 1,860
- Frontage lost = 1,340
- Net gain / (loss) = 520



PROJECT C-3
Concourse C Pavilions with Dual Taxilanes

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PROJECT C-4 **Concourse C Pavilions with Single Taxilane**

PURPOSE

- Build 14 aircraft parking positions
- Construct passenger holdrooms, restrooms, concessions, and airline operations space to support new gates
- Improve level of service for passenger gates

DESCRIPTION

Expand density of aircraft parking positions along the east side of Concourse C by constructing pavilions that extrude out from the current facade. Aircraft parking positions would be provided on the north and south side of the pavilions and accessed via a single taxilane between each set of pavilions. The concentration of gates around each pavilion would be accompanied with appropriate restroom and passenger amenities.

ELEMENTS

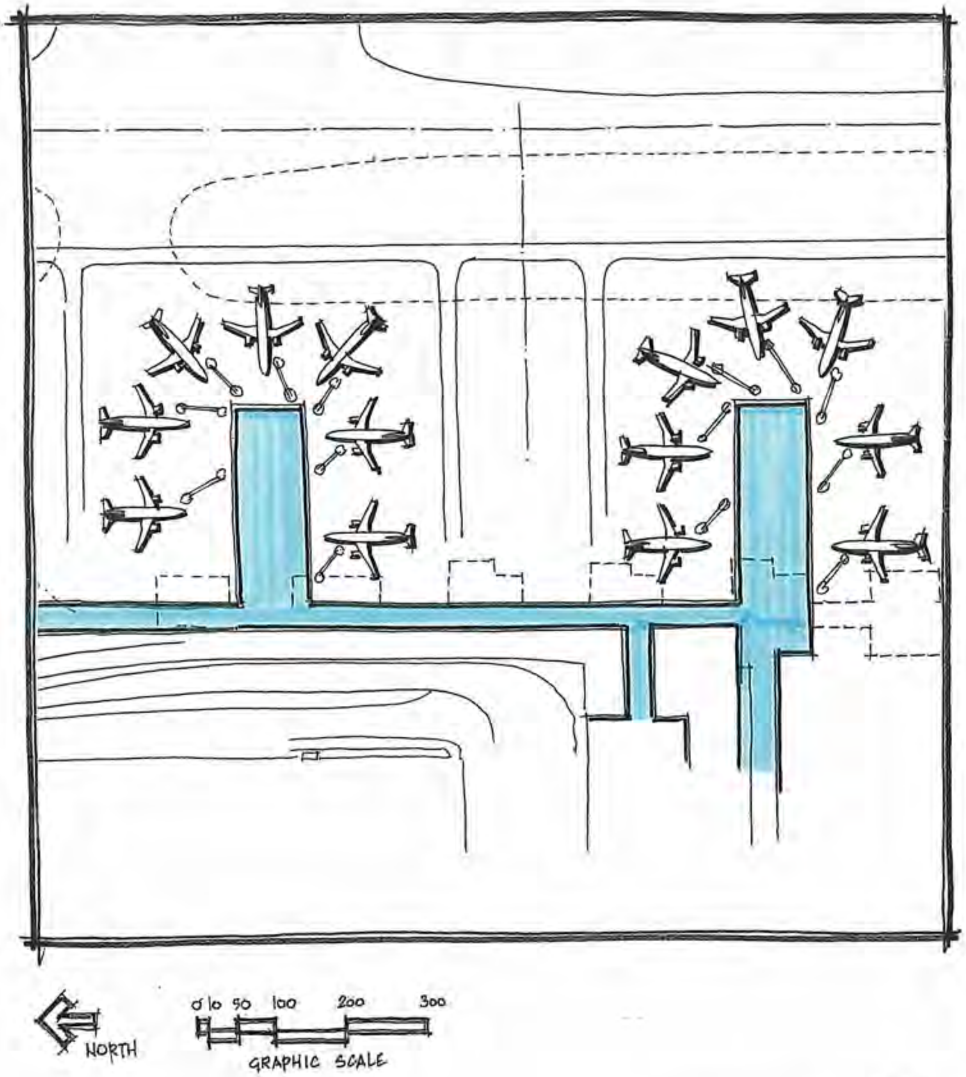
- Remove existing apron pavement as necessary to facilitate building construction
- Construct two two-story pavilions (100 x 250 feet) to extending from the west facade of Concourse C
- Upper level—new passenger circulation and boarding facilities with finishes commensurate with those elsewhere in the terminal
- Lower level—Airline operations space
- Provide an ADG III taxilane between pavilions to facilitate aircraft movements utilizing existing apron pavement
- Install seismic retrofits and MEP upgrades as appropriate

DEPENDENT PROJECTS

- None

LINEAR FRONTAGE (FEET)

- Frontage gained = 1,860
- Frontage lost = 1,340
- Net gain / (loss) = 520



PROJECT C-4
Concourse A Pavilions with Single Taxilane

PROJECT C-5 Concourse C Gate Removal

PURPOSE

- Remove aircraft parking positions on the west and south facades of the existing Concourse C
- Provide a dual ADG III taxilane into the alley between Concourses B and C

DESCRIPTION

This project removes aircraft parking positions located on the south and west facades of Concourse C as well as two bays of the existing terminal building. Removing these gates allows for implementation of dual ADG III taxilanes into the alley between Concourses B and C.

ELEMENTS

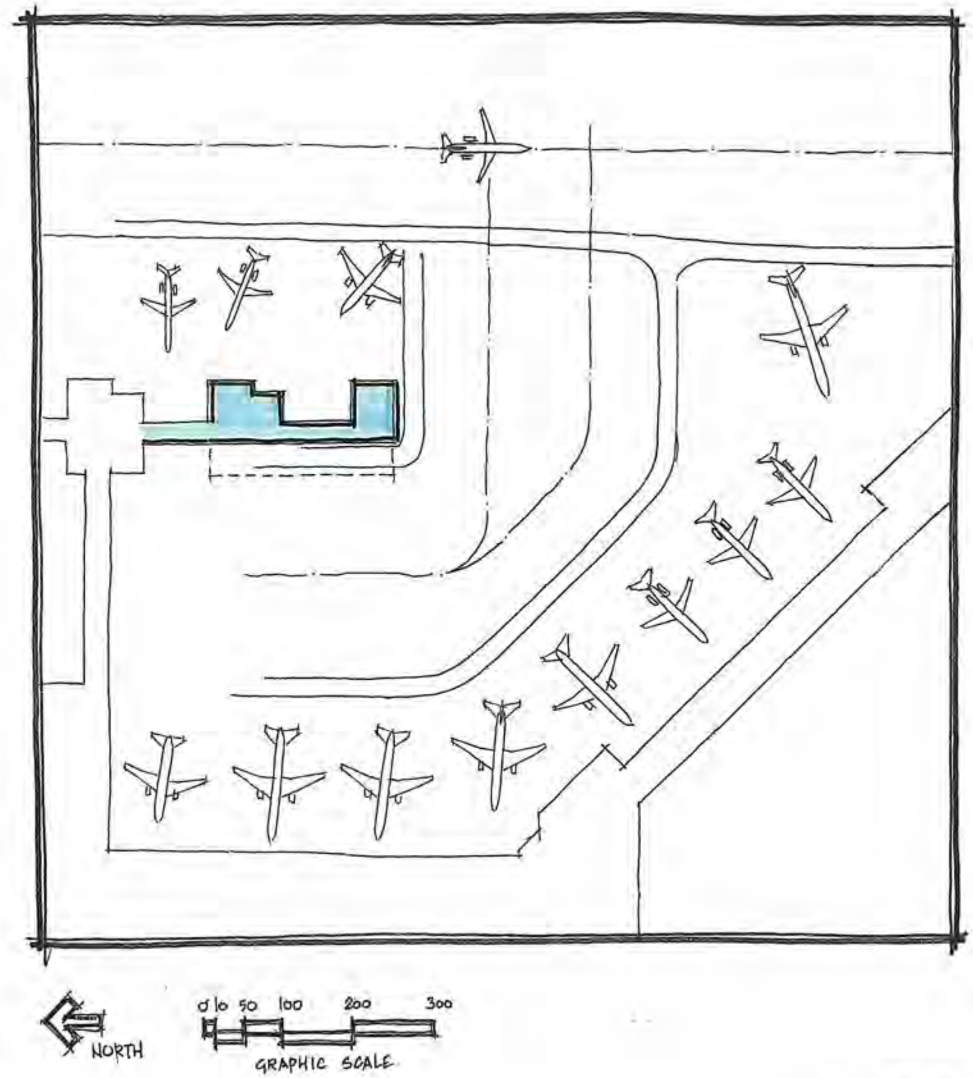
- Remove regional jet facility
- Remove two bays (250 x 40) on the east side of Concourse A
- Re-stripe aircraft parking apron for dual ADG III taxilanes
- Reconfigure aircraft parking positions on the west façade of Concourse A in order to optimize parking positions
- Install seismic retrofits and MEP upgrades as appropriate

DEPENDENT PROJECTS

- None

LINEAR FRONTAGE (FEET)

- Frontage gained = 0
- Frontage lost = 710
- Net gain / (loss) = (710)



PROJECT C-5
Concourse C Gate Removal

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PROJECT T-1 **Narrowbody Gates at South Terminal Facade**

PURPOSE

- Provide ten narrowbody aircraft parking positions at the south facade of the main terminal building
- Add dual ADG III taxilanes in the alleyways between Concourse A and B and Concourses B and C to better facilitate aircraft movements between gates and taxiways

DESCRIPTION

This project adds additional circulation and holdroom space to the south of the existing secure connectors between concourses to support new aircraft gates. These gates would be between the existing concourses and designed to accommodate narrowbody aircraft.

ELEMENTS

West section

- Remove existing CRJ facility and south section of Concourse A
- Infill new aircraft pavement and restripe apron markings in vacated area
- Remove aircraft parking positions at Concourse B and remodel vacated space for circulation functions
- Construct a new two-story (600 x 75 feet) structure along the south frontage of the secure Terminal A connector
- Upper level—new passenger circulation and boarding facilities with finishes commensurate with those elsewhere in the terminal
- Lower level—airline operations area
- Install five new passenger loading bridges at the concourse and associated aircraft services
- Install seismic retrofits and MEP upgrades as appropriate

East section

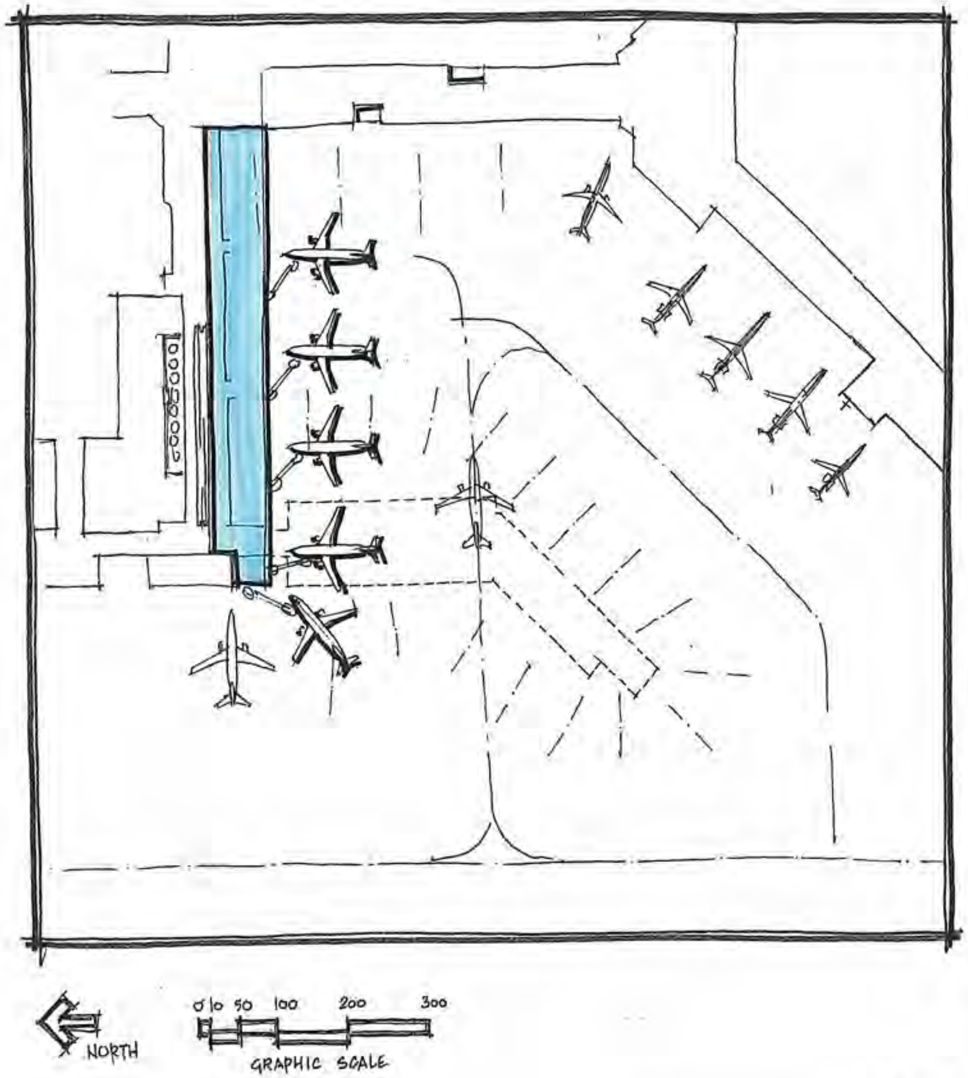
- Same as west section but add an additional two passenger loading bridges

DEPENDENT PROJECTS

- Project B-1—Concourse B Trunk Gate Removal

LINEAR FRONTAGE (FEET)

- Frontage gained = 1,640
- Frontage lost = 3,630
- Net gain / (loss) = (1,990)



PROJECT **T-1**
Narrowbody Gates at South Terminal Facade

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PROJECT T-2 **Regional Jet Gates at South Terminal Facade**

PURPOSE

- Provide 32 regional jet aircraft parking positions at the south facade of the main terminal building
- Add dual ADG III taxilanes in the alleyways between Concourse A and B and Concourses B and C to better facilitate aircraft movements between gates and taxiways

DESCRIPTION

This project adds additional circulation and holdroom space to the south of the existing secure connectors and mini concourse extensions to the east and west to support new aircraft parking positions. These gates would be located between existing concourses and designed to accommodate narrowbody aircraft.

ELEMENTS

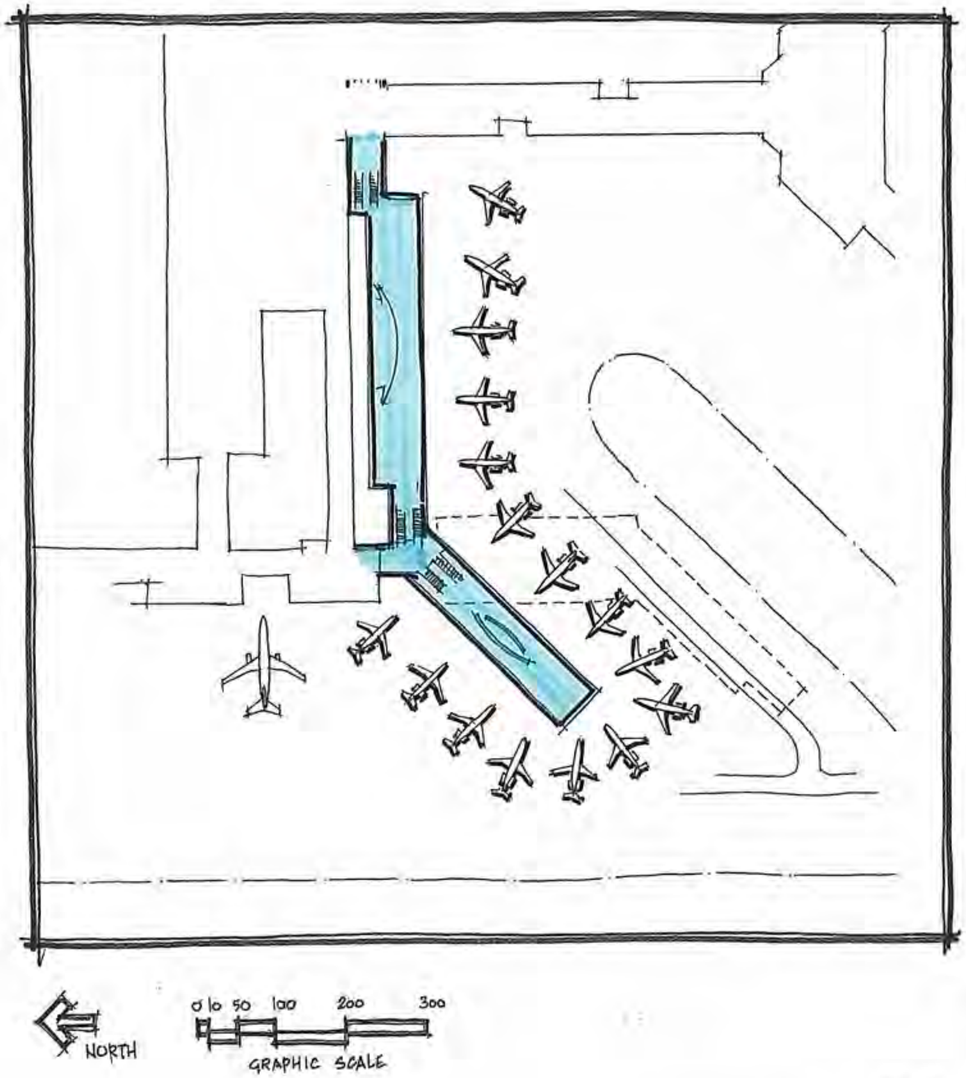
- Construct a lower-level concourse (1,600 x 75 feet) including circulation, passenger holdroom, restroom, and concession spaces for CRJ passengers along the south façade of the main terminal
- Remove two existing gates (B1 and B3)
- Install vertical circulation cores at each end of the concourse for connections to the upper level of Concourses A and B
- Provide allowance for realignment of existing service roads around east and west ends of the concourse
- Acquire and install 11 passenger loading bridges and associated aircraft services
- Install seismic retrofits and MEP upgrades as appropriate

DEPENDENT PROJECTS

- Project B-1—Concourse B Trunk Gate Removal

LINEAR FRONTAGE (FEET)

- Frontage gained = 2,820
- Frontage lost = 3,630
- Net gain / (loss) = (810)



PROJECT T-2
Regional Jet Gates at South Terminal Facade

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PROJECT F-1 **FIS Facility Expansion at Southwest Leg of Concourse B**

PURPOSE

- Expand current FIS facility without wholesale relocation
- Relocate aircraft parking positions impacted by FIS expansion
- Infill portion of existing Concourse B to the north to expand passenger circulation corridors

DESCRIPTION

Double the size of the existing FIS facility by expanding adjacent to its current location at the southeast leg of Concourse B. This project will provide additional space to relieve congestion at the primary screening, baggage claim, and TSA baggage and passenger screening areas. The gates displaced by the FIS expansion on the interior of this section of Concourse B (B34, B36, B38, and B40) will be relocated next to the expanded building. Extensions to the passenger loading bridges will be provided above the single-level building expansion to connect to the relocated gates, making use of existing holdroom, restroom, and concession facilities.

ELEMENTS

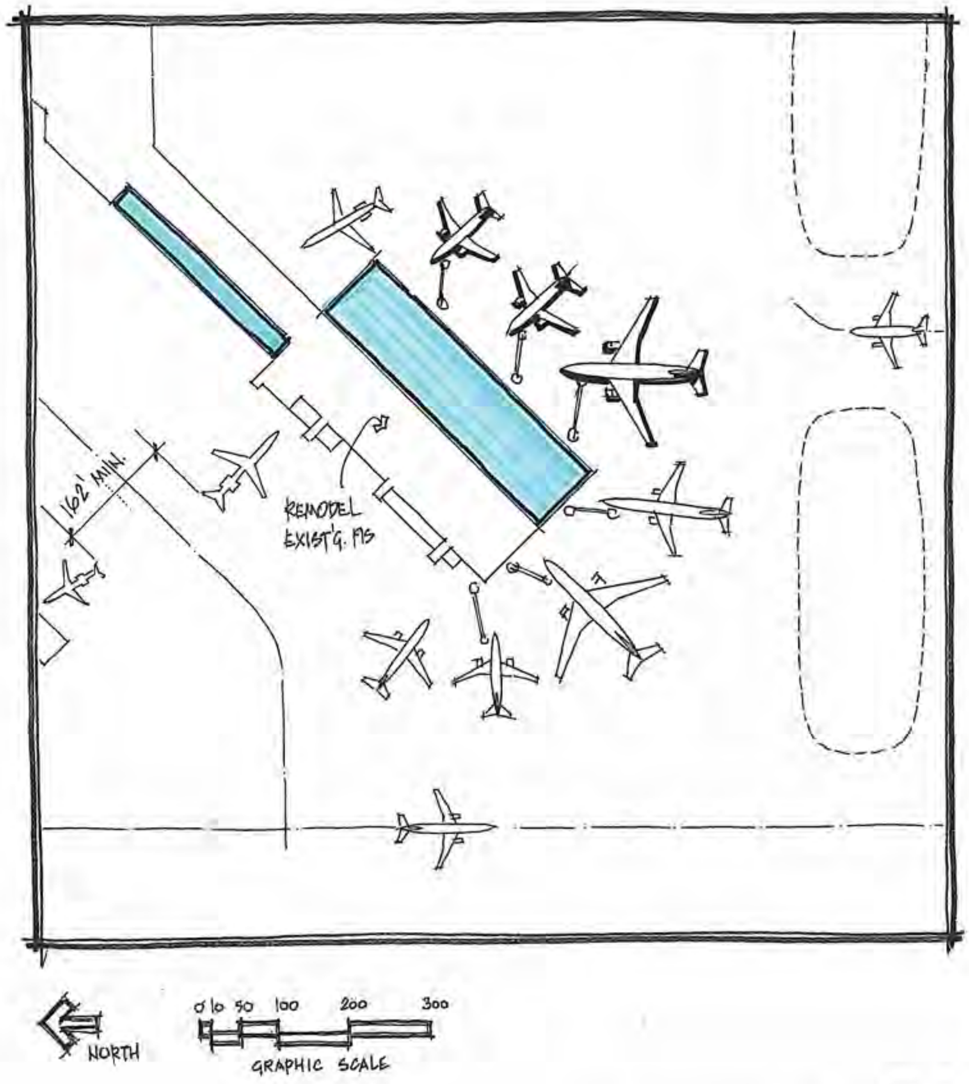
- Remove existing gates B34, B36, B38 and B40 and building façade of vacated gate area
- Construct an expansion (400 x 100 feet) to the existing FIS, providing additional space as necessary for federal agencies to clear arriving international passengers
- Remodel the existing FIS as necessary to accommodate the expansion.
- Infill concourse to the north (300 x 40 feet) and relocate aircraft parking positions as necessary (B27, B29, and B31)
- Install seismic retrofits and MEP upgrades as appropriate

DEPENDENT PROJECTS

- None

LINEAR FRONTAGE (FEET)

- Frontage gained = 0
- Frontage lost = 0
- Net gain / (loss) = 0



PROJECT **F-1**
FIS Facility Expansion at Southwest Leg of Concourse B

Terminal Alternatives Development, Workshop 2
Master Plan Update, Phase 2
Memphis International Airport
December 2008

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PROJECT F-2 **FIS Facility at Concourse B Rotunda**

PURPOSE

- Reconstruct and enlarge FIS facility on mezzanine level above existing rotunda at center of Concourse B
- Provide sterile connections between new FIS and four aircraft parking positions capable of serving widebody aircraft

DESCRIPTION

This project would establish a new and larger FIS facility on the mezzanine level above the concessions rotunda at the hub of Concourse B to process international arrivals. The FIS facility would be connected to the terminal processor via a segregated roof-top passenger walkway above the center leg of Concourse B. Four new aircraft parking positions capable of handling widebody (Airbus A330) aircraft would be provided, connected to the FIS via sterile passageways on the upper level leading to vertical circulation into the FIS. The existing FIS facility would be renovated to accommodate airline operations space.

ELEMENTS

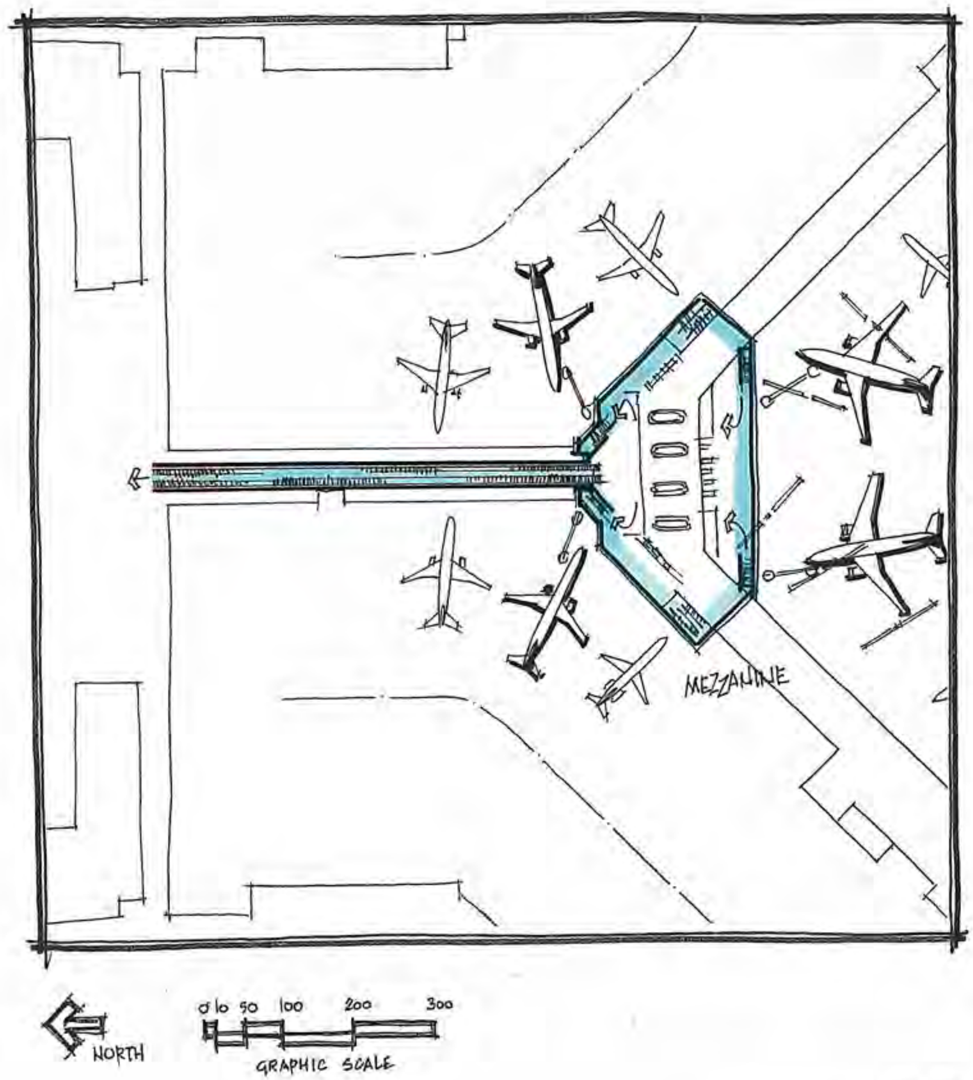
- Adjust existing gates B9 and B28 and service roads to permit construction
- Construct a new FIS facility (250 x 400 feet) above existing Concourse B hub, including all offices, furnishings, devices, etc needed by the federal agencies to process arriving international passengers
- Construct roof-top circulation connector between the new FIS facility and Terminal B processor, including moving walkway and vertical circulation cores at the terminal
- Remove existing FIS facility and convert to airline operations space
- Install four new passenger loading bridges to permit use by Airbus A330-type aircraft and connect to FIS facility via sterile passageways
- Install seismic retrofits and MEP upgrades as appropriate

DEPENDENT PROJECTS

- None, although gates adjacent to the Concourse B rotunda would need to be reconfigured to accommodate widebody aircraft.

LINEAR FRONTAGE (FEET)

- Frontage gained = 0
- Frontage lost = 0
- Net gain / (loss) = 0



PROJECT **F-2**
FIS Facility at Concourse B Rotunda

Terminal Alternatives Development, Workshop 2
Master Plan Update, Phase 2
Memphis International Airport
December 2008

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PROJECT F-3 **FIS Facility at South End of Concourse A**

PURPOSE

- Reconfigure and build a 15-gate regional jet facility at south end of Concourse A to enable construction of a FIS facility
- Add a second ADG III taxilane to the existing alleyway between Concourses A and B

DESCRIPTION

This project removes the existing regional jet facility and south end of Concourse A to permit construction of an FIS as well as an additional ADG III taxilane between Concourses A and B. The FIS would be located on the second level of the building while the regional jet facility (non-international gates) would be located on the ground level. International gates would be provided to the north along Concourse A and connected to the FIS via sterile corridors.

ELEMENTS

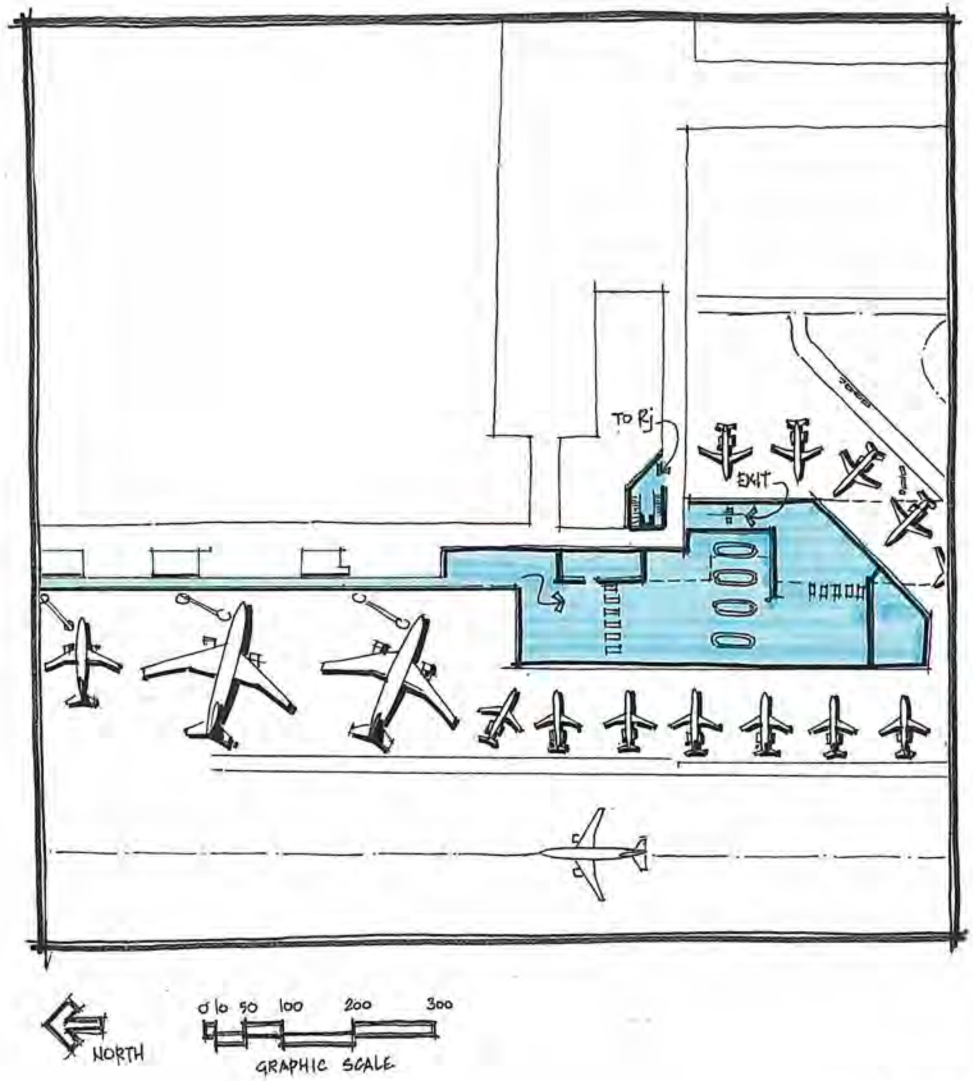
- Remove existing CRJ facility and south leg of Concourse A
- Construct a two-story replacement structure
- Upper level—new FIS facility, including all offices, furnishings, devices, etc. needed by federal agencies to process arriving international passengers and a TSA security checkpoint
- Lower level—new CRJ facility to support 15 aircraft parking positions
- Construct secure circulation connectors to gates A23, A25, A27, and A29 to support international arrivals
- Acquire four new passenger loading bridges for international gates while reusing 15 CRJ boarding bridges
- Finish new CRJ facility with passenger holdrooms, restrooms, and concession areas commensurate with existing facility
- Install seismic retrofits and MEP upgrades as appropriate

DEPENDENT PROJECTS

- Project A-5—Regional Jet Facility at South End of Concourse A

LINEAR FRONTAGE (FEET)

- Frontage gained = 1,380
- Frontage lost = 1,850
- Net gain / (loss) = (470)



PROJECT **F-3**
FIS Facility at South End of Concourse A

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Master Plan Update, Phase 2
Memphis International Airport
December 2008

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PROJECT F-4 **FIS Facility at Concourse B and Terminal Junction**

PURPOSE

- Reconstruct an expanded FIS facility at the junction between Concourse B and the main terminal, reconfiguring adjacent gates on Concourse B as necessary to accommodate international aircraft

DESCRIPTION

This project constructs a ground level FIS facility located at the junction of Concourse B and the main terminal. International aircraft parking positions are located along the trunk of Concourse B and connected to the FIS via sterile corridors and vertical circulation cores.

ELEMENTS

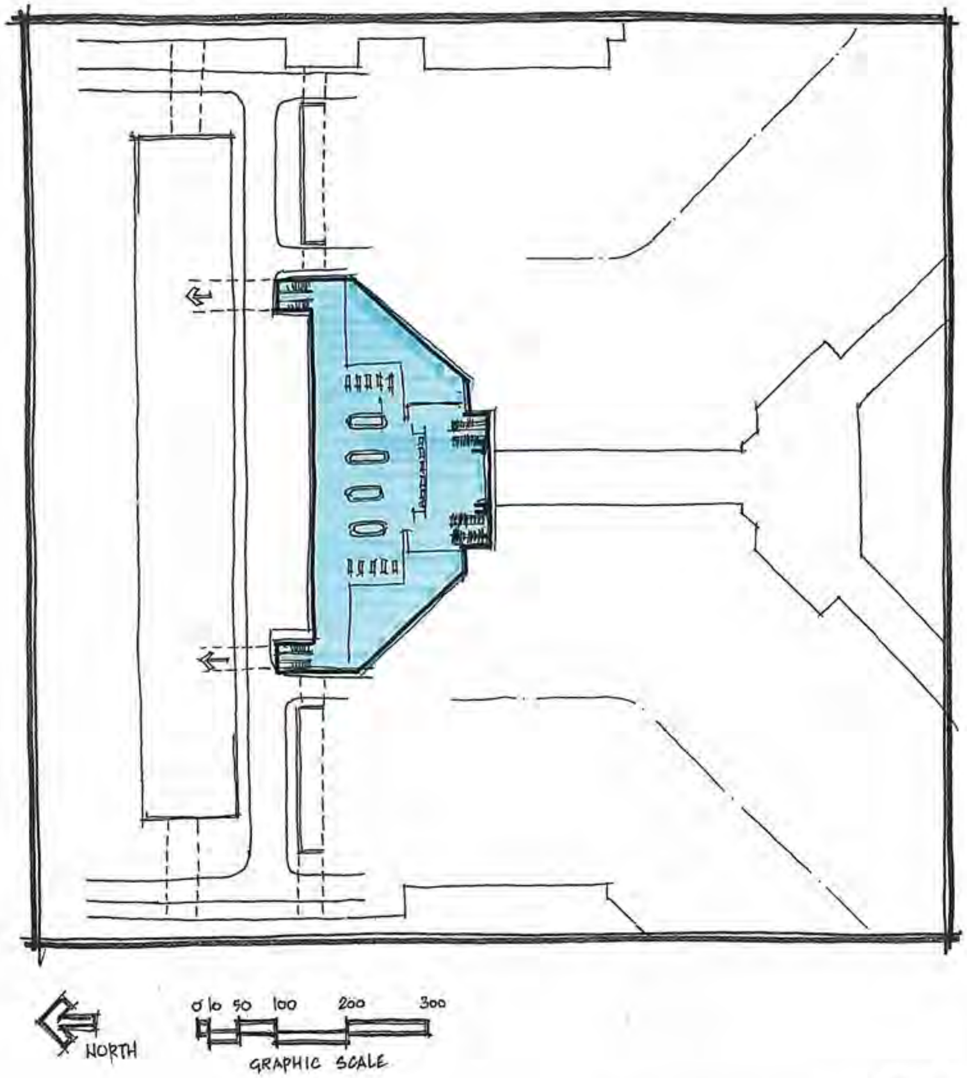
- Construct a new FIS facility at apron level at the junction of Concourse B and the existing central baggage handling facility—occupying approximately 80,000 square feet
- Provide new sterile horizontal and vertical circulation space between the new FIS facility and the non-secure Terminal B lobby
- Install seismic retrofits and MEP upgrades as appropriate

DEPENDENT PROJECTS

- Project B-2—Sterile Connectors along Trunk of Concourse B and/or
- Project B-3—Concourse B Trunk Holdroom Expansion with FIS

LINEAR FRONTAGE (FEET)

- Frontage gained = 0
- Frontage lost = 400
- Net gain / (loss) = (400)



PROJECT F-5 FIS Facility on West Side of Concourse A

PURPOSE

Reconstruct and expand FIS facility to the west of Concourse A, replacing currently-underutilized apron space with a ground-level structure

DESCRIPTION

The project places a new and expanded FIS facility to the west of Concourse A adjacent to the passenger bridges leading to the main terminal. This FIS facility would handle double the throughput of the existing facility and locate international gates to the north along Concourse A. Upon clearance, passengers would be able to undergo security screening and return to the concourse or exit directly into the main terminal building.

ELEMENTS

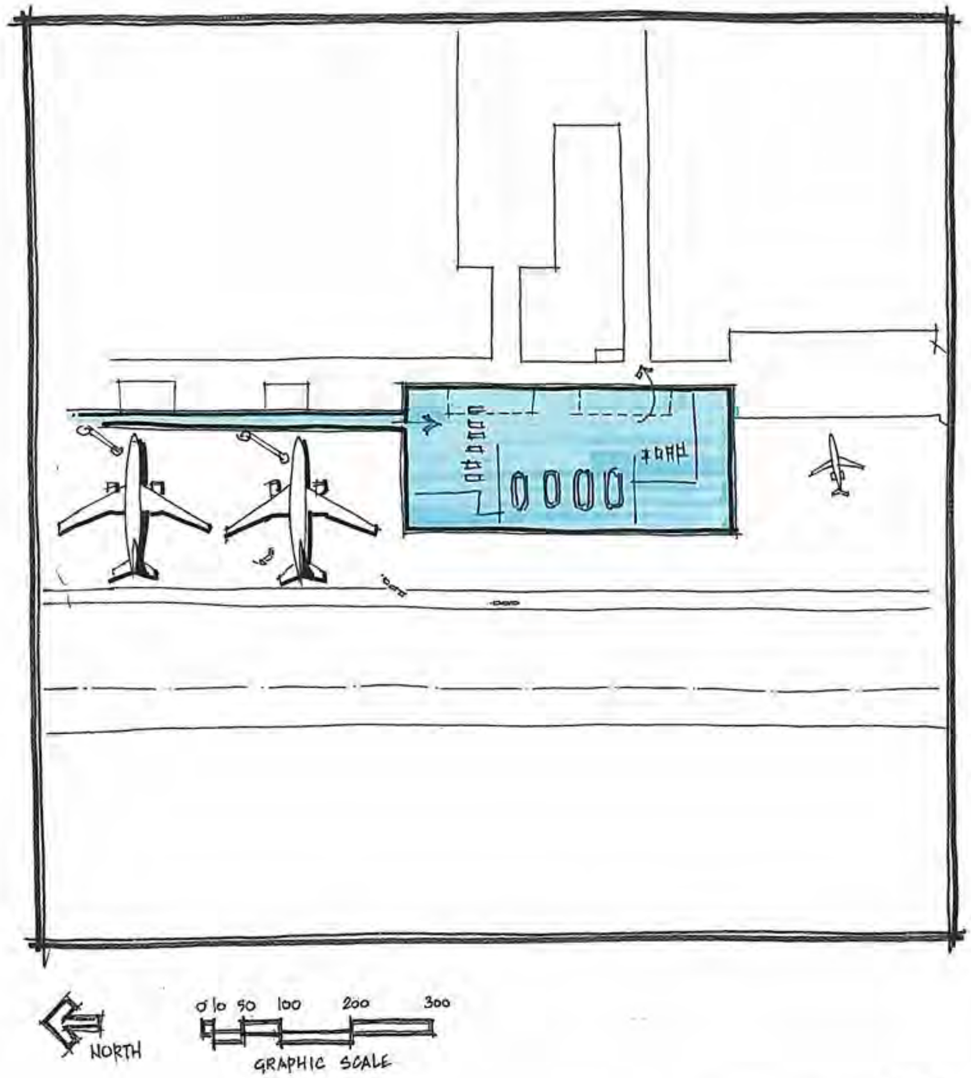
- Adjust existing gates along west façade of Concourse A as necessary to accommodate international aircraft, including replacement of passenger loading bridges
- Construct a new FIS facility (400 x 200 feet) on the ground level, including all offices, furnishings, devices, etc needed by the federal agencies to process arriving international passengers
- Install four new passenger loading bridges to permit use by Airbus A330-type aircraft and connect to FIS facility via sterile passageways
- Install seismic retrofits and MEP upgrades as appropriate

DEPENDENT PROJECTS

- None

LINEAR FRONTAGE (FEET)

- Frontage gained = 0
- Frontage lost = 400
- Net gain / (loss) = (400)



PROJECT **F-5**
FIS Facility on West Side of Concourse A

Terminal Alternatives Development, Workshop 2
Master Plan Update, Phase 2
Memphis International Airport
December 2008

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PROJECT F-6 FIS Facility on Mezzanine Level in Terminal B

PURPOSE

- Construct an addition to the mezzanine level of Terminal B above the junction of Concourse B and the main terminal to support a new and expanded FIS facility

PROJECT F-7 FIS Facility in Transit Tunnel beneath Terminal

PURPOSE

- Utilize the cavernous transit tunnel (currently unused) beneath the existing terminal and curbside to support a new and expanded FIS facility

PROJECT F-8 FIS Facility in Terminal A (Major Rebuild)

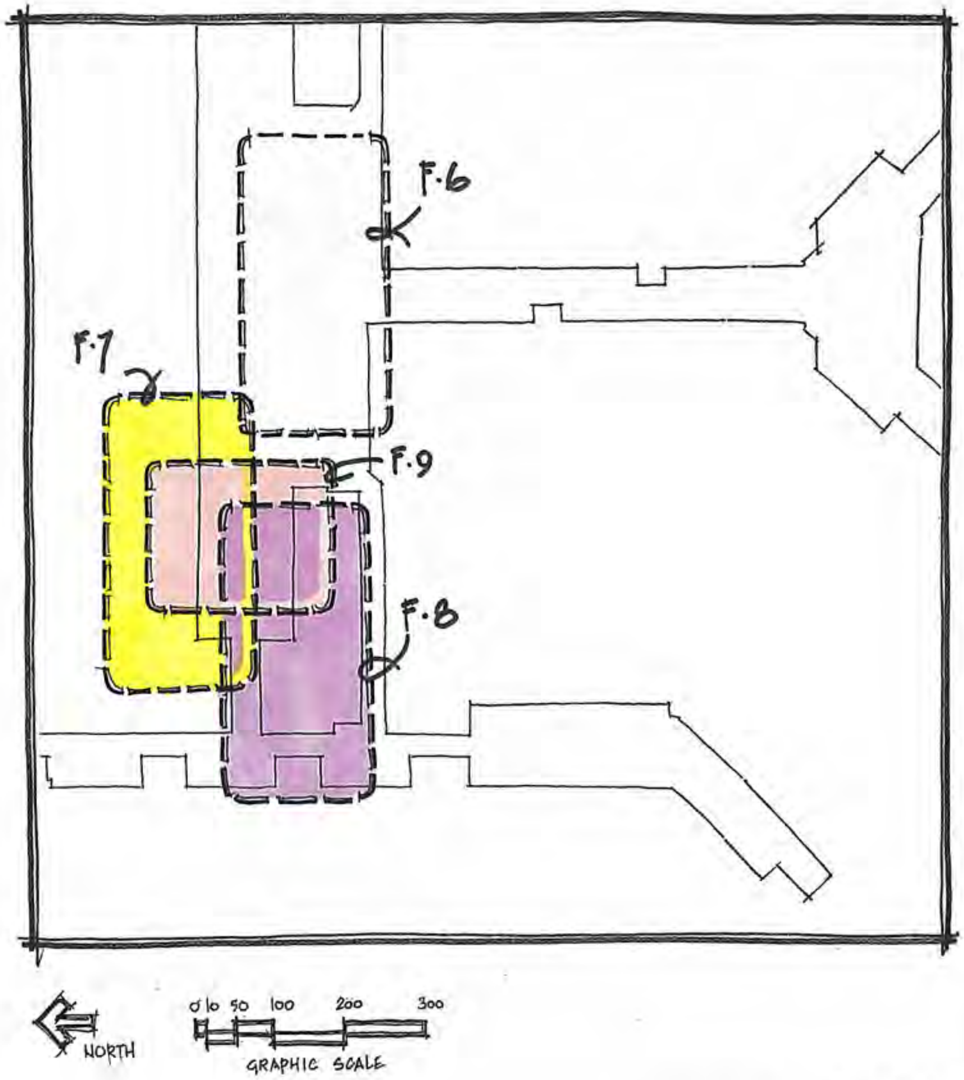
PURPOSE

- Convert underutilized space on all levels of Terminal A to support a new and expanded FIS facility, making significant changes to the current building as warranted

PROJECT F-9 FIS Facility in Terminal A (Minor Rebuild)

PURPOSE

- Convert underutilized space on all levels of Terminal A to support a new and expanded FIS facility without substantially changing the existing footprint of the terminal



PROJECT **F-6-9**
FIS Facility on Mezzanine Level in Terminal B

Terminal Alternatives Development, Workshop 2
Master Plan Update, Phase 2
Memphis International Airport
December 2008

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PROJECT S-1 **Cross-complex Connector**

PURPOSE

- Provide a north-side connection between Concourses A and C to facilitate passenger movements between the two without having to backtrack to the main terminal

DESCRIPTION

This project is designed to provide better connectivity between the north sides of Concourses A and C for pedestrians. The secure connector would be glass-enclosed with moving walkways and open circulation space. Vertical circulation cores are provided at each end. The connector could be located to be attached to the proposed parking garage or over top of the existing parking garage.

ELEMENTS

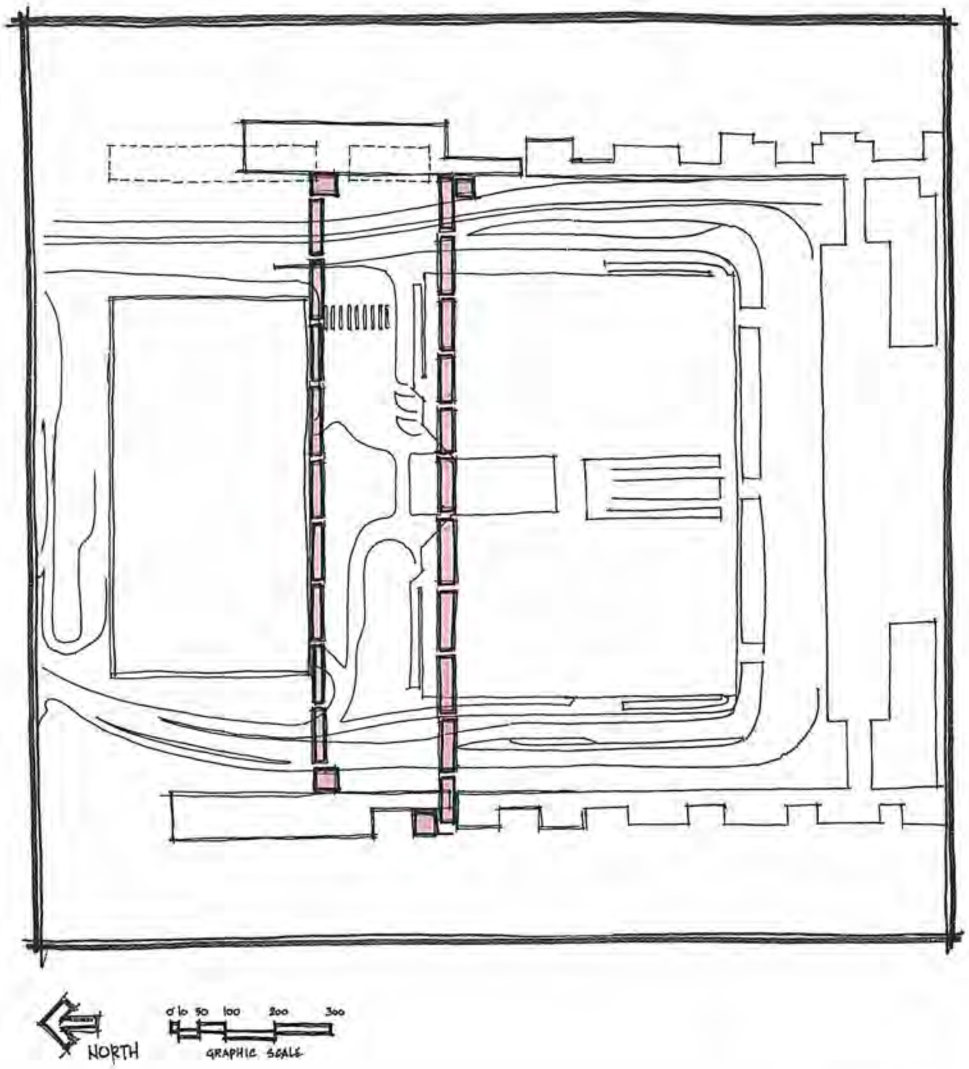
- Construct an elevated corridor (1,200 x 60 feet) with moving walks and hallways for pedestrian circulation
- Prepare sites and install columns to support the bridge throughout the terminal complex
- Construct vertical circulation cores with escalators and elevators to transfer pedestrians from the walkway to the concourse level
- Install moving walkways and finishes commensurate with those found elsewhere in the terminal
- Install seismic retrofits and MEP upgrades as appropriate

DEPENDENT PROJECTS

- Project A-1—Northward Extension of Concourse A
- Project C-1—Northward Extension of Concourse C

LINEAR FRONTAGE (FEET)

- Frontage gained = 0
- Frontage lost = 0
- Net gain / (loss) = 0



PROJECT **S-1**
Cross-complex Connector

Terminal Alternatives Development, Workshop 2
Master Plan Update, Phase 2
Memphis International Airport
December 2008

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Appendix B

COST ESTIMATES

Memphis International Airport

Memphis, Tennessee

Master Plan Update
Terminal Development Alternatives

MASTER PLAN
MEMPHIS INTERNATIONAL AIRPORT

November 2009

Prepared by:

Connico Incorporated
2594 N. Mount Juliet Road
Mount Juliet, TN 37122-3007

Prepared for:

Jacobs Consultancy, Inc.
525 West Monroe, Suite 1300
Chicago, Illinois 60661

Nashville • Cincinnati

a Rider Levett Bucknall company

November 2009

Mr. Robert Hoxie
Jacobs Consultancy, Inc.
525 West Monroe, Suite 1300
Chicago, Illinois 60661

RE: Master Plan Update
Memphis International Airport
Memphis, Tennessee

Dear Mr. Hoxie:

We are pleased to present this final estimate report of the Master Plan Update for the Memphis International Airport in Memphis, Tennessee. This report will summarize the various alternatives that were reviewed at Workshop 3 and subsequently the "Preferred Plan" that was ultimately decided upon by the Airport Authority.

Included within the report are our Estimate Notes, which outlines the criteria and allowances that were used to produce the estimate.

We appreciate the opportunity of working with you on this project. Should you have any questions or need additional information, please contact us at your convenience.

Sincerely,
CONNICO INCORPORATED

Connie S. Gowder, CCC, AVS
cgowder@connico.com
President

Derek L. Brown
dbrown@connico.com
Senior Cost Estimator

Attachment
File No. mem master plan update - final deliverable report november 2009.doc

TABLE OF CONTENTS

PREFACE

This document presents estimates of capital and other costs associated with proposed facility improvements for the passenger terminal complex at the Memphis International Airport. Separate cost estimates were prepared for the various planning alternatives presented to Authority staff at Workshop 3 and for the "Preferred Plan" that was selected by the Authority as best representing its objectives and vision for passenger terminal facilities in the coming 20-year planning period. Estimates were also prepared for the added facilities included in the longer-term "Vision" plan to capture the estimated costs of those projects in the event that currently unforeseeable events make it advisable to consider inclusion of those longer-term projects in the 20-year master planning period.

This report is arranged in three sections, as follows:

Section 1 – Approach, cautions, and cost estimating notes

Section 2 – Preliminary Plan project descriptions and estimated costs

Section 3 – Preferred Plan project descriptions and estimated costs

Certain figures and tables provided in the main body of this report have been reproduced and included in this section as a convenience to the reader.

SECTION 1 – INTRODUCTION

APPROACH

Jacobs Consultancy retained Connico Incorporated as one of several specialist consultants invited to the Planning Team in order to satisfactory prepare the Memphis International Airport Master Plan. Connico Incorporated provided estimates of probable cost for individual projects and for selected multi-project programs in an iterative process with Jacobs Consultancy and other Planning Team members throughout the master planning process. The availability of these cost data from the outset of the planning process ensured that cost information was available as a planning criterion at all times, thereby ensuring that all projects under continuing consideration were not only functionally and operationally desirable but were financially viable as well.

For clarity and continuity of this report, the tabulations of estimated costs prepared in the course of the Planning Team's preparations and analyses of various planning alternatives have been consolidated into the development stages used to describe the recommended plan: Baseline, Preferred, and Long-Term Vision stages.

CAUTIONS

In providing estimates of probable cost, it was understood that Connico Incorporated has no control over the cost or availability of labor, equipment, or materials, or over market conditions or the Contractor's method of pricing. Further, Connico Incorporated's opinions of probable construction costs are made on the basis of our professional judgment and experience. Connico Incorporated makes no warranty, express or implied, that the bids or the negotiated costs of the Work will not vary from the costs reported in this section. In addition, all of the reported estimates were prepared on the basis of information prepared and provided by Jacobs Consultancy and others. Connico Incorporated has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions that may be incorporated as a result of erroneous information provided by others.

COST ESTIMATING NOTES

To provide a consistent framework for estimating the construction costs of improvement projects developed only to a conceptual level of detail, certain assumptions regarding ultimate design decisions and construction realities were applied, as appropriate. To provide as complete an estimate of total costs as possible, certain assumptions regarding the additional "soft costs" (e.g., design fees, construction cost mark-ups, oversight services, etc.) were also applied. These assumptions were formulated in concert with Jacobs Consultancy and reflect information gathered in interviews with Airport staff and a detailed site inspection conducted on December 16, 2008.

The principal assumptions used were:

DESIGN AND CONSTRUCTION

Substructure

- The foundation system includes 2 x 3 foot concrete foundations and grade beams, with an allowance for drilled piers at $100 per VLF.
- The estimate includes a 6" slab on grade.

Shell

- Structure height is estimated at 15 feet for the first level, 17 feet for the new second level.
- Parapet is assumed to be 3 feet above the roof deck (35' total).
- The structural system includes concrete columns, concrete floor and roof beam systems, and elevated concrete floor and roof structure.
- The estimate includes an allowance for miscellaneous metals.
- The building façade includes 75% brick veneer with 25% aluminum storefront windows.
- Flat Roof – EPDM with tapered insulation at the concourse expansion and connector areas.

Interiors

- "Interior Renovations" include renovations to Concourses A, B, and C consisting of finish upgrades (ceiling replacement, painting, flooring replacement (not including terrazzo)), and lighting replacement. No wall removal or relocation is included. This work is assumed to coordinate with MEP and seismic work in these areas. Interior Renovations for the Processor Building are per Architectural Alliance's Scheme 2 for the Processor renovations.
- The estimate includes an allowance for rough carpentry and blocking.
- Interior build-out for the finished areas has been estimated at $125 / SF, which is commensurate with similar airport projects.
- "Shell only" build-out areas have been estimated at $10 / SF. This includes areas such as concession, airline operations, and administration.

Services

Mechanical and Fire Protection

- Testing and balancing, commissioning is included.
- Mechanical and Fire Protection are estimated on a square foot basis by type of area. Cost information was provided by Allen & Hoshall.

Plumbing

- Plumbing is estimated on a square foot basis by type of area. Cost information was provided by Allen & Hoshall.
- All tap fees to be paid by the Owner.

Electrical

- Electrical is estimated on a square foot basis by type of area. Cost information was provided by Allen & Hoshall.
- Electrical systems (fire alarm, communications, etc.) are included on a square foot basis by type of area.
- All impact fees to be paid by Owner.
- It is anticipated that the public telephones will be furnished and installed by the Owner.

Equipment and Furnishings

- Jet bridges are included as an allowance of $500,000 each for new and $100,000 each for relocation / refurbishment.
- Security screening stations are included as an allowance of $20,000 each. Any other security equipment is not included.
- FIDS, MUFIDS and BIDS are included as an allowance in each applicable project and are adjusted based on the individual project size.
- New gate podiums and backscreens are included as an allowance of $25,000 each.
- Holdroom seating is included at $250.00 each.
- The estimate does not include window treatments.
- The estimate does not include kiosks.
- In addition to the cost of elevator equipment, elevator cab finishes are included with a $10,000 allowance per cab.

Special Construction and Demolition

- Demolition of existing apron is included as required.
- Interior demolition is included as indicated.
- Temporary interior partitions are included as indicated to segregate work areas from public space.
- Relocation of existing concessions is not included.

Building Sitework

- Apron is estimated as 20” soil cement, 8” CTB base, 4” asphalt drainable base and 18” PCC pavement.
- Pavement markings are included.
- Temporary AOA fencing is included in areas as necessary.
- All excess dirt and rock material to be wasted on site.
- The estimate does not include provisions for undercut and removal of any unsuitable soil material or rock excavation.

SOFT COSTS

The following markups are included in the estimate, based on traditional design, bid, build with a Construction Manager at Risk:

General Contractor Markups	
General Conditions	8.0% of Construction Costs
General Contractors Fee	5.0% of Construction Costs plus General Conditions
Estimating Design Evolution	10.0% of Construction Costs plus General Conditions plus Fee
Payment & Performance Bonds	1.0% of Construction Costs, General Conditions, Fee & Evolution
Construction Contingency	10.0% of Construction Costs, General Conditions, Fee, Evolution & Payment and Performance Bonds
LEED Requirements	0.0% (not included)
Escalation	0.0% (not included)
Owner Soft Costs	
Project Management	3.0% of Construction Costs plus General Contractor Markups
Construction Manager	6.0% of Construction Costs plus General Contractor Markups
Planning & Preconstruction	0.2% of Construction Costs plus General Contractor Markups
Architectural/Engineering Design	8.0% of Construction Costs plus General Contractor Markups
A/E Construction Admin	2.0% of Construction Costs plus General Contractor Markups
Airport Staff	1.7% of Construction Costs plus General Contractor Markups
Materials Testing	1.4% of Construction Costs plus General Contractor Markups
Plan Check Services	0.1% of Construction Costs plus General Contractor Markups
Cost Estimating and Scheduling	0.3% of Construction Costs plus General Contractor Markups
Other	0.5% of Construction Costs plus General Contractor Markups
Artwork	0.3% of Construction Costs plus General Contractor Markups

Soft Cost Notes:

- Please note that Connico does not advise using these percentages as a “standard” that could be applied to other projects in the future. Caution is suggested if these percentage calculations are applied to different or separate projects in the future, as these values have been derived specifically for the scope of work defined in this study.
- A ten percent (10%) estimating design evolution has been included in the estimate for unforeseen work and final detailing that may be necessary to accomplish the project scope of work. The design evolution is not intended to be used for additions to the general scope of work.
- The estimate is costed on the understanding that there will be free and open competition at all levels of contracting, that there will not be a restricted bidders list either for general or trade contractors, that there will be at minimum three general contract bidders and at minimum three sub bids will be available for each trade involved. The Owner can facilitate these conditions by ensuring that the project is publicly advertised for bids in general circulation as well as trade publications where advertisements for bid are regularly posted, that prequalification requirements, if

prequalification of either general or sub bidders is contemplated, are not unduly restrictive, and by maintaining good industry relations.

- The Opinion of Probable Cost is based on January 2009 dollars with no adjustment for escalation.
- The estimate includes a construction contingency to be utilized for changes and or additions to the scope of work during construction.
- The estimate excludes design/build fees, building permit and fees, overtime and after hours work.
- Allowances included within the Opinion of Probable Cost are amounts the Owner should expect to spend.
- The Opinion of Probable Cost does not include any allowance for fees normally attributed to the Owner such as Real Estate fees, Impact fees, Tap fees, etc.
- Temporary site storage, parking for contractor is assumed to be within the vicinity of the site.
- Hazardous material remediation is not included.

SECTION 2 - PRELIMINARY PLANS and ESTIMATED COSTS

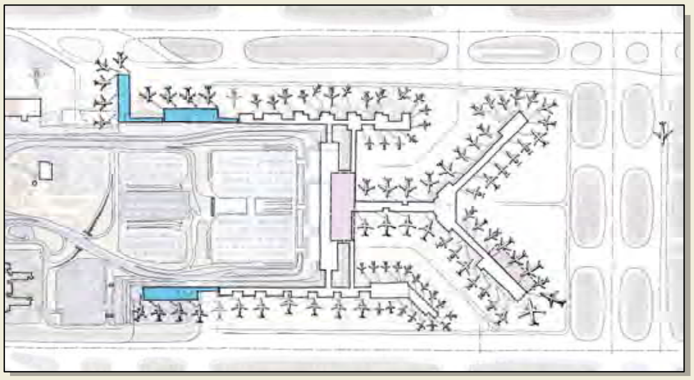
Preliminary Plan Project Descriptions

As described in the main body of this report, a series of initially developed “building block” projects, each project being responsive to specific functional or operational needs, was consolidated into three development alternatives for the passenger terminal complex in the 20-year planning period. These three alternatives were identified as “baseline” alternatives A, B, and C. Each of the baseline alternatives was paired to a longer-term “Vision Concept” plan to illustrate the longer-term potentials of each alternative.

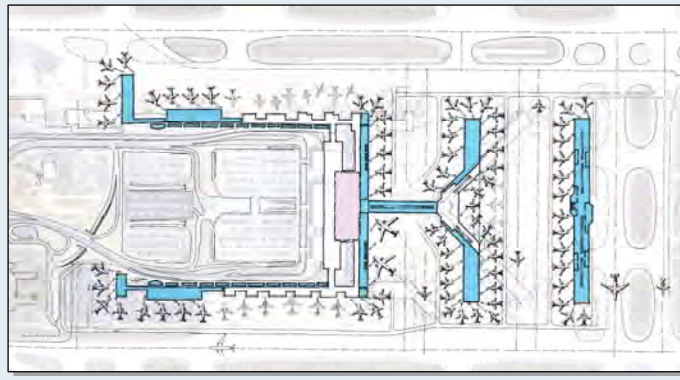
The following reproduction of Figure 3 from the main body of this report illustrates the principal features of the baseline alternatives and long-term concepts. The following paragraphs provide brief descriptions of the constituent building block projects.

BASELINE ALTERNATIVES

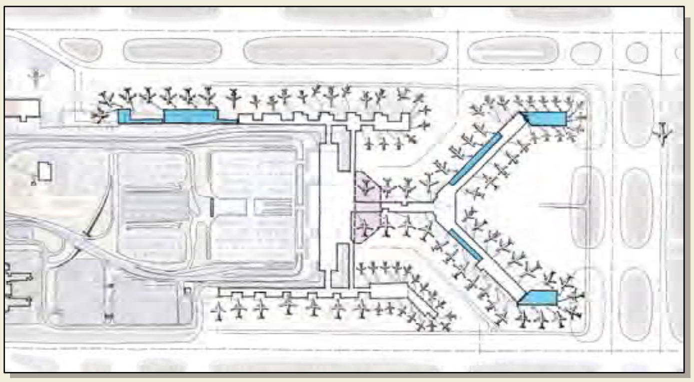
LONG-TERM VISION CONCEPTS



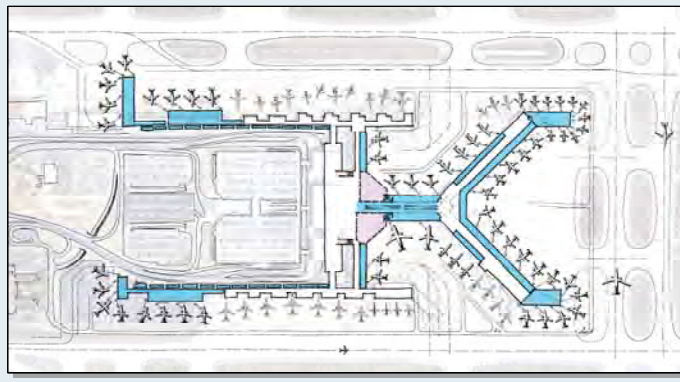
BASELINE A



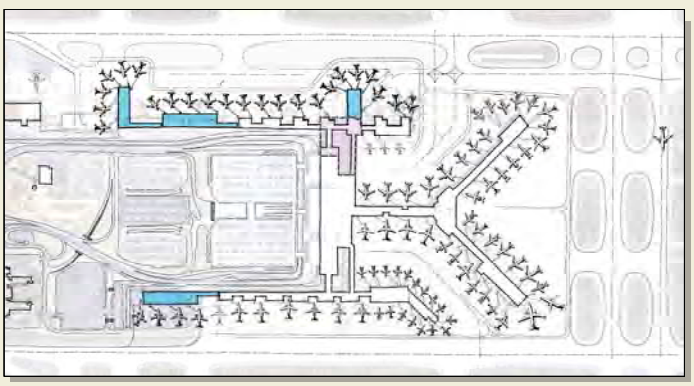
CONCEPT 2



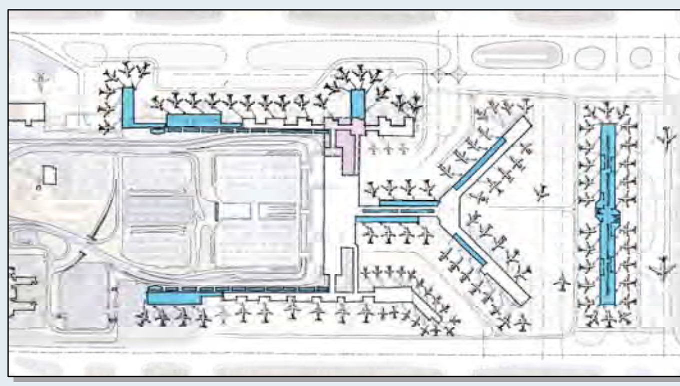
BASELINE B



CONCEPT 4



BASELINE C

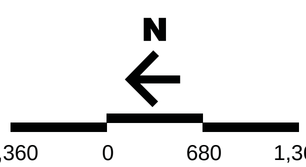


CONCEPT HYBRID

MEM548-5 F-0004

LEGEND

- Existing
- Planned new construction
- FIS facility



Graphic Scale in Feet

Figure 3

BASELINE ALTERNATIVES AND LONG-TERM VISION CONCEPTS

Master Plan Update
Memphis International Airport
November 2009

JACOBS CONSULTANCY

I. Baseline Options (Baseline A, B, and C)

A. Baseline A - comprised of the following components:

1. Project A-1 Northward Extension of Concourse A: includes the extension of Concourse A to the North in order to provide four additional aircraft parking positions. The scope of work includes the construction of a two-level building expansion (400 x 100 feet), which includes an upper level with finished space for passenger holdrooms, two restroom blocks and concession areas, and a lower level with shell space available to airlines for operations space. In addition, four new passenger loading bridges will be provided. Additional aircraft apron will be constructed as needed to accommodate aircraft and ground support equipment operations. AOA fencing and security gates. Seismic retrofits and MEP upgrades will also be provided as appropriate.

2. Project C-1 Northward Extension of Concourse C: includes the extension of Concourse C to the North in order to provide four additional aircraft parking positions. This project, termed the “baseline” project, will provide sufficient gates to enable the Authority to undertake planned apron rehabilitation projects throughout the terminal complex. The scope of work includes the construction of a two-level building expansion (400 x 100 feet), which includes an upper level with finished space for passenger holdrooms, two restroom blocks and concession areas, and a lower level with shell space available to airlines for operations space. In addition, four new passenger loading bridges will be provided. Additional aircraft apron will be constructed as needed to accommodate aircraft and ground support equipment operations. AOA fencing and security gates around new apron will be installed. Seismic retrofits and MEP upgrades will also be provided as appropriate.

3. Project C-2 Concourse C Hammerhead (full): includes the extension of Concourse C North beyond the extent of Project C-1 in order to provide additional aircraft parking positions. The project will include a connecting corridor and a “hammerhead” providing passenger gate areas and associated amenities. The scope of work includes the construction of a 250 x 30 foot circulation connector with moving walkways from the end of the existing concourse to the new gate area, the construction of a 350 x 75 foot two-story concourse, and the addition of five passenger loading bridges. The upper-level will include finished space for passenger holdrooms, two restroom blocks, and one concession block to support seven aircraft (narrowbody) parking positions. The lower-level will include shell space for airlines for operations space. Additional apron construction will be included as necessary to accommodate aircraft and ground support equipment operations. AOA and security fence will be provided around the new apron area.

4. **Project F-6 FIS Facility on Mezzanine Level in Terminal B (refer to AA's FIS Option B):** includes the construction of an addition to the mezzanine level of Terminal B above the junction to Concourse B and the main terminal to support a new and expanded FIS Facility.

B. **Baseline B –** comprised of the following components:

1. **Project B-5 Regional Jet Facility at Southeast Leg of Concourse B:** includes the expansion of aircraft parking positions by the construction of a regional jet facility at the end of the Southeast leg of Concourse B. The concourse extension would be single-level and would provide as many new gates as possible for each square foot of additional building space. The scope of work includes the removal of aircraft gates and the South façade at the existing concourse, the construction of a 200 x 100 foot single-level holdroom area, vertical circulation core, two restroom blocks, and one concessions area to support ten aircraft (regional jet) parking positions. Also included would be the installation of ten new passenger loading bridges, expanded apron areas and island "infills" to support the new aircraft gates, the infill of the Southeast leg of Concourse B with a 40 x 500 foot two-level structure to match the existing concourse, and the relocation of Gates B10, B12, B14, and B16. Seismic retrofits and MEP upgrades will also be provided as appropriate. Additional apron construction will be included as necessary to accommodate aircraft and ground support equipment operations. AOA and security fence will be provided around the new apron area.

2. **Project B-6 Narrowbody Gates at Southwest Leg of Concourse B:** includes the expansion of aircraft parking positions by constructing a mainline aircraft facility at the end of the Southwest leg of Concourse B. The scope of work includes the removal of aircraft gates and the south façade of the existing concourse and the construction of a 250 x 100 foot two-level concourse extension, with an upper level comprised of finished space for passenger holdrooms, two restroom blocks, and one concessions block to support seven aircraft (narrowbody) parking positions and a lower level which provides shell space available to airlines for operations space. Seven new passenger loading bridges will be provided. The South leg of Concourse B will be infilled with a 35 x 300 foot, two-level structure to match the existing concourse. Gates B27, B29, and B31 and associated loading bridges will be relocated to accommodate the infill project. Seismic retrofits and MEP upgrades will also be provided as appropriate. Additional apron construction will be included as necessary to accommodate aircraft and ground support equipment operations. AOA and security fence will be provided around the new apron area.

3. **Project C-1 Northward Extension of Concourse C:** includes the extension of Concourse C to the North in order to provide four additional aircraft parking positions. This project, termed the "baseline" project, will provide sufficient gates to enable the Authority to undertake planned apron rehabilitation projects throughout the terminal

complex. The scope of work includes the construction of a two-level building expansion (400 x 100 feet), which includes an upper level with finished space for passenger holdrooms, two restroom blocks and concession areas, and a lower level with shell space available to airlines for operations space. In addition, four new passenger loading bridges will be provided. Additional aircraft apron will be constructed as needed to accommodate aircraft and ground support equipment operations. AOA fencing and security gates around new apron will be installed. Seismic retrofits and MEP upgrades will also be provided as appropriate.

4. Project C-2 Concourse C Hammerhead (partial): includes the extension of Concourse C North beyond the extent of Project C-1 in order to provide additional aircraft parking positions. The project will include a connecting corridor and a "hammerhead" providing passenger gate areas and associated amenities. The scope of work includes the construction of a 250 x 30 foot circulation connector with moving walkways from the end of the existing concourse to the new gate area, the construction of a 100 x 75 foot two-story concourse, and the addition of three passenger loading bridges. The upper-level will include finished space for passenger holdrooms, two restroom blocks, and one concession block to support seven aircraft (narrowbody) parking positions. The lower-level will include shell space for airlines for operations space. Additional apron construction will be included as necessary to accommodate aircraft and ground support equipment operations. AOA and security fence will be provided around the new apron area.

5. Project F-4 FIS Facility at Concourse B & Terminal Junction (refer to AA's FIS Option C): this project constructs a ground level FIS facility located at the junction of Concourse B and the main terminal. International aircraft parking positions are located along the trunk of Concourse B and connected to the FIS via sterile corridors and vertical circulation cores. Elements include the construction of a new FIS facility at apron level at the junction of Concourse B and the existing central baggage handling facility – occupying approximately 80,000 square feet, a new sterile horizontal and vertical circulation space between the new FIS facility and the non-secure Terminal B lobby, and seismic retrofits and MEP upgrades as appropriate.

C. Baseline C – comprised of the following components:

1. Project A-1 Northward Extension of Concourse A: includes the extension of Concourse A to the North in order to provide four additional aircraft parking positions. The scope of work includes the construction of a two-level building expansion (400 x 100 feet), which includes an upper level with finished space for passenger holdrooms, two restroom blocks and concession areas, and a lower level with shell space available to airlines for operations space. In addition, four new passenger loading bridges will be provided. Additional aircraft apron will be constructed as needed to accommodate aircraft and ground support equipment operations. AOA fencing and security gates

around new apron will be installed. Seismic retrofits and MEP upgrades will also be provided as appropriate.

2. Project C-1 Northward Extension of Concourse C: includes the extension of Concourse C to the North in order to provide four additional aircraft parking positions. This project, termed the "baseline" project, will provide sufficient gates to enable the Authority to undertake planned apron rehabilitation projects throughout the terminal complex. The scope of work includes the construction of a two-level building expansion (400 x 100 feet), which includes an upper level with finished space for passenger holdrooms, two restroom blocks and concession areas, and a lower level with shell space available to airlines for operations space. In addition, four new passenger loading bridges will be provided. Additional aircraft apron will be constructed as needed to accommodate aircraft and ground support equipment operations. AOA fencing and security gates around new apron will be installed. Seismic retrofits and MEP upgrades will also be provided as appropriate.

3. Project C-2 Concourse C Hammerhead (full): includes the extension of Concourse C North beyond the extent of Project C-1 in order to provide additional aircraft parking positions. The project will include a connecting corridor and a "hammerhead" providing passenger gate areas and associated amenities. The scope of work includes the construction of a 250 x 30 foot circulation connector with moving walkways from the end of the existing concourse to the new gate area, the construction of a 350 x 75 foot two-story concourse, and the addition of five passenger loading bridges. The upper-level will include finished space for passenger holdrooms, two restroom blocks, and one concession block to support seven aircraft (narrowbody) parking positions. The lower-level will include shell space for airlines for operations space. Additional apron construction will be included as necessary to accommodate aircraft and ground support equipment operations. AOA and security fence will be provided around the new apron area.

4. Project C-4A Concourse C Pavilion and International Gates: includes the construction of a new pavilion to facilitate new FIS and International gates at Concourse C. Aircraft parking positions would be provided on the East side of the pavilion. The concentration of gates around each pavilion would be accompanied with appropriate restroom, passenger amenities, and capacity to accommodate international departures and arrivals. The scope of work includes the removal of Gates C8, C10, C12A, and C12B, loading bridges, existing apron pavement, etc. as necessary to facilitate building construction and the construction of two, two-story pavilions (100 x 200 feet) to extend from the west façade of Concourse C. The upper level will include new passenger circulation and boarding facilities with finishes commensurate with those elsewhere in the terminal. The lower level will include shell space for future airline operation space. The adjacent apron will be reconstructed as needed to accommodate aircraft and ground support equipment operations. Seismic retrofits and MEP upgrades will also be provided as appropriate.

5. Project A2 Architectural Alliance's FIS Option 2: includes the construction of a new FIS facility above the existing Concourse B terminal, with a sterile corridor connecting the FIS to the existing Terminal Processor Building mezzanine level.

II. Concept Options (Concept 2, 4, and Hybrid)

A. Concept 2 – comprised of the following components:

1. Project A-1 Northward Extension of Concourse A: includes the extension of Concourse A to the North in order to provide four additional aircraft parking positions. The scope of work includes the construction of a two-level building expansion (400 x 100 feet), which includes an upper level with finished space for passenger holdrooms, two restroom blocks and concession areas, and a lower level with shell space available to airlines for operations space. In addition, four new passenger loading bridges will be provided. Additional aircraft apron will be constructed as needed to accommodate aircraft and ground support equipment operations. AOA fencing and security gates around new apron will be installed. Seismic retrofits and MEP upgrades will also be provided as appropriate.

2. Project A-2 Concourse A Hammerhead: includes the extension of Concourse A North beyond extent of Project A-1 in order to provide additional aircraft parking positions. This project will include a connecting corridor and a "hammerhead" providing passenger gate areas and associated amenities. The scope of work includes the construction of a 150 x 30 foot circulation connector with moving walkways from the end of the existing concourse to the new gate area, the construction of a 150 x 75 foot, two story concourse which at the upper level includes finished space for passenger holdrooms, two restroom blocks, and one concession block to support seven aircraft (narrowbody) parking positions and at the lower includes shell space available to airlines for operations space, and the installation of four passenger loading bridges.

3. Project B-1 Concourse B Trunk Gate Removal: this project takes the existing circulation corridor and passenger holdrooms along the trunk section of Concourse B and converts the entire portion of the building to circulation space. This requires that Gates B-1 thorough B-8 be removed and passenger holdrooms adapted to other uses. Circulation improvements would include the installation of moving walkways and wider floor space to facilitate passenger movements between the main terminal and Concourse B rotunda. The scope of the project includes the removal of eight existing holdrooms and interior walls, the removal of eight passenger loading bridges, and the installation of moving walks, wider circulation corridor, and finishes commensurate with the existing passenger terminal.

4. Project B-8 Realignment of Concourse B Legs at Rotunda: this project reconfigures the legs of Concourse B in an east-west fashion to improve passenger level of service as well as airfield – terminal interactions. Reconfiguration of the legs allows for preservation of the existing rotunda area while reducing walking distance to the gates on the Concourse B legs. The scope of work includes the removal of 400 feet of Concourse B and the east and west ends, the repair of aircraft pavements for aircraft use and the construction of two new two-story structures (400 x 120 feet) in an east-west orientation at the new concourse ends. The upper level will include new passenger circulation and boarding facilities with finishes commensurate with those elsewhere in the terminal while the lower level includes shell space for future airline operations space. Twelve new passenger loading bridges and concourse additions with associated aircraft services will also be provided. An allowance will be provided for the adjustment of remaining existing aircraft parking positions. Seismic retrofits and MEP upgrades will also be provided as appropriate.

5. Project B-11B Remote South Concourse: this project constructs a remote passenger concourse at the southern end of the existing terminal complex. The concourse would be connected to the existing Concourse B rotunda via either an underground walkway or bridge. Moving walkways would assist passengers to move from the midpoint, adjacent to the connection to the tunnel or bridge, to either end with ease. The concourse is shown as double-loaded, although providing south façade gates would require demolition and relocation of Taxiway T. The scope of work includes the construction or a new double-loaded two-story (1,300 x 120 feet) satellite terminal concourse to the north of Taxiway T. The upper level will include new passenger circulation with moving walks and boarding facilities with finishes commensurate with those elsewhere in the terminal. The lower level will provide shell space for airline operations. A bridge or tunnel connection from mid-field concourse to new satellite concourse with moving walks will also be included. Installation of 13 passenger loading bridges will be required. The addition or reconfiguration of aircraft parking apron will be required as necessary to provide parking positions.

6. Project C-1 Northward Extension of Concourse C: includes the extension of Concourse C to the North in order to provide four additional aircraft parking positions. This project, termed the "baseline" project, will provide sufficient gates to enable the Authority to undertake planned apron rehabilitation projects throughout the terminal complex. The scope of work includes the construction of a two-level building expansion (400 x 100 feet), which includes an upper level with finished space for passenger holdrooms, two restroom blocks and concession areas, and a lower level with shell space available to airlines for operations space. In addition, four new passenger loading bridges will be provided. Additional aircraft apron will be constructed as needed to accommodate aircraft and ground support equipment operations. AOA fencing and security gates around new apron will be installed. Seismic retrofits and MEP upgrades will also be provided as appropriate.

7. Project C-2 Concourse C Hammerhead (full): includes the extension of Concourse C North beyond the extent of Project C-1 in order to provide additional aircraft parking positions. The project will include a connecting corridor and a "hammerhead" providing passenger gate areas and associated amenities. The scope of work includes the construction of a 250 x 30 foot circulation connector with moving walkways from the end of the existing concourse to the new gate area, the construction of a 350 x 75 foot two-story concourse, and the addition of five passenger loading bridges. The upper-level will include finished space for passenger holdrooms, two restroom blocks, and one concession block to support seven aircraft (narrowbody) parking positions. The lower-level will include shell space for airlines for operations space. Additional apron construction will be included as necessary to accommodate aircraft and ground support equipment operations. AOA and security fence will be provided around the new apron area.

8. Project F-6 FIS Facility at Mezzanine Level in Terminal B (refer to AA's FIS Option B): includes the construction of an addition to the mezzanine level of Terminal B above the junction to Concourse B and the main terminal to support a new and expanded FIS Facility.

9. Project T-1 Narrowbody Gates at South Terminal Façade: this project adds additional circulation and holdroom space to the South of the existing secure connectors between the concourses to support new aircraft gates. These gates would be between the existing concourses and designed to accommodate narrowbody aircraft. The scope of work includes

removing the existing CRJ facility and south section of Concourse A, infilling the new aircraft pavement and restriping the apron markings in vacated areas and removing aircraft parking positions at Concourse B and remodeling vacated space for circulation function. A new two-story (600 x 75 feet) structure along the south frontage of the secure Terminal A connector will also be constructed, which will include at the upper level new passenger circulation and boarding facilities with finishes commensurate with those found elsewhere in the terminal and at the lower level will include shell space for airline operations. Five new passenger loading bridges will be installed at the concourse and associated aircraft services. Seismic retrofits and MEP upgrades will also be provided as appropriate.

B. Concept 4 – comprised of the following components:

1. Project A-1 Northward Extension of Concourse A: includes the extension of Concourse A to the North in order to provide four additional aircraft parking positions. The scope of work includes the construction of a two-level building expansion (400 x 100 feet), which includes an upper level with finished space for passenger holdrooms, two restroom blocks and concession areas, and a lower level with shell space available to airlines for operations space. In addition, four new passenger loading bridges will be provided. Additional aircraft apron will be constructed as needed to accommodate aircraft and ground support equipment operations. AOA fencing and security gates around new apron will be installed. Seismic retrofits and MEP upgrades will also be provided as appropriate.

2. Project A-2 Concourse A Hammerhead: includes the extension of Concourse A North beyond extent of Project A-1 in order to provide additional aircraft parking positions. This project will include a connecting corridor and a "hammerhead" providing passenger gate areas and associated amenities. The scope of work includes the construction of a 150 x 30 foot circulation connector with moving walkways from the end of the existing concourse to the new gate area, the construction of a 150 x 75 foot, two story concourse which at the upper level includes finished space for passenger holdrooms, two restroom blocks, and one concession block to support seven aircraft (narrowbody) parking positions and at the lower includes shell space available to airlines for operations space, and the installation of four passenger loading bridges.

3. Project A-6 Concourse A Gate Removal: this project removes aircraft parking positions located on the south and east facades of Concourse A as well as two bays of the existing terminal building. Removing these gates allows for implementation of dual ADG III taxilanes into the alley between Concourses A and B. The scope of work includes the removal of the regional jet facility, the removal of two bays (270 x 40) on the east side of Concourse A, restriping the aircraft parking apron for dual ADG III taxilanes, and reconfiguring aircraft parking positions on the west façade of Concourse A in order to optimize parking positions. Seismic retrofits and MEP upgrades will also be provided as appropriate.

4. Project B-3 Concourse B Trunk Holdroom Expansion with FIS: this project would expand the trunk of Concourse B to the east and west by adding holdroom capacity and passenger amenity space on the upper level and airline operations space on the lower level. This project would allow the current circulation corridor to be widened and improved through the installation of moving walkways. This project is envisioned to be undertaken with the construction of an FIS at the intersection of the terminal and Concourse B as described in Project F-3. Increasing

the width of Concourse B in this vicinity may restrict the aircraft types that can park either along the trunk of Concourse B or the interior portions of Concourses A and C. The scope of work includes the construction of the two-story widening to the trunk section of Concourse B with the addition of two 250 x 60 foot additions to the east and west. The upper level will consist of new passenger circulation and boarding facilities with finishes commensurate with those elsewhere in the terminal. The lower level will include shell space for airline operations. The existing concourse and holdrooms will be reconfigured to provide entirely circulation space with bi-directional moving walks. Eight passenger loading bridges will be removed and reinstalled. Seismic retrofits and MEP upgrades will also be provided as appropriate.

5. Project B-5 Regional Jet Facility at Southeast Leg of Concourse B: includes the expansion of aircraft parking positions by the construction of a regional jet facility at the end of the Southeast leg of Concourse B. The concourse extension would be single-level and would provide as many new gates as possible for each square foot of additional building space. The scope of work includes the removal of aircraft gates and the South façade at the existing concourse, the construction of a 200 x 100 foot single-level holdroom area, vertical circulation core, two restroom blocks, and one concessions area to support ten aircraft (regional jet) parking positions. Also included would be the installation of ten new passenger loading bridges, expanded apron areas and island "infills" to support the new aircraft gates, the infill of the Southeast leg of Concourse B with a 40 x 500 foot two-level structure to match the existing concourse, and the relocation of Gates B10, B12, B14, and B16. Seismic retrofits and MEP upgrades will also be provided as appropriate. Additional apron construction will be included as necessary to accommodate aircraft and ground support equipment operations. AOA and security fence will be provided around the new apron area.

6. Project B-6 Narrowbody Gates at Southwest Leg of Concourse B: includes the expansion of aircraft parking positions by constructing a mainline aircraft facility at the end of the Southwest leg of Concourse B. The scope of work includes the removal of aircraft gates and the south façade of the existing concourse and the construction of a 250 x 100 foot two-level concourse extension, with an upper level comprised of finished space for passenger holdrooms, two restroom blocks, and one concessions block to support seven aircraft (narrowbody) parking positions and a lower level which provides shell space available to airlines for operations space. Seven new passenger loading bridges will be provided. The South leg of Concourse B will be infilled with a 35 x 300 foot, two-level structure to match the existing concourse. Gates B27, B29, and B31 and associated loading bridges will be relocated to accommodate the infill project. Seismic retrofits and MEP upgrades will also be provided as appropriate. Additional apron construction will be included as necessary to accommodate aircraft and ground support equipment operations. AOA and security fence will be provided around the new apron area.

7. Project B-10 Widening of Southeast & Southwest Legs of Concourse B: this project increases the width of the legs of Concourse B in order to provide larger holdrooms and passenger circulation corridors. The increase in width is to be provided to the south of the existing concourse, requiring relocation and reconfiguration of existing parking positions, passenger boarding bridges, etc. The scope of work includes widening both legs (two-level structure) of Concourse B to the south by 50 feet to provide holdroom expansion and improved concourse circulation. The upper level will include finished space for passenger holdrooms, restroom blocks and concession areas. The lower level will include shell space available to

airlines for operations space. Two moving walks at each leg of Concourse B will be installed, each at a length of 300 LF (1,200 LF total). Passenger loading bridges will be reconfigured as required. The aircraft parking apron will be reconstructed as needed, including hydrant fueling pits, apron striping, etc. Seismic retrofits and MEP upgrades will also be provided as appropriate.

8. Project C-1 Northward Extension of Concourse C: includes the extension of Concourse C to the North in order to provide four additional aircraft parking positions. This project, termed the "baseline" project, will provide sufficient gates to enable the Authority to undertake planned apron rehabilitation projects throughout the terminal complex. The scope of work includes the construction of a two-level building expansion (400 x 100 feet), which includes an upper level with finished space for passenger holdrooms, two restroom blocks and concession areas, and a lower level with shell space available to airlines for operations space. In addition, four new passenger loading bridges will be provided. Additional aircraft apron will be constructed as needed to accommodate aircraft and ground support equipment operations. AOA fencing and security gates around new apron will be installed. Seismic retrofits and MEP upgrades will also be provided as appropriate.

9. Project C-2 Concourse C Hammerhead (full): includes the extension of Concourse C North beyond the extent of Project C-1 in order to provide additional aircraft parking positions. The project will include a connecting corridor and a "hammerhead" providing passenger gate areas and associated amenities. The scope of work includes the construction of a 250 x 30 foot circulation connector with moving walkways from the end of the existing concourse to the new gate area, the construction of a 350 x 75 foot two-story concourse, and the addition of five passenger loading bridges. The upper-level will include finished space for passenger holdrooms, two restroom blocks, and one concession block to support seven aircraft (narrowbody) parking positions. The lower-level will include shell space for airlines for operations space. Additional apron construction will be included as necessary to accommodate aircraft and ground support equipment operations. AOA and security fence will be provided around the new apron area.

10. Project C-5 Concourse C Gate Removal: this project removes aircraft parking positions located on the south and west facades of Concourse C as well as two bays of the existing terminal building. Removing these gates allows for implementation of dual ADG III taxilanes into the alley between Concourses B and C. The scope of work includes the removal of the regional jet facility, the removal of two bays (250 x 40) on the east side of Concourse A, restriping the aircraft parking apron for dual ADG III taxilanes, reconfiguring aircraft parking positions on the west façade of Concourse A in order to optimize parking positions, and seismic retrofits and MEP upgrades as appropriate.

11. Project F-4 FIS Facility at Concourse B & Terminal Junction (refer to AA's FIS Option C): this project constructs a ground level FIS facility located at the junction of Concourse B and the main terminal. International aircraft parking positions are located along the trunk of Concourse B and connected to the FIS via sterile corridors and vertical circulation cores. Elements include the construction of a new FIS facility at apron level at the junction of Concourse B and the existing central baggage handling facility – occupying approximately 80,000 square feet, a new sterile horizontal and vertical circulation space between the new FIS facility and the non-secure Terminal B lobby, and seismic retrofits and MEP upgrades as appropriate.

12. Project T-3 Frontage Gates at South Terminal Façade: this project adds additional circulation and holdroom space to the south of the existing secure connectors. These gates would be located between existing concourses and designed to accommodate narrowbody aircraft. It is assumed that this project will be associated with Project F-4 and A-6. Elements include the construction of a two-level concourse expansion (320 x 50 feet) including circulation, passenger holdroom, restroom, and concession spaces along the south façade of the main terminal. Four new passenger loading bridges will be provided. Seismic retrofits and MEP upgrades will also be provided as appropriate.

C. Concept Hybrid – comprised of the following components:

1. Project A-1 Northward Extension of Concourse A: includes the extension of Concourse A to the North in order to provide four additional aircraft parking positions. The scope of work includes the construction of a two-level building expansion (400 x 100 feet), which includes an upper level with finished space for passenger holdrooms, two restroom blocks and concession areas, and a lower level with shell space available to airlines for operations space. In addition, four new passenger loading bridges will be provided. Additional aircraft apron will be constructed as needed to accommodate aircraft and ground support equipment operations. AOA fencing and security gates around new apron will be installed. Seismic retrofits and MEP upgrades will also be provided as appropriate.

2. Project B-11A Remote South Concourse: this project constructs a remote passenger concourse at the southern end of the existing terminal complex. The concourse would be connected to the existing Concourse B rotunda via either an underground walkway or bridge. Moving walkways would assist passengers to move from the midpoint, adjacent to the connection to the tunnel or bridge, to either end with ease. The concourse is shown as double-loaded, although providing south façade gates would require demolition and relocation of Taxiway T. The scope of work includes the construction or a new double-loaded two-story (1,300 x 120 feet) satellite terminal concourse to the north of Taxiway T. The upper level will include new passenger circulation with moving walks and boarding facilities with finishes commensurate with those elsewhere in the terminal. The lower level will provide shell space for airline operations. A bridge or tunnel connection from mid-field concourse to new satellite concourse with moving walks will also be included. Installation of 26 passenger loading bridges will be required. The addition or reconfiguration of aircraft parking apron will be required as necessary to provide parking positions.

3. Project C-1 Northward Extension of Concourse C: includes the extension of Concourse C to the North in order to provide four additional aircraft parking positions. This project, termed the "baseline" project, will provide sufficient gates to enable the Authority to undertake planned apron rehabilitation projects throughout the terminal complex. The scope of work includes the construction of a two-level building expansion (400 x 100 feet), which includes an upper level with finished space for passenger holdrooms, two restroom blocks and concession areas, and a lower level with shell space available to airlines for operations space. In addition, four new passenger loading bridges will be provided. Additional aircraft apron will be constructed as needed to accommodate aircraft and ground support equipment operations. AOA fencing and security gates around new apron will be installed. Seismic retrofits and MEP upgrades will also be provided as appropriate.

4. **Project C-2 Concourse C Hammerhead (full):** includes the extension of Concourse C North beyond the extent of Project C-1 in order to provide additional aircraft parking positions. The project will include a connecting corridor and a "hammerhead" providing passenger gate areas and associated amenities. The scope of work includes the construction of a 250 x 30 foot circulation connector with moving walkways from the end of the existing concourse to the new gate area, the construction of a 350 x 75 foot two-story concourse, and the addition of five passenger loading bridges. The upper-level will include finished space for passenger holdrooms, two restroom blocks, and one concession block to support seven aircraft (narrowbody) parking positions. The lower-level will include shell space for airlines for operations space. Additional apron construction will be included as necessary to accommodate aircraft and ground support equipment operations. AOA and security fence will be provided around the new apron area.

5. **Project C-4A Concourse C Pavilion and International Gates:** includes the construction of a new pavilion to facilitate new FIS and International gates at Concourse C. Aircraft parking positions would be provided on the East side of the pavilion. The concentration of gates around each pavilion would be accompanied with appropriate restroom, passenger amenities, and capacity to accommodate international departures and arrivals. The scope of work includes the removal of Gates C8, C10, C12A, and C12B, loading bridges, existing apron pavement, etc. as necessary to facilitate building construction and the construction of two, two-story pavilions (100 x 200 feet) to extend from the west façade of Concourse C. The upper level will include new passenger circulation and boarding facilities with finishes commensurate with those elsewhere in the terminal. The lower level will include shell space for future airline operation space. The adjacent apron will be reconstructed as needed to accommodate aircraft and ground support equipment operations. Seismic retrofits and MEP upgrades will also be provided as appropriate.
6. **Project A2 AA's FIS Option A2:** includes the construction of a new FIS facility above the existing Concourse B terminal, with a sterile corridor connecting the FIS to the existing Terminal Processor Building mezzanine level.

III. Terminal Processor Building Renovations

Scheme 2 – This option is meant to take a full Master Plan look at issues associated with optimizing circulation and curbside access, and maximizing modifications during the building systems upgrade. The focus will be on clear circulation, capacity issues, organization of functions and working with the proposed changes to the concourse, security requirements and operational issues. The scope of work includes:

A. No vertical circulation work for enhanced access to the mezzanine level is proposed under this scheme. The unused hotel area may be used for Mezzanine Level office expansion and relocation of office type functions from the Ticketing Level.
B. Increase Security Screening capacity at Concourse B to seven screening lanes.
C. Redefine Security Screening area at Concourse A for three screening lanes.
D. Relocate the restrooms adjacent to Concourse A security checkpoint to the north terminal face.
E. Redefine Security Screening area at Concourse C for three screening lanes.
F. Relocate the restrooms adjacent to Concourse C security checkpoint to the north terminal face.
G. Remove vertical circulation at the ticketing level and relocate to the north wall in an east-west orientation. The required vertical circulation would extend from Mezzanine level to the baggage claim level.
H. A new set of elevators from in all three Terminal Lobbies down to baggage claim and the tunnel levels and up to the Mezzanine level.
I. Down escalators and stairs from Ticketing to Baggage Claim would be relocated.
J. A central corridor for circulation would be developed south of the new vertical circulation linking all three terminals.
K. Larger concessions would be moved to the south side of the ticketing lobby. Smaller concessions would remain.
L. Office and business functions would be relocated from the Ticketing level to the unused hotel space at the Mezzanine.
M. New restrooms would be developed at the ticketing level along the north wall.
N. At the B Concourse Security checkpoint, a down-only pair of escalators and a set of stairs across from the B concourse would be provided.
O. At the baggage claim level, a new enlarged corridor connecting the three terminals would be created.
P. At the baggage claim level, all vertical circulation in the middle of all three claim areas would be relocated.
Q. Relocate the four baggage claim devices in B Terminal Claim area.
R. Provide two new sloped claim devices in B and C Terminal Claim areas (2 per terminal)
S. A new set of elevators would be provided in all three terminal lobbies down to the tunnel level and up to the ticketing level.
T. New vertical circulation from each Tunnel to the baggage claim Level along the north face of the terminal.

Preliminary Plan – Estimated Costs

Rough order-of-magnitude cost estimates were prepared for each of the three baseline alternatives and the associated long-term vision concepts. These estimates included not only costs of the proposed additional structures and facilities, but also renovation, upgrade, and seismic retrofit of current facilities. Table 1, reproduced from Table 3 in the main body of the report, summarizes the construction and soft costs of the three baseline alternatives and the three concept plans. Table 2 presents a summary of the incremental costs leading to the summarized values.

Table 1

ESTIMATED COSTS FOR BASELINE ALTERNATIVES AND LONG-TERM VISION CONCEPTS
Master Plan Update
Memphis International Airport

	Cost estimates (in $ millions) *(a)*			
	Construction	General conditions *(b)*	Owner soft costs *(c)*	Total
Baseline Alternatives				
Baseline A	$251.3	$ 97.0	$ 81.8	$ 430.1
Baseline B	259.9	100.3	84.6	444.8
Baseline C	263.6	101.7	85.8	451.1
Long-term Vision Concepts *(d)*				
Concept 2	$604.1	$233.1	$196.8	$1,034.0
Concept 4	473.9	182.8	154.3	811.0
Concept Hybrid	527.8	203.7	172.0	903.5

(a) Costs presented in 2008 dollars.
(b) Includes markups for general conditions, contractors' fees, design and construction contingencies, and payment and performance bonds.
(c) Includes markups for project and construction management, design fees, construction administration, materials testing, and other associated services.
(d) Includes projects that were included in the paired Baseline Alternative (i.e. Concept 2 includes the cost of all projects part of Baseline A).

Source: Connico, May 2009.

Table 1 – Estimated Costs for Baseline Alternatives and Long-Term Vision Concepts

Project Title	Master Plan		
Location	Memphis International Airport		
Submittal Stage	Program		
Client Project No.		Revision	6
Original Date	2-Dec-08	Revision Date	24-Nov-09
Assumed Bid Opening Date		CI Project No.	2466.08.2
Project Manager	DLB	Checked by	CSG

Baseline A Summary

	Description			Total
	Project A-1	Northward Extension of Concourse A	$	*30,126,900*
	Project C-1	Northward Extension of Concourse C	$	*31,683,900*
	Project C-2	Concourse C Hammerhead (Full)	$	*33,279,476*
	Project F-6	FIS Facility on Mezzanine Level in Terminal B	$	*49,672,115*
	Concourse Renovations		$	*19,868,271*
	Processor Building Renovations		$	*30,150,000*
	MEP Improvements		$	*24,250,177*
	Seismic Upgrades		$	*32,257,521*
	Subtotal		***$***	***251,288,361***
8.0%	General Conditions		$	20,103,069
5.0%	General Contractor's Fee		$	13,569,572
10.0%	Design Contingency		$	28,496,100
1.0%	Payment & Performance Bonds		$	3,134,571
10.0%	Construction Contingency		$	31,659,167
0.0%	LEED Requirements		$	-
0.0%	Escalation		$	-
	Subtotal		***$***	***348,250,840***
	Owner Soft Costs			
3.0%	Project Management		$	10,447,525
6.0%	Construction Manager		$	20,895,050
0.2%	Planning and Preconstruction		$	696,502
8.0%	Architectural / Engineering Design		$	27,860,067
2.0%	Architectural / Engineering Construction Admin		$	6,965,017
1.7%	Airport Staff		$	5,920,264
1.4%	Materials Testing		$	4,875,512
0.1%	Plan Check Services		$	348,251
0.3%	Cost Estimating and Scheduling		$	1,044,753
0.5%	Other		$	1,741,254
0.3%	Artwork		$	1,044,753
	Opinion of Probable Construction Cost		***$***	***430,089,787***
	Breakout of MEP Costs for Projects A-1, C-1, C-1, F-6		***$***	***106,045,324***
				42.80%

Table 2 – Baseline A Summary

Project Title	Master Plan		
Location	Memphis International Airport		
Submittal Stage	Program		
Client Project No.		**Revision**	5
Original Date	2-Dec-08	**Revision Date**	05-Feb-09
Assumed Bid Opening Date		**CI Project No.**	2466.08.2
Project Manager	DLB	**Checked by**	CSG

Baseline B Summary

	Description			Total
	Project B-5	Regional Jet Facility at Southeast Leg of Concourse B	$	36,758,297
	Project B-6	Narrowbody Gates at Southwest Leg of Concourse B	$	28,686,707
	Project C-1	Northward Extension of Concourse C	$	31,683,900
	Project C-2	Concourse C Hammerhead (Partial)	$	14,193,775
	Project F-4	FIS Facility at Concourse B & Terminal Junction	$	45,460,928
	Concourse Renovations		$	19,868,271
	Processor Building Renovations		$	30,150,000
	MEP Improvements		$	24,250,177
	Seismic Upgrades		$	28,841,004
	Subtotal		***$***	***259,893,060***
8.0%	General Conditions		$	20,791,445
5.0%	General Contractor's Fee		$	14,034,225
10.0%	Design Contingency		$	29,471,873
1.0%	Payment & Performance Bonds		$	3,241,906
10.0%	Construction Contingency		$	32,743,251
0.0%	LEED Requirements		$	-
0.0%	Escalation		$	-
	Subtotal		***$***	***360,175,760***
	Owner Soft Costs			
3.0%	Project Management		$	10,805,273
6.0%	Construction Manager		$	21,610,546
0.2%	Planning and Preconstruction		$	720,352
8.0%	Architectural / Engineering Design		$	28,814,061
2.0%	Architectural / Engineering Construction Admin		$	7,203,515
1.7%	Airport Staff		$	6,122,988
1.4%	Materials Testing		$	5,042,461
0.1%	Plan Check Services		$	360,176
0.3%	Cost Estimating and Scheduling		$	1,080,527
0.5%	Other		$	1,800,879
0.3%	Artwork		$	1,080,527
	Opinion of Probable Construction Cost		***$***	***444,817,064***
	Breakout of MEP Costs for Projects B-5, B-6, C-1, C-2, F-4		***$***	***107,689,061***
				40.13%

Table 3 – Baseline B Summary

Project Title	Master Plan		
Location	Memphis International Airport		
Submittal Stage	Program		
Client Project No.		**Revision**	5
Original Date	2-Dec-08	**Revision Date**	05-Feb-09
Assumed Bid Opening Date		**CI Project No.**	2466.08.2
Project Manager	DLB	**Checked by**	CSG

Baseline C Summary

	Description			Total
	Project A-1	Northward Extension of Concourse A	$	30,126,900
	Project A2	Architectural Alliance's FIS Option A2	$	42,820,390
	Project C-1	Northward Extension of Concourse C	$	31,683,900
	Project C-2	Concourse C Hammerhead (Full)	$	33,279,476
	Project C-4A	Concourse C Pavilion and International Gates	$	26,992,427
	Concourse Renovations		$	17,979,971
	Processor Building Renovations		$	30,150,000
	MEP Improvements		$	24,250,177
	Seismic Upgrades		$	26,290,668
	Subtotal		***$***	***263,573,908***
8.0%	General Conditions		$	21,085,913
5.0%	General Contractor's Fee		$	14,232,991
10.0%	Design Contingency		$	29,889,281
1.0%	Payment & Performance Bonds		$	3,287,821
10.0%	Construction Contingency		$	33,206,991
0.0%	LEED Requirements		$	-
0.0%	Escalation		$	-
	Subtotal		***$***	***365,276,906***
	Owner Soft Costs			
3.0%	Project Management		$	10,958,307
6.0%	Construction Manager		$	21,916,614
0.2%	Planning and Preconstruction		$	730,554
8.0%	Architectural / Engineering Design		$	29,222,152
2.0%	Architectural / Engineering Construction Admin		$	7,305,538
1.7%	Airport Staff		$	6,209,707
1.4%	Materials Testing		$	5,113,877
0.1%	Plan Check Services		$	365,277
0.3%	Cost Estimating and Scheduling		$	1,095,831
0.5%	Other		$	1,826,385
0.3%	Artwork		$	1,095,831
	Opinion of Probable Construction Cost		***$***	***451,116,979***
	Breakout of MEP Costs for Projects A-1, A2, C-1, C-2, C-4A		***$***	***116,927,750***
				41.43%

Table 4 – Baseline C Summary

Memphis International Airport
Memphis, Tennessee

Master Plan
Terminal Development Alternatives

November 2009

Proposed Improvement Scenarios

Improvements Location	Improvements Description	Baseline A PAL 1	Baseline A PAL 2	Baseline A PAL 3	Total Baseline A	Baseline B PAL 1	Baseline B PAL 2	Baseline B PAL 3	Total Baseline B	Baseline C PAL 1	Baseline C PAL 2	Baseline C PAL 3	Total Baseline C
■ Project A-1	Northward Extension of Concourse A			$ 51,563,359	$ 51,563,359							$ 51,563,359	$ 51,563,359
■ Project B-5	Regional Jet Facility at Southeast Leg of Concourse B						$ 62,913,253		$ 62,913,253				
■ Project B-6	Narrowbody Gates at Southwest Leg of Concourse B							$ 49,098,412	$ 49,098,412				
■ Project C-1	Northward Extension of Concourse C	$ 54,228,225			$ 54,228,225	$ 54,228,225			$ 54,228,225	$ 54,228,225			$ 54,228,225
■ Project C-2	Concourse C Hammerhead (Full)		$ 56,959,115		$ 56,959,115						$ 56,959,115		$ 56,959,115
■ Project C-2	Concourse C Hammerhead (Partial)							$ 24,293,197	$ 24,293,197				
■ Project C-4A	Concourse C Pavilion and International Gates										$ 46,198,586		$ 46,198,586
■ Project A2	Architectural Alliance's FIS A										$ 73,288,760		$ 73,288,760
■ Project F-4	FIS Facility at Concourse B & Terminal Junction						$ 77,808,143		$ 77,808,143				
■ Project F-6	FIS Facility on Mezzanine Level in Terminal B		$ 85,015,754		$ 85,015,754								
Concourses A, B, and C	Interior Renovations (Finish / Lighting Upgrades)	$ 9,234,000	$ 3,567,318	$ 21,204,000	$ 34,005,318	$ 9,234,000	$ 11,433,318	$ 13,338,000	$ 34,005,318	$ 3,693,600	$ 5,875,818	$ 21,204,000	$ 30,773,418
Processor Building	Interior Renovations (per AA Scheme 2)	$ 12,900,724	$ 25,801,448	$ 12,900,724	$ 51,602,896	$ 12,900,724	$ 25,801,448	$ 12,900,724	$ 51,602,896	$ -	$ 38,702,172	$ 12,900,724	$ 51,602,896
A, B, C & Processor	MEP Improvements*	$ 15,803,820	$ 8,806,500	$ 16,894,800	$ 41,505,120	$ 15,803,820	$ 8,806,500	$ 16,894,800	$ 41,505,120	$ 15,803,820	$ 8,806,500	$ 16,894,800	$ 41,505,120
A, B, C & Processor	Seismic Upgrades	$ 30,797,500	$ 11,112,500	$ 13,300,000	$ 55,210,000	$ 28,530,000	$ 13,026,250	$ 7,806,250	$ 49,362,500	$ 21,092,500	$ 16,030,000	$ 7,875,000	$ 44,997,500
	Opinion of Total Estimated Construction Cost	$ 122,964,269	$ 191,262,634	$ 115,862,883	$ 430,089,787	$ 120,696,769	$ 199,788,912	$ 124,331,383	$ 444,817,064	$ 94,818,145	$ 245,860,951	$ 110,437,883	$ 451,116,979
	Deduct for Structural Retrofit Option 1	$ (2,837,500)	$ (2,600,000)	$ (2,925,000)	$ (8,362,500)	$ (5,675,000)	$ (1,300,000)	$ (2,080,000)	$ (9,055,000)	$ 1,412,500	$ (2,275,000)	$ -	$ (862,500)

*Note: This scope of work is for MEP items that do not directly relate to individual projects or Central Plant upgrades, but will be required due to current deficiencies as noted by Allen & Hoshall.

Clarification: Values listed above include all markups and soft costs.

MASTER PLAN
MEMPHIS INTERNATIONAL AIRPORT

Table 5 – Terminal Development Alternatives

Memphis International Airport
Memphis, Tennessee

November 2009

Master Plan
Terminal Development Alternatives

Proposed Improvement Scenarios

Improvements Location	Improvements Description	Concept 2	Concept 4	Concept Hybrid
■ Project A-1	Northward Extension of Concourse A	$ 51,563,359	$ 51,563,359	$ 51,563,359
■ Project A-2	Concourse A Hammerhead	$ 26,203,431	$ 26,203,431	
■ Project A-6	Concourse A Gate Removal		$ 3,371,903	
■ Project B-1	Concourse B Trunk Gate Removal	$ 22,269,859		
■ Project B-3	Concourse B Trunk Holdroom Expansion with FIS		$ 43,362,136	
■ Project B-5	Regional Jet Facility at Southeast Leg of Concourse B		$ 62,913,253	
■ Project B-6	Narrowbody Gates at Southwest Leg of Concourse B		$ 49,098,412	
■ Project B-8	Realignment of Concourse B Legs at Rotunda	$ 113,914,436		
■ Project B-10	Widening of Southeast & Southwest Legs of Concourse B		$ 79,300,957	
■ Project B-11 A	Remote South Concourse (26 Gates)			$ 264,176,711
■ Project B-11 B	Remote South Concourse (13 Gates)	$ 257,660,455		
■ Project C-1	Northward Extension of Concourse C	$ 54,228,225	$ 54,228,225	$ 54,228,225
■ Project C-2	Concourse C Hammerhead (Full)	$ 56,959,115	$ 56,959,115	$ 56,959,115
■ Project C-4A	Concourse C Pavilion and International Gates			$ 46,198,586
■ Project C-5	Concourse C Gate Removal		$ 1,446,764	
■ Project A2	Architectural Alliance's FIS Option A			$ 73,288,760
■ Project F-4	FIS Facility at Concourse B & Terminal Junction		$ 77,808,143	
■ Project F-6	FIS Facility on Mezzanine Level in Terminal B	$ 85,015,754		
■ Project T-1	Narrowbody Gates at South Terminal Façade	$ 79,571,437		
■ Project T-3	Frontage Gates at South Terminal Façade		$ 41,043,831	
Concourses A, B, and C	Interior Renovations (Finish / Lighting Upgrades)	$ 34,005,318	$ 34,005,318	$ 34,005,318
Processor Building	Interior Renovations (per AA Scheme 2)	$ 51,602,896	$ 51,602,896	$ 51,602,896
Concourses A, B, and C	MEP Central Plant Cost	$ 44,300,401	$ 27,245,999	$ 44,713,649
A, B, C & Processor	MEP Improvements*	$ 41,505,120	$ 41,505,120	$ 41,505,120
A, B, C & Processor	Seismic Upgrades	$ 55,210,000	$ 49,362,500	$ 44,997,500
Concourses A & C	Moving Walkways Allowance	$ 60,000,000	$ 60,000,000	$ 60,000,000
Taxiway	Taxiway Reconstruction South of Remote South Concourse			$ 9,000,000
	Opinion of Total Estimated Construction Cost	$ 1,034,009,805	$ 811,021,361	$ 832,239,240

Additional Concept Hybrid Options

Concourse B	Widening Entire Length of Trunk at Concourse B			$ 40,865,536
Concourse B	Infills of Southeast and Southwest Legs of Concourse B			$ 30,369,359
	Revised Opinion of Total Estimated Construction Cost	$ 1,034,009,805	$ 811,021,361	$ 903,474,134

*Note: This scope of work is for MEP items that do not directly relate to individual projects or Central Plant upgrades, but will be required due to current deficiencies as noted by Allen & Hoshall.

MASTER PLAN
MEMPHIS INTERNATIONAL AIRPORT

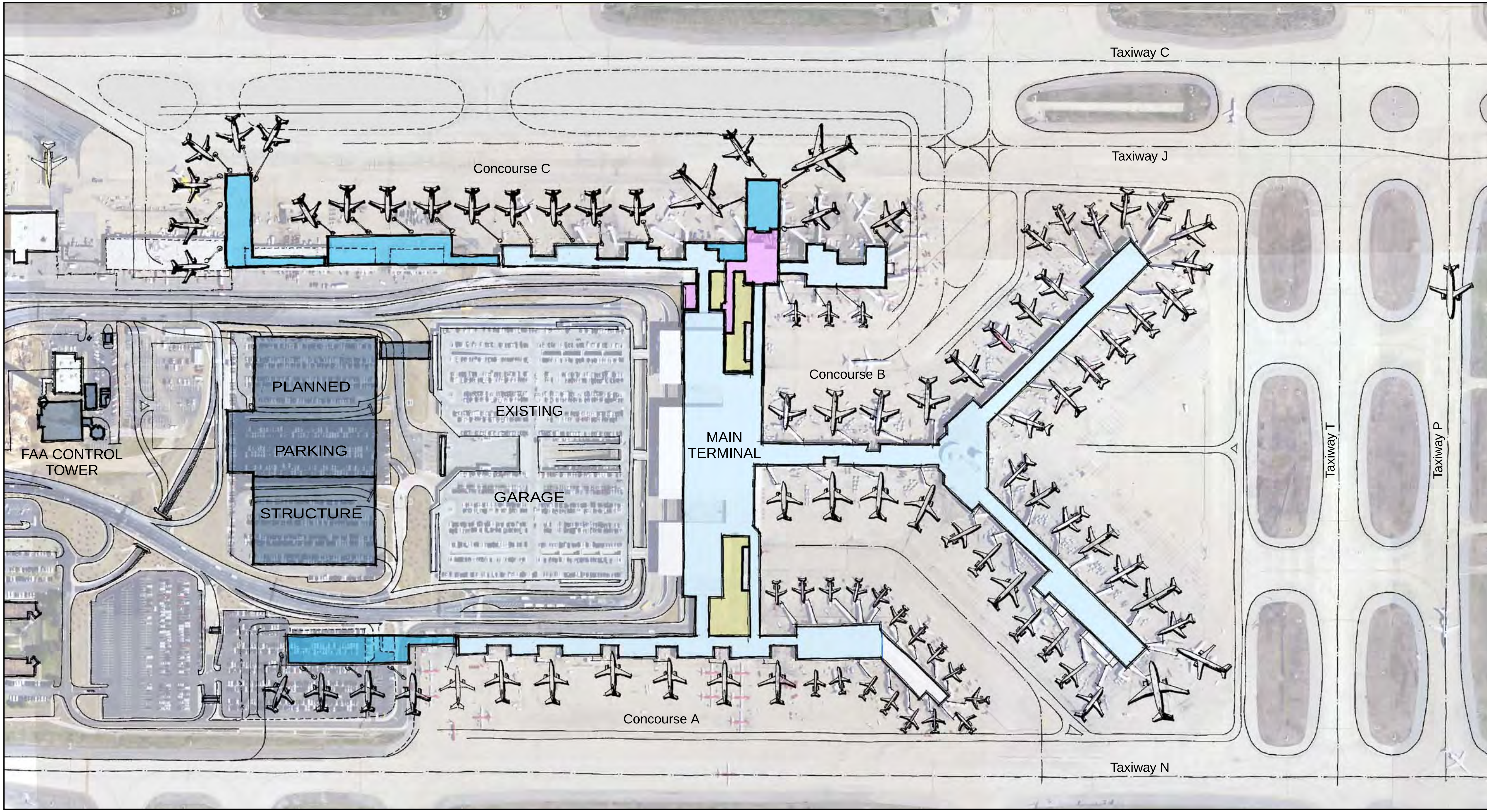
Table 6 – Terminal Development Alternatives

SECTION 3 - PREFERRED PLAN and ESTIMATED COSTS

Preferred Plan Project Descriptions

Following a comprehensive review of the preliminary baseline plans and the associated long-term vision concepts, a series of revisions were undertaken to the Baseline C and Hybrid Concept plans to better reflect the Authority's objectives in regard to improved operational opportunities and to the levels of service provided to the traveling public and users of the terminal facilities. These plans were also augmented with more thoroughly studied and refined information concerning the preferred phasing of improvements and the infrastructure and seismic improvements that will need to be addressed within the 20-year planning period.

Figure 2 presents the Preferred Plan at the conclusion of the 20-year master planning period. Figure 3 presents reduced copies of the preferred phasing schedule of the preferred plan (i.e., PAL 1, PAL 2, and PAL 3 development stages) as well as the preferred long term vision concept for the passenger terminal complex beyond the 20-year planning period. Each exhibit was reproduced from the main body of this report and is provided here as a convenience to the reader. The following paragraphs provide brief descriptions of the Preferred Plan projects, as used in the preparation of estimated costs.



LEGEND

- Existing
- New construction
- FIS facility
- Interior renovations
- In-line baggage system
- Ongoing Airport projects

N

150 0 150 300

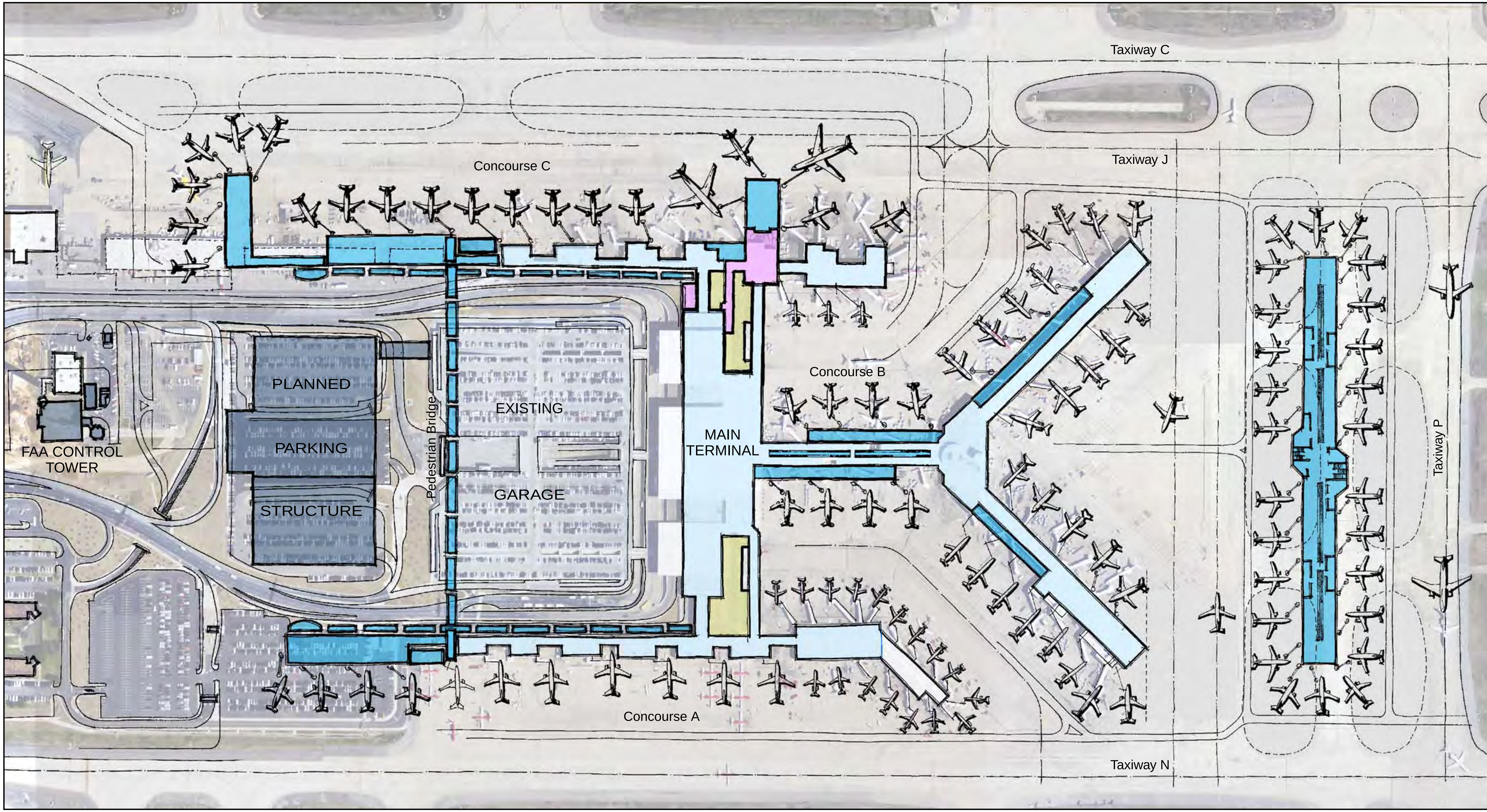
Graphic Scale in Feet

Figure 4

PREFERRED PLAN

Master Plan Update
Memphis International Airport
November 2009

JACOBS CONSULTANCY



LEGEND

- Existing
- New construction
- FIS facility
- Interior renovations
- In-line baggage system
- Ongoing Airport projects

N

150 0 150 300

Graphic Scale in Feet

Figure 5

PREFERRED LONG TERM VISION

Master Plan Update
Memphis International Airport
November 2009

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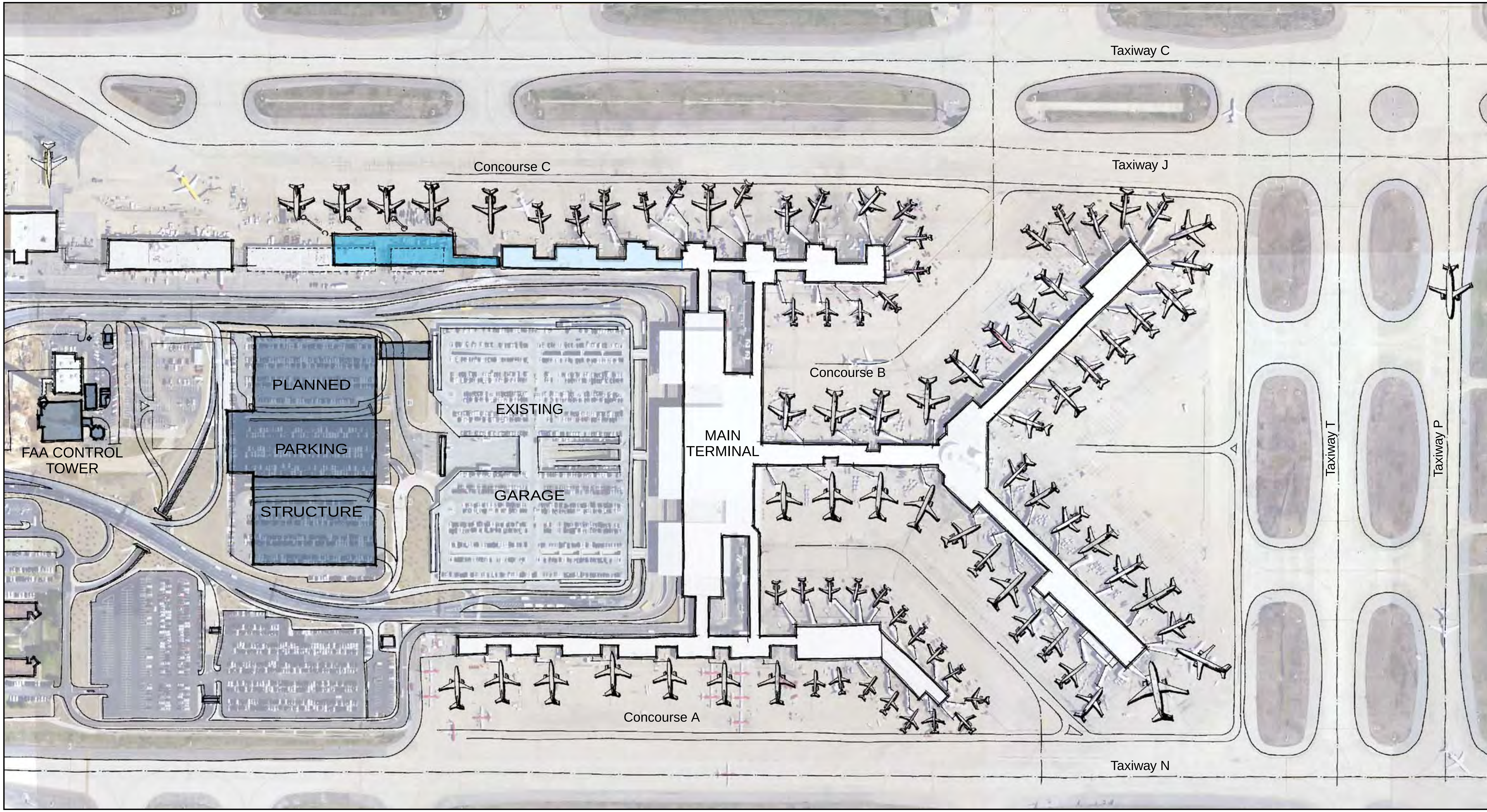
CONSULTANCY



LEGEND

- Existing
- New construction
- Interior renovations
- Ongoing Airport projects

N

150 0 150 300

Graphic Scale in Feet

Figure 6

PREFERRED PLAN—PAL 1

Master Plan Update
Memphis International Airport
November 2009

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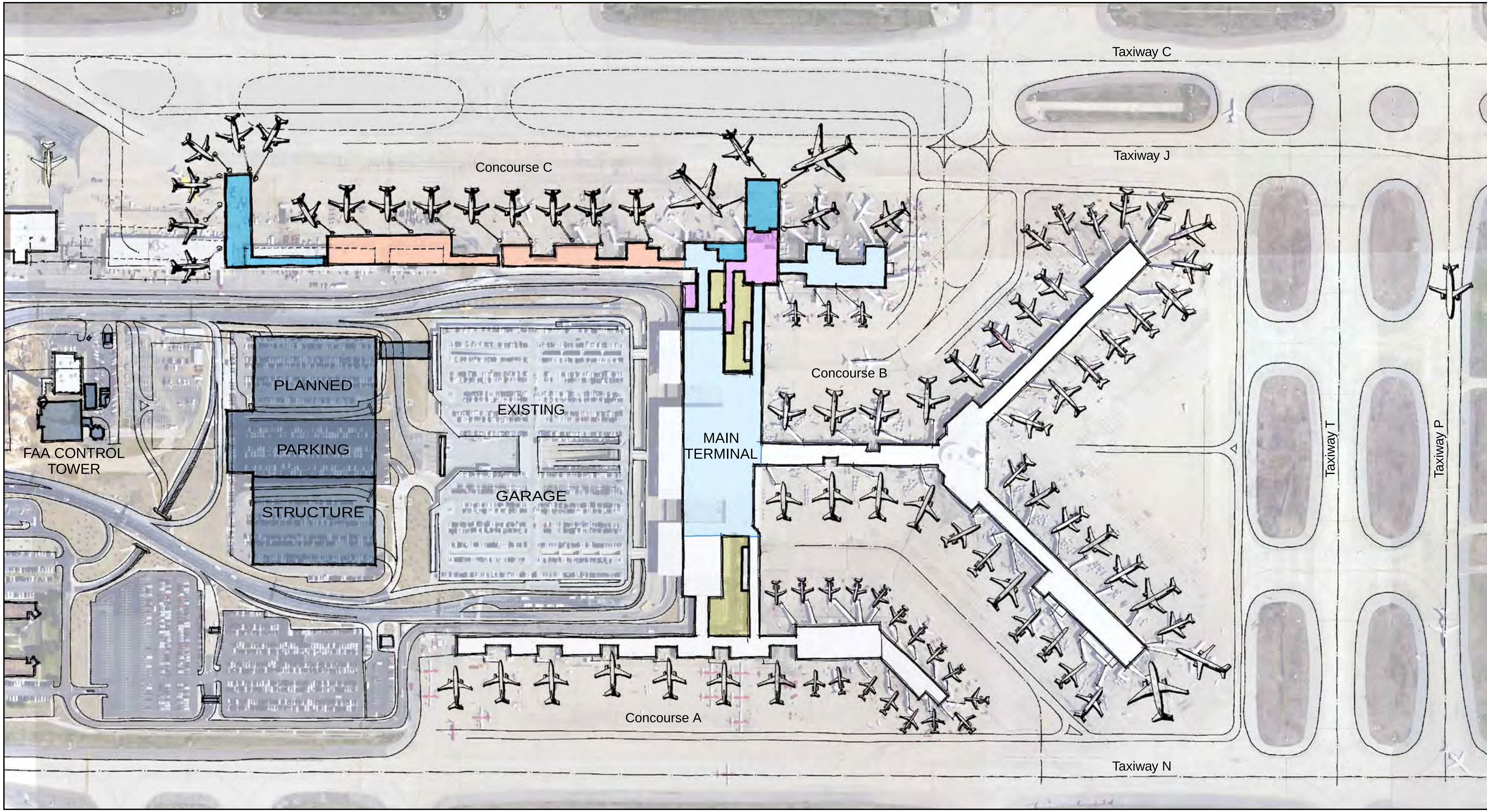

LEGEND

	Existing
	Completed in prior PAL
	Completed in this PAL
	Renovated in this PAL
	FIS facility (completed in this PAL)
	In-line baggage system
	Ongoing Airport projects

N

150 0 150 300

Graphic Scale in Feet

Figure 7

PREFERRED CONCEPT—PAL 2

Master Plan Update
Memphis International Airport
November 2009

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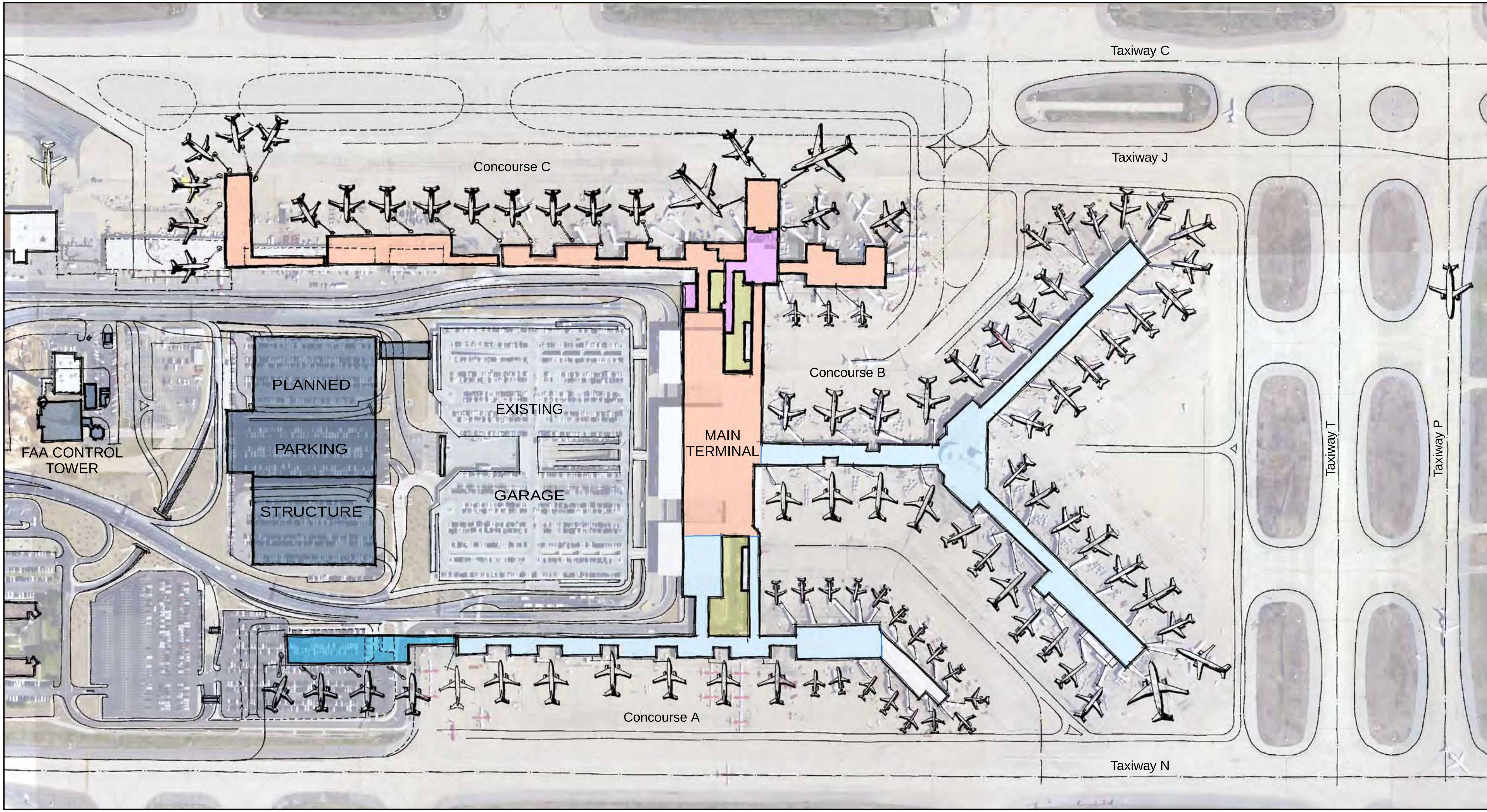

LEGEND

- Existing
- Completed in prior PAL
- Completed in this PAL
- Renovated in this PAL
- FIS facility (completed in prior PAL)
- In-line baggage system
- Ongoing Airport projects

N

150 0 150 300

Graphic Scale in Feet

Figure 8

PREFERRED PLAN—PAL 3

Master Plan Update
Memphis International Airport
November 2009

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Based on the feedback received from Workshop 3, a "Preferred Plan" was developed. The components of this plan are as follows:

I. PREFERRED PLAN

A. PAL 1 includes the following projects and construction components:

1. Project C-1 Northward Extension of Concourse C: includes the extension of Concourse C to the North in order to provide four additional aircraft parking positions. This project, termed the "baseline" project, will provide sufficient gates to enable the Authority to undertake planned apron rehabilitation projects throughout the terminal complex. The scope of work includes the construction of a two-level building expansion (400 x 100 feet), which includes an upper level with finished space for passenger holdrooms, two restroom blocks and concession areas, and a lower level with shell space available to airlines for operations space. In addition, four new passenger loading bridges will be provided. Additional aircraft apron will be constructed as needed to accommodate aircraft and ground support equipment operations. AOA fencing and security gates around new apron will be installed. Seismic retrofits and MEP upgrades will also be provided as appropriate.

2. Interior Renovations to Concourses: the scope of work for the interior renovations to the existing Concourses includes finish upgrades (flooring, painting, ceilings) and new lighting.

3. Main Terminal Processor Interior Renovations: interior renovations to the Main Terminal building includes the reconfiguration of existing spaces, new exterior doors, vertical circulation modifications, and modifications to baggage claim areas. Interior renovations also include new finishes as required due to disruption of existing conditions due to seismic upgrade construction.

4. MEP Improvements – Infrastructure Improvements: these costs are included to upgrade existing services required due to the additional square footage of new construction projects.

5. MEP Improvements – Repair/Upgrade of Existing Equipment: upgrades required to bring current equipment up to code, repairs to currently deficient equipment, etc.

6. Seismic Upgrades – these costs are included for the seismic improvements per Thornton Tomasetti.

B. PAL 2 includes the following projects and construction components:

1. **Project C-2 Concourse C Hammerhead:** includes the extension of Concourse C North beyond the extent of Project C-1 in order to provide additional aircraft parking positions. The project will include a connecting corridor and a "hammerhead" providing passenger gate areas and associated amenities. The scope of work includes the construction of a 250 x 30 foot circulation connector with moving walkways from the end of the existing concourse to the new gate area, the construction of a 350 x 75 foot two-story concourse, and the addition of five passenger loading bridges. The upper-level will include finished space for passenger holdrooms, two restroom blocks, and one concession block to support seven aircraft (narrowbody) parking positions. The lower-level will include shell space for airlines for operations space. Additional apron construction will be included as necessary to accommodate aircraft and ground support equipment operations. AOA and security fence will be provided around the new apron area.

2. **Revised FIS / Pavilion:** this project incorporates components of the previous Project C-4A Concourse C Pavilion and International Gates and Architectural Alliance's original FIS Option A. This hybrid version includes the International Gates at Concourse C and a new FIS facility that incorporates new construction at the roof level of the Concourse, elevated connector that takes passengers from roof level to baggage claim level, and ground level recheck / baggage claim area, exit, and meeter/greeter space.

3. **Interior Renovations to Concourses:** the scope of work for the interior renovations to the existing Concourses includes finish upgrades (flooring, painting, ceilings) and new lighting.

4. **Main Terminal Processor Interior Renovations:** interior renovations to the Main Terminal building includes the reconfiguration of existing spaces, new exterior doors, vertical circulation modifications, and modifications to baggage claim areas. Interior renovations also include new finishes as required due to disruption of existing conditions due to seismic upgrade construction.

5. **MEP Improvements – Infrastructure Improvements:** these costs are included to upgrade existing services required due to the additional square footage of new construction projects.

6. **MEP Improvements – Repair/Upgrade of Existing Equipment:** upgrades required to bring current equipment up to code, repairs to currently deficient equipment, etc.

7. **Seismic Upgrades** – these costs are included for the seismic improvements per Thornton Tomasetti.

C. PAL 3 includes the following projects and construction components:

1. Project A-1 Northward Extension of Concourse A: includes the extension of Concourse A to the North in order to provide four additional aircraft parking positions. The scope of work includes the construction of a two-level building expansion (400 x 100 feet), which includes an upper level with finished space for passenger holdrooms, two restroom blocks and concession areas, and a lower level with shell space available to airlines for operations space. In addition, four new passenger loading bridges will be provided. Additional aircraft apron will be constructed as needed to accommodate aircraft and ground support equipment operations. AOA fencing and security gates around new apron will be installed. Seismic retrofits and MEP upgrades will also be provided as appropriate.

2. Interior Renovations to Concourses: the scope of work for the interior renovations to the existing Concourses includes finish upgrades (flooring, painting, ceilings) and new lighting.

3. Main Terminal Processor Interior Renovations: interior renovations to the Main Terminal building includes the reconfiguration of existing spaces, new exterior doors, vertical circulation modifications, and modifications to baggage claim areas. Interior renovations also include new finishes as required due to disruption of existing conditions due to seismic upgrade construction.

4. MEP Improvements – Infrastructure Improvements: these costs are included to upgrade existing services required due to the additional square footage of new construction projects.

5. MEP Improvements – Repair/Upgrade of Existing Equipment: upgrades required to bring current equipment up to code, repairs to currently deficient equipment, etc.

6. Seismic Upgrades – these costs are included for the seismic improvements per Thornton Tomasetti.

II. PREFERRED LONG TERM VISION

In addition to the projects mentioned above for the Preferred Plan, the preferred long-range alternatives are as follows:

1. Project B-11A Remote South Concourse: this project constructs a remote passenger concourse at the southern end of the existing terminal complex. The concourse would be connected to the existing Concourse B rotunda via either an underground walkway or bridge. Moving walkways would assist passengers to move from the midpoint, adjacent to the connection to the tunnel or bridge, to either end with ease. The concourse is shown as double-loaded, although providing south façade gates would require demolition and relocation of Taxiway T. The scope of work includes the construction or a new double-loaded two-story (1,300 x 120 feet) satellite terminal concourse to the north of Taxiway T. The upper level will include new passenger circulation with moving walks and boarding facilities with finishes commensurate with those elsewhere in the terminal. The lower level will provide shell space for airline operations. A bridge or tunnel connection from mid-field concourse to new satellite concourse with moving walks will also be included. Installation of 26 passenger loading bridges will be required. The addition or reconfiguration of aircraft parking apron will be required as necessary to provide parking positions.

2. Moving Walkways at Concourses A and C: new elevated enclosed moving walkways at Concourses A and C.

3. Taxiway Reconstruction South of Remote Concourse: new taxiway pavement due to the construction of the Remote South Concourse.

4. Widening of Concourse B Trunk: includes the widening of the trunk at Concourse B to include new moving walkways.

5. Infills of Southeast and Southwest Legs of Concourse B – includes the widening of sections of Concourse B to allow for improved passenger flow.

Preferred Plan – Estimated Costs

Cost estimates were prepared for each of the three phasing stages of the Preferred Plan and for the Preferred Long-Term Vision plan that reflects the Authority's preferences for improvements beyond the 20-year planning period. The cost estimates summarized in Table 7 reflect the incremental costs of projects at each phase of development and the total cost of the Preferred Plan. It also indicates the estimated cost of the Preferred Long-Term Vision Plan. Tables 8 and 9 provide cost information detail for the Preferred Plan values shown in Table 7.

Table 7

ESTIMATED COSTS FOR THE PREFERRED PLAN
Master Plan Update
Memphis International Airport

	Cost estimates (in $ millions) *(a)*			
	Construction	General conditions *(b)*	Owner soft costs *(c)*	Total
PAL 1				
Facilities *(d)*	$ 31.7	$12.3	$10.3	$ 54.2
Interior renovations *(e)*	2.2	0.8	0.7	3.7
Main terminal renovations *(f)*	4.8	1.9	1.6	8.3
MEP system upgrades	9.2	3.6	3.0	15.7
Seismic retrofits	1.8	0.7	0.6	3.1
Subtotal	$ 49.6	$19.2	$16.1	$ 84.9
PAL 2				
Facilities *(d)*	$ 78.1	$30.2	$25.4	$133.7
Interior renovations *(e)*	3.5	1.3	1.1	5.9
Main terminal renovations *(f)*	16.8	6.5	5.4	28.7
Mechanical	5.1	2.0	1.7	8.8
Seismic	16.1	6.2	5.2	27.6
Subtotal	$119.7	$46.1	$38.9	$204.7
PAL 3				
Facilities *(d)*	$ 30.1	$11.7	$9.8	$ 51.6
Interior renovations *(e)*	12.4	4.8	4.0	21.3
Main terminal renovations *(f)*	4.0	1.5	1.3	6.9
Mechanical	9.9	3.8	3.2	16.9
Seismic	16.3	6.3	5.3	27.8
Subtotal	$ 72.7	$28.0	$23.6	$124.4
Preferred Plan Total	**$242.0**	**$93.3**	**$78.7**	**$414.0**
Preferred Long-term Vision *(g)*	**$495.9**	**$191.3**	**$161.5**	**$848.6**

(a) Costs presented in 2008 dollars.
(b) Includes markups for general conditions, contractors' fees, design and construction contingencies, and payment and performance bonds.
(c) Includes markups for project and construction management, design fees, construction administration, materials testing, and other associated services.
(d) Includes proposed FIS facility.
(e) Concourses only.
(f) Includes both facility improvements and interior renovations to the main terminal building.
(g) Includes projects included in the Preferred Plan.

Source: Connico, May 2009.

Project Title	Master Plan		
Location	Memphis International Airport		
Submittal Stage	Program		
Client Project No.		**Revision**	
Original Date	18-May-09	**Revision Date**	
Assumed Bid Opening Date		**CI Project No.**	2466.08.2
Project Manager	DLB	**Checked by**	CSG

Preferred Plan Summary

	Description			Total
	Project A-1	Northward Extension of Concourse A	*$*	*30,142,397*
	Project C-1	Northward Extension of Conourse C	*$*	*31,700,198*
	Project C-2	Concourse C Hammerhead	*$*	*33,296,595*
	FIS / Pavilion	Extend Concourse C to East with 4 Gates and Construct New FIS Facility	*$*	*44,805,674*
	Concourse Renovations		*$*	*17,989,219*
	Processor Building Renov.		*$*	*25,546,860*
	MEP Improvements - Central Plant Upgrades		*$*	*18,196,989*
	MEP Improvements - Repairs and Code Upgrades		*$*	*5,965,663*
	Seismic Upgrades		*$*	*34,239,450*
	Subtotal		***$***	***241,883,045***
8.0%	General Conditions		$	19,350,644
5.0%	General Contractor's Fee		$	13,061,684
10.0%	Design Contingency		$	27,429,537
1.0%	Payment & Performance Bonds		$	3,017,249
10.0%	Construction Contingency		$	30,474,216
0.0%	LEED Requirements		$	-
0.0%	Escalation		$	-
	Subtotal		***$***	***335,216,375***
	Owner Soft Costs			
3.0%	Project Management		$	10,056,491
6.0%	Construction Manager		$	20,112,983
0.2%	Planning and Preconstruction		$	670,433
8.0%	Architectural / Engineering Design		$	26,817,310
2.0%	Architectural / Engineering Construction Admin		$	6,704,328
1.7%	Airport Staff		$	5,698,678
1.4%	Materials Testing		$	4,693,029
0.1%	Plan Check Services		$	335,216
0.3%	Cost Estimating and Scheduling		$	1,005,649
0.5%	Other		$	1,676,082
0.3%	Artwork		$	1,005,649
	Opinion of Probable Construction Cost		***$***	***413,992,224***

Table 8 – Preferred Plan Summary

Project Title	Master Plan		
Location	Memphis International Airport		
Submittal Stage	Program		
Client Project No.		**Revision**	
Original Date	18-May-09	**Revision Date**	
Assumed Bid Opening Date		**CI Project No.**	2466.08.2
Project Manager	DLB	**Checked by**	CSG

Long Range Alternatives

	Description		Total
	Remote South Concourse	$	154,429,802
	Taxiway Reconstruction at Remote South Concourse	$	5,261,131
	Widening at Concourse B Trunk	$	23,888,770
	Infills at Southeast and Southwest Legs of Concourse B	$	17,753,019
	Moving Walkways at Concourse A and C	$	35,074,205
	Bridge Connector from Concourse A to Concourse C	$	17,537,102
	Subtotal	***$***	***253,944,029***
8.0%	General Conditions	$	20,315,522
5.0%	General Contractor's Fee	$	13,712,978
10.0%	Design Contingency	$	28,797,253
1.0%	Payment & Performance Bonds	$	3,167,698
10.0%	Construction Contingency	$	31,993,748
0.0%	LEED Requirements	$	-
0.0%	Escalation	$	-
	Subtotal	***$***	***351,931,228***
	Owner Soft Costs		
3.0%	Project Management	$	10,557,937
6.0%	Construction Manager	$	21,115,874
0.2%	Planning and Preconstruction	$	703,862
8.0%	Architectural / Engineering Design	$	28,154,498
2.0%	Architectural / Engineering Construction Admin	$	7,038,625
1.7%	Airport Staff	$	5,982,831
1.4%	Materials Testing	$	4,927,037
0.1%	Plan Check Services	$	351,931
0.3%	Cost Estimating and Scheduling	$	1,055,794
0.5%	Other	$	1,759,656
0.3%	Artwork	$	1,055,794
	Opinion of Probable Construction Cost	***$***	***434,635,066***

Table 9 – Long Range Alternatives

Appendix C

BUILDING SYSTEMS

BACKGROUND

This appendix provides an assessment of existing conditions and a summary of the approach and recommended improvements to various mechanical, electrical, and plumbing (MEP) systems within the passenger terminal complex at Memphis International Airport (the Airport).

A comprehensive assessment of the current condition, capacity, and age of MEP systems within the passenger terminal complex was prepared during Phase I of the Master Plan Update. This assessment, coupled with anecdotal information from Authority staff, concluded that several basic building systems (1) are currently operating at or above their functional capacities; (2) have components that require heavy maintenance, overhaul, or replacement; and/or (3) will restrict future additions to the building without simultaneously upgrading the capacity of the system in question.

SUMMARY OF INFRASTRUCTURE ASSESSMENT

The analysis of the MEP systems in and serving the terminal building complex was conducted to assess the respective system's age, condition, system deficiencies, ability to accommodate future demands, and building code compliance (based on BC 2004). Recommendations for equipment replacement are based on the theoretical useful life of the equipment professional judgment. The useful life is the point where the life-cycle cost of ongoing maintenance exceeds the cost of equipment replacement. The following paragraphs summarize the key findings of the assessment analysis. Detailed discussion of findings is provided in the following section.

Mechanical

Existing chilled water and hot water distribution systems are in good condition but the current connected load does not allow for any future expansions in the concourses without major upgrades to the chiller and steam plants. Three chillers, three steam boilers, and 51 air handling units are beyond the recommended service life per ASHRAE (American Society of Heating, Refrigeration, and Air Conditioning Engineers) and should to be replaced. Currently, 64 undampered gravity hoods in the roof of the Main Terminal building lobbies open the space to the exterior and prevent containment of conditioned air. The ventilation system is at system capacity and will need to be upgraded to meet current airflow rates per ASHRAE 62.1, preferably at the time of building renovation or expansion. Any new upgrades to the ventilation system should include modulating the ventilation rates based on CO_2 monitoring to reduce the required ventilation rates at each gate during unoccupied times, provide some diversity in the system, and to reduce the energy consumption of the system. The exhaust flow rates for the main banks of restrooms in Concourse A and C are not adequate, per current local codes.

Electrical

The electrical high-voltage system consists of a 100% redundant service which is in good condition. Substation 6 and switchboard CB are beyond their recommended service life and need to be replaced. The existing remaining substations are in fair condition but a majority of these have no spare breakers for future additions. Switchboard CB, Substation 6, 3 motor control centers, 8 panel boards, 117 variable frequency drives, and 2 generators are beyond their recommended service lives and should to be replaced.

Plumbing

Domestic potable water service consists of 4 meters serving the complex. Assuming a 20% simultaneous usage of all plumbing fixtures in the building, the existing pipe sizes are not adequate to supply the required pressure during peak conditions. The east sanitary service main is at 69% of capacity and the west service main is at 150% of capacity. Future additions to Concourse A would require upgrade of the west sanitary main capacity. Existing underground storm drain piping below the Main Terminal building is undersized per current building codes.

Overall Capacity Assessment

Table C-1 provides a summary of the current capacities and useful life remaining of various building systems evaluated for the Master Plan Update by area of the Main Terminal building and concourses. Estimates for each region of the terminal were developed by looking holistically at the pieces of each system that provide service to that area. The aggregate numbers presented in Table C-1, which provide a high-level overview of the findings, may not convey limitations of each specific component within the system. Detailed information on specific pieces of equipment was provided in the *Building Inventory Assessment* (September 2008), prepared by Allen & Hoshall and summarized the followings section of this appendix.

As shown in Table C-1, mechanical systems providing ventilation air for Concourses A and B are operating at 94% at 102% of their functional capacities, respectively, and are beyond the end of their useful lives. Additionally, plumbing systems providing fresh water to all parts of the passenger terminal and sewer systems in Concourse A are operating significantly above their functional capacities. Other systems, such as the electrical for Concourse C, ventilation in the terminal processor, and hot water in Concourses A and C, are all operating above 90% of their functional capacities.

Table C-1

SUMMARY OF PASSENGER TERMINAL INFRASTRUCTURE ASSESSMENT
Master Plan Update
Memphis International Airport

	Current system capacity (%) *(a)*	Useful life remaining *(b)*
Electrical System		
Terminal *(c)*	50%	5
Concourse A	60	13
Concourse B	67	13
Concourse C	94	13
Mechanical—Ventilation Air		
Terminal *(c)*	98%	15
Concourse A	94	--
Concourse B	102	--
Concourse C	102	15
Mechanical—Chilled Water		
Terminal *(c)*	88%	5
Concourse A	95	5
Concourse B	89	25
Concourse C	80	25
Central Plant	88	6
Mechanical—Hot Water		
Terminal *(c)*	85%	10
Concourse A	95	10
Concourse B	82	40
Concourse C	90	10
Central Plant	85	5
Plumbing—Domestic Water		
Terminal *(c)*	125%	15
Concourse A	125	15
Concourse B	125	15
Concourse C	125	15
Plumbing—Sanitary Sewer		
Terminal *(c)*	70%	15
Concourse A	150	15
Concourse B	70	15
Concourse C	70	15

Notes:
(a) System capacities estimated based on the performance of individual system components.
(b) Useful life remaining calculated based on accepted industry standards and professional judgement, when applicable.
(c) Terminal includes the entirety of the main terminal building at all levels.

Source: Allen & Hoshall, Inc., June 2008.

DETAILED INFRASTRUCTURE ASSESSMENT

The Main Terminal building and concourses encompass about 943,000 square feet of conditioned space. This is an increase from the 720,000 square feet recorded in 1986. The Main Terminal building is a three-story facility principally providing baggage handling and claim facilities at the Ground Level, ticketing, security checkpoint, and retail space at the Second Level, and Authority and tenant office spaces at the Mezzanine Level. The adjoining three two-story concourses provide aircraft support facilities at the Apron Level and retail and aircraft boarding facilities at the Concourse Level. A tunnel system extends under the Main Terminal and the three concourses. This tunnel system allows for the routing of mechanical, electrical and plumbing infrastructure throughout the complex. Two mechanical equipment rooms (i.e., boilers, chillers) are also in the Tunnel Level.

The assessment of infrastructure systems in the Main Terminal building and concourses was undertaken to:

1) Provide an equipment inventory of the existing systems
2) Estimate the expected remaining life of major equipment
3) Identify major equipment needing replacement
4) Determine the systems' capacity constraints
5) Compare the current mechanical system types and operating efficiencies with new higher-efficiency equipment and systems
6) Serve as a planning input to the development and evaluation of future Airport improvements.

The assessment was primarily based on review of existing plans and studies provided by the Authority, on-site facility and equipment inspections, discussions with engineering and maintenance department staff, and our past experience and familiarity with Airport facilities.

Mechanical System

The mechanical system is a four-pipe, variable-volume system. Chilled water and steam for the entire Main Terminal building and concourses is generated in two main mechanical rooms located in the Tunnel and Apron levels. Both rooms were built as part of the original construction in 1961. A major addition was constructed in 1971. Since the 1971 addition, there have been no major upgrades to existing mechanical or piping systems. The central mechanical room provides chilled water and hot water to individual air handling units, terminal units, and fan coil units located at all levels of the complex.

Cooling Plant. The existing chilled water system consists of five water-cooled chillers (WCM-1 -3, -4, -5, and -6) located in the main mechanical room in the Tunnel Level of the Main Terminal building (with the exception of chiller WCM-1 which is on the Apron Level in the CB equipment room). Chillers WCM-3, -4, and -5 were installed in 1971 and are scheduled to be replaced within the next five years. To reduce the energy consumption of the cooling plant, these three chillers should be replaced with high-efficiency units (i.e., units that each have a high Delta T). Chiller WCM-1 was replaced in 1996 and WCM-6 was replaced in 1989. Each chiller has a single constant-volume pump (PWA-1 -11, -12, and -13) with the exception of WCM-6. Chiller WCM-6 has three constant-volume primary pumps (PWA-14, -15, and -16) with PWA-16 as a standby pump. The current connected cooling load to the chiller plant is 88% of the plant capacity. Any major additions to the Main Terminal building or concourses will likely require the installation of new chillers, pumps, and cooling towers.

The five chillers are served by cooling towers CT-1, CT-East, and CT-West. The towers are located in the spaces south of the Main Terminal and north of the elevated east and west connectors providing secure passenger circulation between concourses. Tower CT-1 has a two-speed tower which was replaced in 1999, CT-East is a two-cell variable speed tower which was replaced in 2002, and CT-West is a three-cell, two-speed, and in-ground tower. CT-West was built in 1961 and will need to be replaced within the next five years.

Condenser water pumps (P-1 -2, -3, -4, -5, and -6) circulate water between the four cooling towers and five chillers. WCM-l has a plate and frame exchanger (HX-1) installed in parallel to provide free cooling in conjunction with CT-1 only. WCM-6 has a waterside bundle on the chiller and is normally connected to CT-East.

Chilled water is distributed to air handling units and fan coil units by nine variable volume chilled water pumps. Currently AHUCB 1-1, 2, CA1-4, -5, -6, and EC2-1 have three-way chilled water control valves that need to be replaced with two-way modulating control valves.

Heating Plant. The heating system consists of four gas fired steam boilers (B-1, -2, -3, and -4) located in the Tunnel Level with a combined capacity of 1,920 bhp. Boiler B-1 was upgraded from a 200 hp boiler to a 250 hp boiler in 2003. Boilers B-2, -3, and -4 are original from 1961 or 1971 and will need to be replaced within the next five years. Replacement boilers should be new high-efficiency, gas-fire units with modulating gas burners to reduce gas consumption.

Medium pressure steam is routed to 15 steam/hot water exchangers (HX-1 thru -2, HCCB-1, -2, and -3) for building heat and serving the steam domestic water heaters (DWHTC-1, -2, -3, and -4) providing potable hot water. Steam condensate is returned from each heat exchanger by condensate pumps located at each group of heat exchangers to a boiler-feed water system replaced in 2005. The existing steam traps are regularly inspected and replaced on an effective maintenance schedule.

The three heat exchangers (HCCB-1, -2, and -3) installed in 1961 were replaced in 2004 and the remaining twelve units are original from 1970.

Hot water from the heat exchangers is circulated throughout the Main Terminal building by 19 primary hot-water heating pumps. Secondary blending pumps located in the tunnel, apron, and concourse levels supply hot water to associated variable volume terminal units, fan coil units, air-handling units, and baseboard heaters. The blending pumps regulate water temperature by mixing the hot water primary supply and return temperatures to maintain desired overall system loop temperature.

Mechanical System – Main Terminal Building. The mechanical system equipment serving the Main Terminal building consists of:

- Five constant-volume air handling units (AHUEAB-1, -2, -3, -4, and -5) located in the Tunnel Level

- Nine variable-volume air handling units (AHU-CB-6, 1-1, 1-2, 1-5, 1-6, 2-1, EA2-2, WA2-1, and WA2-2)

- Eight constant-volume units (AHU-CA-1, 2, 3, CB2-4, EA1 -1, 1-2, WA1-1, and WA1-2) located on the Apron Level

- 14 variable-volume air handling units (AHU-CA2-1, CB1-3, 2-2, 2-3, 3-2, EA2-1, 3-2, EC2-2, 2-3, WA3-1, WC2-1,2-2, 2-3, and 2-5)

- One constant-volume unit (AHU-WC2-6) located on the Concourse Level

- 11 variable-volume air handling units (AHU-CA-12, -13, -14, -15,-16, -17-20, CB-18, -19, 3-1, and EA3-3) located on the Mezzanine Level

Each air handling unit is provided with preconditioned outside air from a variable-volume 100% outside-air unit (OSA-1, -2, -3, or -4) located in the Tunnel and Apron Levels. Outside air for each AHU is controlled by a terminal unit interlocked with its respective supply fan. Currently, the outside-air terminal coils do not modulate the ventilation air based upon space occupancy. Each variable-volume air handling unit provides conditioned air to variable volume terminal units with hot water heating controls based on input from pneumatic zone thermostats.

Mechanical System – Concourses. The mechanical system equipment serving the three concourses consists of the following major components:

Concourse A

- Twelve variable volume air handling units (AHU-ED-1, 2, EE-1, 2, EF-1, 2, EO-2, EH-2, EI-1, 2, and EJ-1, 2) located in the Tunnel Level

- One constant-volume air handling unit (AHU-Carpentry)

- One variable-volume air handling unit (AHU-ED-3) located on the Apron Level

- One variable-volume air handling unit (AHU-EC2-4) located on the Concourse Level boarding level

Concourse B

- Six variable volume air handling units (AHU-CL1-1, 2, CK1-1-2, 2-1, and 2-2) located in the Tunnel Level

- 16 variable-volume air handling units (AHU-CC-2, CD-1, -2, -3, 1-3, CE-2, CF-2, CG-2, CG-5, CG-6 CG-7, CH -1, 1-2, CJ1 -1, 1-2, and CK2-3)

- Five constant-volume units (AHU CC-1, 1-3, CG-1, CH-1, CG-4, and CE- 1) located on the Apron Level

- Eight variable-volume air handling units (AHU-CH2-1, 2-2, 02-1, 2-2, CL1-2, 2-1, 2-2, and 2-3) located on the Concourse Level

Concourse C

- 16 variable volume air handling units (AHU-WD-1, 2, WE-1, 2, WF-2, WG-2, WH-1, 2, WI-1 2, WJ-1, 2, WK-1, 2, RJ-2E, and 2W) located on the Tunnel Level

- Three variable-volume air handling units (AHU-RJ-1E, 1W, and AHUCW2-4) located on the Apron Level

As in the Main Terminal, each concourse air handling unit is provided with preconditioned outside air from a variable-volume 100% outside-air unit (OSA-2) located in the mechanical room in the Tunnel Level. Outside air for each AHU is controlled by a terminal unit interlocked with its respective supply fan. Currently, the outside-air terminal coils do not modulate the ventilation air based upon space occupancy. Each variable-volume air handling unit provides conditioned air to variable volume terminal units with hot water heating controls based on input from pneumatic zone thermostats.

Electrical

High Voltage Distribution. The local utility company currently provides two primary 15 kV circuits to a point on the Airport's west property line near Airways Boulevard. One circuit is the preferred source of power and the other is considered as an alternate in case the primary is lost. The Airport is currently in the process of replacing the primary service switchgear and adding enough generator capacity to carry the entire load of the Airport. The primary service switchgear has two output feeder sections that feed two separate pieces of main distribution switchgear located in the Main Terminal building.

The two pieces of main distribution switchgear in the building are labeled as HV Switchgear #1 and HV Switchgear #2. These two pieces of switchgear are connected together through a switch that can be closed in the event that one of the feeds to the Main Terminal building and concourses is lost.

Emanating from each of the main distribution switchgear is a loop feed. These feeders run throughout the complex to secondary unit substations 1 through 13. Each secondary unit substation includes a primary selector switch, one (or more) transformers, and the secondary distribution equipment.

Equipment at the west Airport property line is being upgraded and is, thus, considered to be in excellent condition. High Voltage equipment in the Main Terminal building is in good condition.

The Airport's ability to carry the peak load at any time is adequate and is only approximately 45% loaded at the worst case peak load. However the ability to carry the entire peak load on only one of the "redundant" primary feeders has been diminished within the last eight years with additional loads that have been added to the overall system. The smaller of the two primary feeders is capable of carrying 500 amperes. At the worst case, peak load is approximately 493 amperes. This leaves a 6% overload on the 500-amp circuit in the event that the larger of the two primary feeders is lost. Essentially during a peak load power outage, the 500-amp circuit could not carry the entire load. The Airport would have to shed some of the load to use only the smaller of these two feeds.

The planned new parking garage project is expected to remove substations #8, #9, #9A, #10 and #11 from the existing electrical system and connect to a new primary feeder from the local utility company. This change would increase the spare capacity on the main feeders from the West property switchgear by 10%, but only allows 4% of expansion while maintaining the redundancy the Authority requires.

Secondary High Voltage Distribution Substations. Each unit substation has a 480 output section, except #5A, that feeds multiple panels and 120/208 volt step-down transformers throughout the terminal complex. Substation #5A is unique in that it has a 120/208 volt output that feeds 120/208 volt loads in the southerly portions of Concourse B.

The original 1961 construction included substations #6 (later relocated), #10 and #11. The additions built in 1971 and 1979 included substations #1, #2, #3, #5, #4, #7 and #8. The additions built in 1983 and 1989 included substations #9 and #9A. The addition of the regional jet facility at the southern end of Concourse A in 2000 included substation #13. The renovation of the Concourse B rotunda in 2004 included addition of substation #5A. The parking lot and road construction projects in 2005 and 2007 added substations #9B, Parking Lot E and Exit Road LC.

Substation 1

The original transformer for Substation 1 was installed in the original 1961 building by the local utility company and was relocated. A second transformer was installed in the 1971 renovation project by the local utility company. The current configuration includes two switchboards fed by 2-1,500A bus ducts (each) from two 3,000 KVA oil-filled transformers. The switchboards are owned by the Authority and the substation transformers are owned by the utility company. The two switchboards are referred to as Substation #1, Switchboard WA and CB North and South. Switchboard WA rated for 3,000 Amps and Switchboard CB North and South combined are rated for 3,000 Amps.

Switchboard WA is in fair condition and should be replaced within the next 13 years. Switchboard CR North and South are in poor condition and should be replaced this year. The current National Electrical Code requires ground fault protection on breakers 1,200 amps and greater. Neither switchboard has a Ground Fault Protection main breaker. The current code requires six-foot clear space in front of the switchboard. Switchboards WA and CB do not meet the current code requirements.

Substation 2

Substation 2 was installed in the 1971 renovation project. This is a Westinghouse packaged unit substation with a single 1,500 KVA dry-type transformer. The switchboard for this unit is rated at 1800 amps. This unit is in fair condition and should be replaced within the next 13 years. The current National Electrical Code requires a ground fault protection on breakers 1,000 amps and greater. This unit does not have a Ground Fault Protection main breaker.

Substation 3

Substation 3 was installed in the 1971 renovation project. This is a Westinghouse packaged Unit Substation with a single 1,500 KVA dry-type transformer. The switchboard for this unit is rated at 1,800 amps. This unit is in fair condition and should be replaced within the next 13 years. The current National Electrical Code requires a ground fault protection on breakers 1,000 amps and greater. This unit does not have a Ground Fault Protection main breaker.

Substation 4

Substation 4 was installed in the 1971 renovation project. This is a Westinghouse packaged unit substation with a single 1,500 KVA dry-type transformer. The switchboard for this unit is rated at 1,800 Amps. The Airport replaced the transformer core in 1983 after a partial failure, but did not replace the entire switchboard. This unit is in fair condition and should be replaced within the next three years. The current National Electrical Code requires a ground fault protection on breakers 1,000 amps and greater. This unit does not have a Ground Fault Protection main breaker.

Substation 5

Substation 5 was installed in the 1971 renovation project. This is a Westinghouse packaged unit substation with a single 1,000 KVA dry-type transformer. The switchboard for this unit is rated at 1,200 amps. This unit is in fair condition and should be replaced and the room should be expanded within the next three years. The current National Electrical Code requires a ground fault protection on breakers 1,000 amps and greater. This unit does not have a Ground Fault Protection main breaker. The current code requires a six-foot clear space in front of the switchboard and either a clear path of egress from the front of the board, or a door at both ends of the room. This substation is located in a room that does not meet the current code requirements.

Substation 5A

Substation 5A was installed in the 2004 renovation to the Concourse B rotunda project. This is a Cutler-Hammer packaged unit substation with a single 500 KVA dry-type transformer. The switchboard for this unit is rated at 1,600 amps. This unit is in excellent condition and has no known code issues.

Substation 6

Substation 6 was originally installed in the initial construction project in 1961 and was relocated in 1971. This is a Westinghouse packaged unit substation with a single 1,000 KVA dry-type transformer. The switchboard for this unit is rated at 1,200 amps. This unit is in poor condition and has reached the end of its recommended service life and should be replaced this year. The current National Electrical Code requires a ground fault protection on breakers rated 1,000 amps and greater. This unit does not have a Ground Fault Protection main breaker. The current code requires a six-foot clear space in front of the switchboard and either a clear path of egress in front of the board, or a door at both ends of the room. This substation is in a room that does not meet the current code requirements.

Substation 7

Substation 7 was installed in 1971. This is a Westinghouse packaged unit substation with a single 1,000 KVA dry-type transformer. The switchboard for this unit is rated at 1,200 amps. This unit should be replaced within the next 13 years. The current National Electrical Code requires a ground fault protection on breakers rated 1,000 amps and greater. This unit does not have a Ground Fault Protection main breaker. The current code requires a six-foot clear space in front of the switchboard and either a clear path of egress from the board, or a door at both ends of the room. This substation is in a room that does not meet the current code requirements.

Substation 13

Substation 13 was built in concert with the 2000 Commuter Facility project at the south end of Concourse A. This is a General Electric packaged unit substation with a single 2,500 KVA dry-type transformer. The switchboard for this unit is rated at 3000 amps. This substation is relatively and has no known deficiencies.

Assessment of Entire Substation System

The original output breaker sections in many of the substations were not large enough to handle subsequent building renovations and additions. Therefore, a large number of the panel buses have been tapped multiple times and either fused disconnects or enclosed circuit breakers are used to feed other loads. This does not diminish the life of the equipment, but additional space will need to be provided to the replacement for each. Additional cooling or ventilation should also be considered to prevent overload heat related failures.

Switchboards CB North and South and Substation 6 are in poor condition, have reached the end of their recommended service life, and should be replaced this year.

Secondary Distribution Motor Control Centers. There are ten motor control centers (MCC) in the Main Terminal building and concourses. Eight of the MCCs are in the tunnels and two are located on the Apron Level. Two of the MCCs (MCC-CB North and MCC-CB South) were manufactured by General Electric and installed in 1971.

Visual inspection indicates multiple revisions and some failures to the starter motors have occurred. Smoke stains on the exterior of some buckets indicate arcing has taken place. Some of the starters appear to be original equipment and should be replaced as a direct result of age. Code compliance is also noted as being an issue with some of the centers and some relocation will be required to meet access/egress requirements. Replacement of the centers will be required within 13 years, except for MCC-E2 (as soon as feasible), and MCC-CB-1 and MCC-CB-2 (within three years).

Secondary Distribution Panel boards. There are multiple panel boards and transformers located on each level of the Main Terminal building and concourses. Most of the distribution panel boards are located in the Tunnel Level and most of the branch circuit panel boards are located on the Apron Level. Some of the panel boards are located on the remaining levels. The panel boards in Concourse B have an estimated remaining life of three years or less and should be replaced. Remaining panel boards require monitoring.

Generators. There are seven generators located throughout the Main Terminal building and concourses. The units are located in the tunnels, inside the building, and some are located outside at the Apron Level. Assessment of these generators indicates that the generator at the Concourse B rotunda should be replaced as soon as feasible. Its motor has already been replaced and it is again showing signs of malfunction. The three generators in the Tunnel Level of Terminals A and C and at the Ground Level of Terminal A will need to be replaced within ten years (six, nine, and five years, respectively). The remaining two generators in Concourse B and the unit at the Ground Level of Terminal A will need to be replaced in 10 to 15 years (12, 14, and 15 years, respectively).

Variable Frequency Drives (VFD). There are multiple VFDs located throughout each level of the Main Terminal building and concourses. Authority staff has evaluated each of the VFDs and is presently compiling projected required replacement dates and associated costs. In summary, the vast majority of units needs to be replaced within the next five years.

Plumbing

Water Service. The local utility company provides four water service entrances into the Main Terminal building and concourses:

- Entrances 1 and 2 are located under the Main Terminal building. Both are four-inch mains with dual six-inch reduced pressure backflow preventers
- Entrance 3 is located under the southeast leg of Concourse B and is a six-inch main with dual six-inch reduced pressure backflow preventers
- Entrance 4 is located under the regional jet facility at the south end of Concourse A and is a six-inch main with dual four-inch reduced pressure backflow preventers

The four service points are interconnected by a distribution system in the Tunnel Level. In all four cases, the water main immediately downstream of the backflow preventer is six inches in diameter.

There are two approaches to determining the total water load on a given building. The first is the "fixture units" method which yields a total water flow demand of 1,319 gpm. The second is an analysis of peak water demand based on an assumption of 20% simultaneous usage of all plumbing fixtures plus the cooling tower load, which yields a total water flow of 3,691 gpm. Based on these two numbers, the four service entrances are adequate to supply the volume of water required but not at the pressure required during peak load conditions. However, the upgrades to the cold water mains outlined below will be required to reduce the low pressure occurrences that the facility currently experiences.

Cold Water System. The overall condition of the domestic cold water piping is good and there are no visible code violations. Due to numerous expansion projects which resulted in the addition of plumbing fixtures, the domestic water infrastructure has been upgraded numerous times. Even with those upgrades, the facility occasionally experiences pressure losses that contribute to problems with flush valves at water closets and urinals. Given the existing infrastructure and the erratic peak load patterns, there is no guaranteed solution to the pressure losses in the system. However, there are several upgrades that would reduce the pressure losses in the existing system:

– Extend the six-inch cold water main extension 900 feet along the Concourse B connector to Water Entrance 1. Replacing the existing four-inch line with a six-inch line will reduce the average pressure losses in this pipe section by a minimum of 50%

– Extend the six-inch cold water main 550 feet from the regional jet facility at the south end of Concourse A to the five-inch main from Water Entrance 1. Replacing the existing three-inch and four-inch lines with a six-inch line will reduce the average pressure losses in this pipe section by a minimum of 50-75%

– Replace the eight existing Watts 909 backflow preventers with six-inch Watts 957 backflow preventers. This will reduce the pressure loss at a rated flow of 675 gpm by three psi at water entrances 1, 2, and 3 and by six psi at water entrance 4.

– Increase the meter size at water entrance 4 from the existing three-inch turbine meter to a four-inch turbine meter. This will increase the available continuous flow from that meter from 450 gpm to 1,000 gpm.

Hot Water System. The domestic hot water system is comprised of three subsystems: System 1 is a circulated system serving fixtures in the Main Terminal building and Concourse B. The two steam water healers in System 1, installed in 1961 and 1971, are both 1,600-gallon storage tanks with a recovery of 1,500 gph at 100 degree rise. System 2 is a circulated system serving fixtures in Concourse C. The steam water heater in System 2, installed in 1971, is a 275-gallon storage tank with a recovery of 300 gph at 100 degree rise. System 3 is a circulated system serving fixtures in Concourse A. System 3 has two steam water heaters. The first was installed in 1971 and is a 275-gallon storage tank with a recovery of 300 gph at 100 degree rise. The second was installed in 2000 and is a 250-gallon storage lank with a recovery of 335 gph at 100 degree rise.

The domestic hot and hot water return piping are in satisfactory condition. However there is noticeable corrosion of the piping around the water heaters in Concourses A and C. Water heaters WH-1, -2, -3 and -4 are original to the building and are past their recommended service life per ASHRAE. During the regional jet facility expansion in 2000 on Concourse A, WH-5 was added to increase the hot water capacity in Concourse A. There is a current project to replace WH-1 and WH-2 later this year. The water heater serving Concourses A and C (WH-3) should be replaced with two water heaters to provide a redundant unit and avoid any down time of the system. WH-4 and WH-5 serve Concourse A in parallel. However, should WH-4 go out of service, WH-5 would not be able to handle 100% of the load in Concourse A.

The demand on the hot water system serving the Main Terminal building and Concourse B (System 1) is well below capacity due to the closure of the in-terminal hotel facilities. System 1 heaters will be replaced soon and a new hot water load analysis should be performed before any additions are made to that system. Both hot water Systems 2 and 3 are operating within their theoretical capacities; however, System 2 (Concourse C) is within 10% of its maximum calculated load capacity. The capacity of System 2 should be increased prior to future expansion occurs.

Restaurant facilities within the Main Terminal building and concourses provide their own hot water and these loads were not calculated in the assessment of the overall hot water system.

Sanitary Waste System. The interior sanitary waste water system is comprised entirely of cast iron piping most of which is of "hub and spigot". "No-hub" piping is used in areas that have been added, renovated, or repaired in the last 15 to 20 years. The sanitary piping on the Apron and Concourse Levels is routed from the tunnels and maintenance areas to the exterior of the building where it is collected into mains. The two site sewer mains drain to the north and are routed along the west side of Concourse A (eight-inch) and the east side of Concourse C (ten-inch). Once past the parking garage, the two mains combine and are routed to the city sewer system.

The interior waste-system piping is in satisfactory condition. The condition of the underground piping has not been investigated, but there have been repairs made to the piping installed in 1961. These repairs suggest that the underground sanitary piping is deteriorating. A complete investigation of the underground sanitary system with a pipe camera should be completed before any commitments to specific long term expansion plans are made.

The two sanitary site mains serve either the east half or the west half of the Main Terminal building and concourses. The east main starts as an eight-inch line along the east side of Concourse B, collects the sanitary waste from the east portion of the Main Terminal building, increases to a ten-inch line and collects the sanitary waste from Concourse C. The load on this ten-inch main is 1,993 drainage fixture units. A ten-inch sanitary drain with 1% slope has a capacity of 2,900 drainage fixture units, so the east sanitary main is at 69% of capacity. The west main starts as an eight-inch line along west side of Concourse B, collects the sanitary waste for the west portion of the Main Terminal building and collects the sanitary waste from Concourse A. The load on the eight-inch main line is 2,411 drainage fixture units. An eight-inch sanitary drain with 1% slope has a capacity of 1,600 drainage fixture units, so the east sanitary main is at 150% of capacity.

There is expansion capacity on the east side of Main Terminal building and concourses, as well as Concourse C. There is no room for any expansion on the west side. The assessment suggests that the eight-inch sanitary main along Concourse A be replaced with a ten-inch line before major additions are built.

Roof Drainage System. Storm system piping from the roof drainage is installed in the same manner as the sanitary piping, exclusively cast iron with a mix of hub and spigot and no-hub. The interior storm drains are collected and routed to storm inlets outside of the building.

The interior piping is in satisfactory condition. The condition of the underground piping has not been investigated, but there is evidence (floor and wall failures near downspouts) that suggest the underground storm drain system is deteriorating. Inspection with a pipe camera is recommended.

Per the International Plumbing Code, the hourly Airport rain load is calculated to be 3.75 inches. The placement and size of roof drains at the Main Terminal building and concourses is adequate to handle the calculated rain load. However, the collection of roof drains beneath the Main Terminal is inadequate. The roof drains collect an average area of 1,760 square feet, requiring four-inch drains (existing). Two roof drains require five-inch drains, which is also met by existing conditions. However, once there are three or more drains collected underground, the system is consistently one pipe size too small. The undersized piping coupled with possible serious deterioration suggests that full replacement of the underground system may be advisable in the near future.

RECOMMENDED INFRASTRUCTURE IMPROVEMENTS

Figures C-1, C-2, and C-3 illustrate the improvements to existing infrastructure that will be required to address age, condition, and capacity issues as described in the preceding sections. These recommended improvements have been arranged to coincide with the planning activity level "triggers" used in the Airport's Master Plan Update. Table C-2 presents estimated costs for the recommended improvements, stated in 2008 dollars.

PREFERRED PLAN

In addition to the recommended improvements described in the preceding sections, which reflect needed investment to maintain existing MEP system integrity, substantial infrastructure upgrades and expansions will be required to support facility expansions triggered by increases in aviation activity at the Airport. A description of these improvements has been integrated in discussion of the preferred plan and preferred long-term vision presented in other sections of this report, including Appendix B – Cost Estimates.

Table C-2

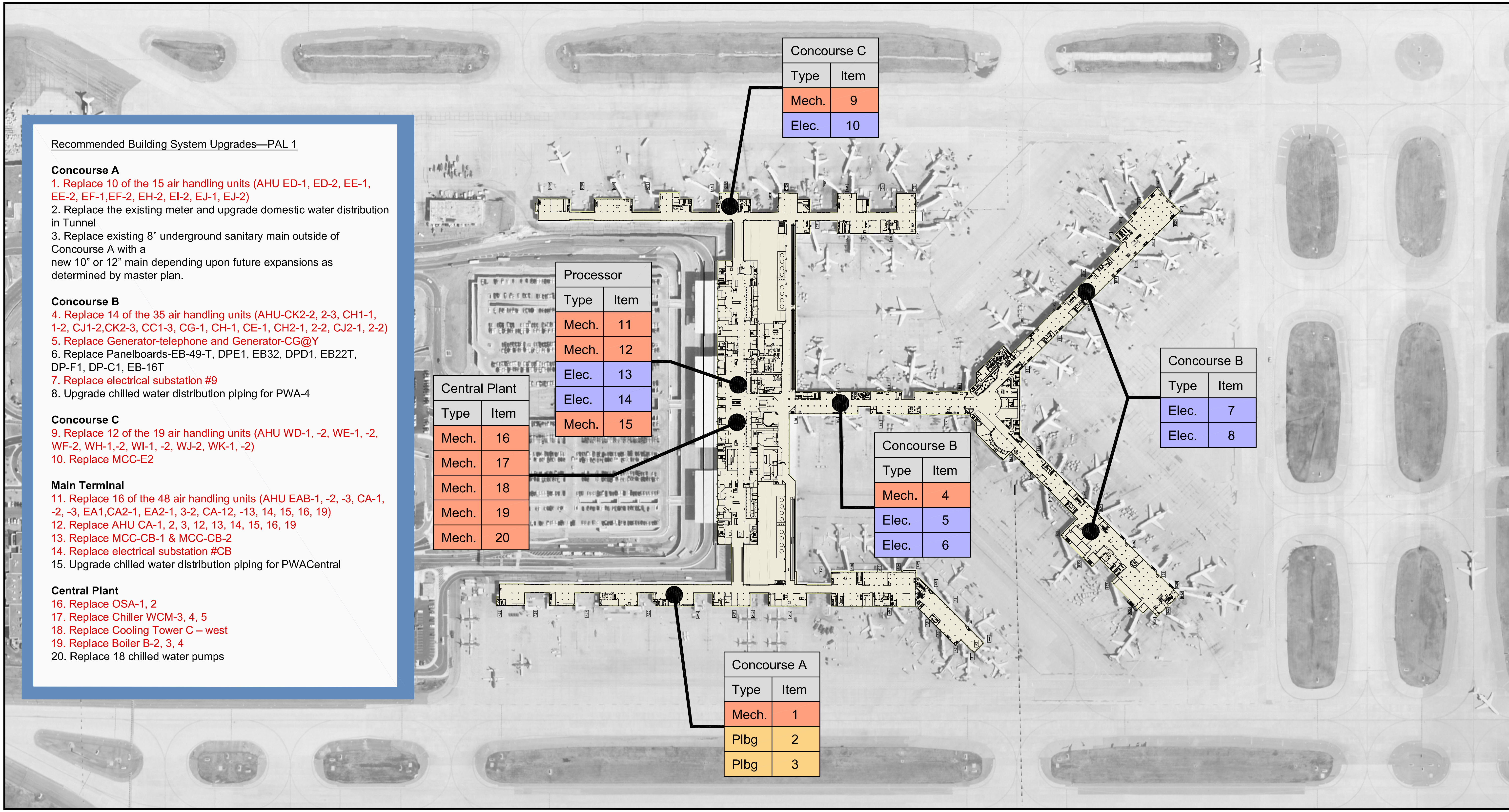
RECOMMENDED INFRASTRUCTURE IMPROVEMENTS
Master Plan Update
Memphis International Airport

Project	Location	Description	Cost
PAL 1			
1	Concourse A	Replace 10 of the 15 air handling units (AHU ED-1, ED-2, EE-1, EE-2, EF-1, EF-2, EH-2, EI-2, EJ-1, EJ-2)	$ 640,000
2	Concourse A	Replace the existing meter and upgrade domestic water distribution in tunnel	150,000
3	Concourse A	Replace existing 8" underground sanitary main outside of Concourse A with a new 10" or 12" main depending on future expansions	750,000
4	Concourse B	Replace 14 of the 35 air handling units (AHU-CK2-2, 2-3, CH1-1, 1-2, CJ1-2, CK2-3, CC1-3, CG-1, CH-1, CE-1, CH2-1, 2-2, CJ2-1, 2-2)	788,500
5	Concourse B	Replace generator-telephone and generator-CG@Y	60,000
6	Concourse B	Replace panel boards EB-49-T, DPE1, EB32, DPD1, EB22T, DP-F1, DP-C1, EB-16T	31,000
7	Concourse B	Replace electrical substation #9	300,000
8	Concourse B	Upgrade chilled water distribution piping for PWA-4	410,000
9	Concourse C	Replace 12 of the 19 air handling units (AHU WD-1, -2, WE-1, -2, WF-2, WH-1, -2, WJ-2, WK-1, -2)	727,500
10	Concourse C	Replace MCC-E2	50,000
11	Main Terminal	Replace 16 of the 48 air handling units (AHU EAB-1, -2, -3, CA-1, -2, -3, EA1, CA2-1, EA2-1, 3-2, CA-12, -13, -14, -15, -16, -19)	131,000
12	Main Terminal	Replace AHU CA-1, 2, 3, 12, 13, 14, 15, 16, 19	253,000
13	Main Terminal	Replace MCC-CB-1 and MCC-CB-2	164,000
14	Main Terminal	Replace electrical substation #CB	154,000
15	Main Terminal	Upgrade chilled water distribution piping for PWA Central	422,000
16	Central Plant	Replace OSA-1, 2	560,000
17	Central Plant	Replace chiller WCM-3, 4, 5	2,400,000
18	Central Plant	Replace cooling tower C-west	250,000
19	Central Plant	Replace boiler B-2, 3, 4	625,000
20	Central Plant	Replace 18 chilled water pumps	432,000
	Subtotal		**$ 9,298,000**
PAL 2			
21	Concourse A	Replace AHU WK-1	$ 70,000
22	Concourse A	Replace electrical switchboard WA	480,000
23	Concourse B	Replace air handling units AHU-CA1-4, CA1-5, CA1-6, CB1-1, CB1-2, CB1-3, CB2-3, CJ1-2, CK2-3	275,000

Table C-2 *(page 2 of 2)*
SUMMARY OF BUILDING SYSTEM UPGRADES INCLUDED IN PREFERRED PLAN
Master Plan Update
Memphis International Airport

Project	Location	Description	Cost
PAL 2 (continued)			
24	Concourse B	Replace domestic water heater 1, 2	75,000
25	Main Terminal	Replace underground storm drain piping in main lobby	750,000
26	Central Plant	Replace 12 steam to hot water heat exchangers	1,500,000
27	Central Plant	Upgrade building energy management system in central plant from pneumatic controls to DDC controls	2,000,000
	Subtotal		**$ 5,150,000**
PAL 3			
28	Concourse A	Replace motor control center MCC-W2 and W3	$ 300,000
29	Concourse A	Replace electrical generator CB	100,000
30	Concourse A	Replace 250 variable volume terminal units and related controls	950,000
31	Concourse B	Replace electrical HV substation 5 and 7	800,000
32	Concourse B	Replace motor control center MCC-SE-Y, MCC-SW-Y, and MCC-W1	770,000
33	Concourse B	Replace electrical generator ACC	100,000
34	Concourse B	Replace 350 variable volume terminal units and related controls	1,350,000
35	Concourse C	Replace electrical HV substation 3	400,000
36	Concourse C	Replace motor control center MCC-E1 and 3	610,000
37	Concourse C	Replace electrical generator EA	100,000
38	Concourse C	Replace 250 variable volume terminal units and related controls	950,000
39	Main Terminal	Replace electrical generator WA	100,000
40	Main Terminal	Complete underground storm drain replacement	1,000,000
41	Main Terminal	Replace 150 variable volume terminal units and related controls	500,000
42	Central Plant	Replace electrical HV substation 2	350,000
43	Central Plant	Replace water cooled chiller WCM-6 and related primary pumps	1,500,000
	Subtotal		**$ 9,880,000**
	Total		**$24,328,000**

Source: Allen & Hoshall, May 2009.



Recommended Building System Upgrades—PAL 1

Concourse A

1. Replace 10 of the 15 air handling units (AHU ED-1, ED-2, EE-1, EE-2, EF-1,EF-2, EH-2, EI-2, EJ-1, EJ-2)
2. Replace the existing meter and upgrade domestic water distribution in Tunnel
3. Replace existing 8" underground sanitary main outside of Concourse A with a new 10" or 12" main depending upon future expansions as determined by master plan.

Concourse B

4. Replace 14 of the 35 air handling units (AHU-CK2-2, 2-3, CH1-1, 1-2, CJ1-2,CK2-3, CC1-3, CG-1, CH-1, CE-1, CH2-1, 2-2, CJ2-1, 2-2)
5. Replace Generator-telephone and Generator-CG@Y
6. Replace Panelboards-EB-49-T, DPE1, EB32, DPD1, EB22T, DP-F1, DP-C1, EB-16T
7. Replace electrical substation #9
8. Upgrade chilled water distribution piping for PWA-4

Concourse C

9. Replace 12 of the 19 air handling units (AHU WD-1, -2, WE-1, -2, WF-2, WH-1,-2, WI-1, -2, WJ-2, WK-1, -2)
10. Replace MCC-E2

Main Terminal

11. Replace 16 of the 48 air handling units (AHU EAB-1, -2, -3, CA-1, -2, -3, EA1,CA2-1, EA2-1, 3-2, CA-12, -13, 14, 15, 16, 19)
12. Replace AHU CA-1, 2, 3, 12, 13, 14, 15, 16, 19
13. Replace MCC-CB-1 & MCC-CB-2
14. Replace electrical substation #CB
15. Upgrade chilled water distribution piping for PWACentral

Central Plant

16. Replace OSA-1, 2
17. Replace Chiller WCM-3, 4, 5
18. Replace Cooling Tower C – west
19. Replace Boiler B-2, 3, 4
20. Replace 18 chilled water pumps

Note: Red text denotes upgrades included in the Authority's Capital Outlay Program.

Source: Allen & Hoshall, in conjunction with materials provided by the Memphis-Shelby County Airport Authority.

N

0 150 300 600
Graphic Scale in Feet

Figure C-1
BUILDING SYSTEM UPGRADES—PAL 1

Master Plan Update
Memphis International Airport
November 2009

JACOBS CONSULTANCY

Source: Allen & Hoshall, in conjunction with materials provided by the Memphis-Shelby County Airport Authority.

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Graphic Scale in Feet

Figure C-2
BUILDING SYSTEM UPGRADES—PAL 2

Master Plan Update
Memphis International Airport
November 2009

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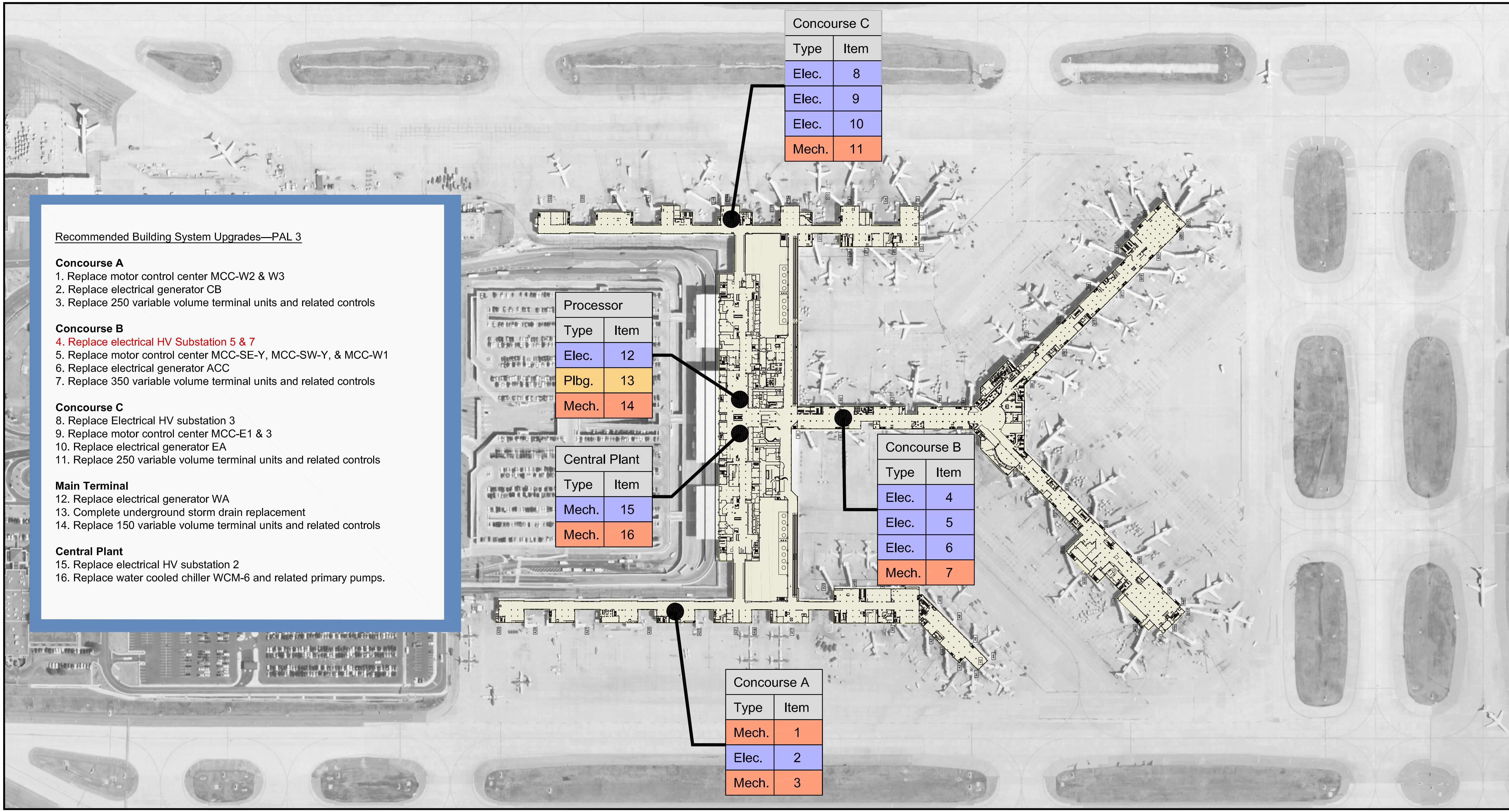

Note: Red text denotes upgrades included in the Authority's Capital Outlay Program.

Source: Allen & Hoshall, in conjunction with materials provided by the Memphis-Shelby County Airport Authority.

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Graphic Scale in Feet

Figure C-3
BUILDING SYSTEM UPGRADES—PAL 3

Master Plan Update
Memphis International Airport
November 2009

JACOBS CONSULTANCY

Appendix D

SEISMIC RETROFITS

Thornton Tomasetti
Building Solutions

Project

Memphis International Airport
Terminal Development Alternatives
Seismic Upgrades

Prepared For

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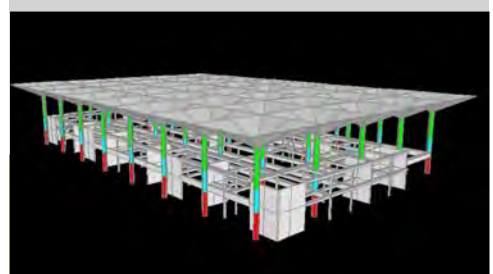

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Revision 1
December 2, 2009

Thornton Tomasetti

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ATTACHMENTS

1.0 INTRODUCTION

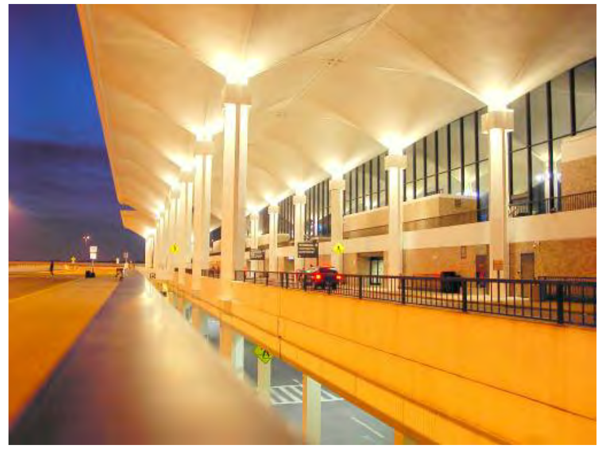


Fig. 1-1 North side of the Main Terminal Building Showing Columns and Roof Structure

Consideration of potential seismic retrofit measures was performed as part of the *Terminal Development Alternatives* project in Phase 2. Potential retrofit concepts were developed further from the Phase 1 Seismic Risk Assessment completed by Thornton Tomasetti during 2008 and tie into the current Master Planning project being led by Jacobs Consultancy.

The purpose of this part of the study was to:

- Develop recommendations for seismic upgrades of the structural and nonstructural components in the Terminal and Concourses.
- Co-ordinate these upgrades with other components of the Master Plan and develop phasing recommendations for implementation of the seismic upgrades
- Develop cost estimates (by Connico as part of the Master Planning Team) for the recommended upgrades.

Upgrading the seismic resistance of existing buildings is typically completed either as a mandatory requirement of the local building authority, or voluntarily by an owner who wishes to improve the performance of the building/facility and reduce damage, downtime or business interruption in the event of an earthquake.

Mandatory seismic upgrades are typically required when significant changes are made to an existing building that increase the weight supported by the building, reduce the earthquake-resisting capacity of the building, or alter the occupancy within the building. When one or more of these occurs, upgrade of the seismic resisting system to the current building code is normally required. In Memphis this will currently mean upgrading to the seismic provisions in the IBC 2006[2]. However, for the work proposed in the MEM master plan, the only part of the terminal where we anticipate this mandatory upgrade requirement would be triggered is the area of Concourse C underneath the proposed new FIS facility.

For the remainder of the terminal, it is unlikely that mandatory seismic retrofit of the existing structure will be triggered by any of the work in the proposed master plan. However, voluntary upgrades are recommended to most parts of the existing building, to address key vulnerabilities and reduce the seismic risk. Because these retrofit measures are voluntary, there is no “code” that has to be met. Instead, we recommend that the retrofits be designed to meet the “Basic Safety” performance objective as described in ASCE41-06[3]. This level is similar to retrofitting to 75% of the current code requirements which is another target commonly used for voluntary retrofit.

Benefit Cost Analysis (BCA) is a useful tool for helping decide to what extent retrofits should be performed. The cost of the retrofit work can be estimated and compared to the monetary

Thornton Tomasetti

savings resulting from reduced damage, downtime and personal injury that are expected following an earthquake. A BCA analysis has been completed for the seismic retrofit options at Memphis International Airport and is included as part of the Phase 2 Seismic Risk Assessment Report[7]. The BCA generally confirms that the "Basic Safety" performance objective is a reasonable target for voluntary seismic retrofit of the MEM terminal structures.

Seismic retrofits generally require the main structural elements (beams, columns, foundations) and non structural elements (equipment and linear pipe runs) to be accessed and strengthened; as a result the work can be disruptive requiring finishes to be removed and replaced. Phasing the voluntary seismic retrofit work with other Master Planning renovations is normally most efficient, to achieve economies with the replacement of architectural finishes and upgrade of building services. There are exceptions such as safety issues associated with the water and gas in the tunnels, and "no brainer" retrofits associated with anchorage and/or bracing of key communications, IS and electrical equipment, which we recommend be addressed in the near future, rather than waiting for Master Plan renovation work.

2.0 BUILDING ASSESSMENT

The main areas of the Terminal ("Processor") and Concourses at Memphis International Airport (MEM) and the year in which each main area was built are shown in Figure 2-1. The majority of the building areas were constructed before seismic design was required in the Memphis area.

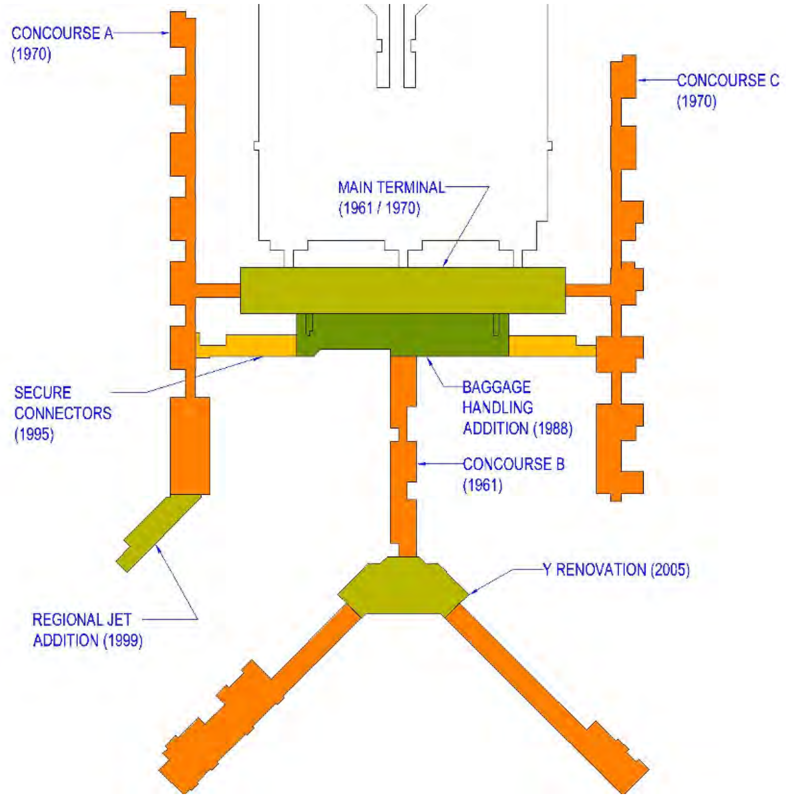


Fig. 2-1 Terminal Building Plan and Vintages of Main Areas

During Phase 1 of this study the main building areas were evaluated using ASCE 31[1] Tier 1 procedures for four different hazard levels:

Table 2-1: Seismic Ground Motions used in the Phase 1 MEM Seismic Risk Assessment

Earthquake Level (1)	Probabilistic Ground Motions (2)				Representative Scenario (Site Class D)			
	Return Period	PGA	0.2s	1.0s	Event	PGA	0.2s	1.0s
Moderate	225 yr (20% in 50 yrs)	0.11	0.22	0.07	M6.2 at Marked Tree	0.11	0.22	0.07
Large	475 yr (10% in 50 yrs)	0.26	0.53	0.19	M7.0 at MT	0.23	0.47	0.18
Major (3)	975 yr (5% in 50 yrs)	0.42	0.80	0.35	M7.7 at MT	0.37	0.76	0.34
Severe	2475 yr (2% in 50 yrs)	0.61	1.13	0.56	N/A (4)			

Notes to Table 2-1:

Note 1: The "Moderate, Large, Major and Severe" names were chosen for this project and are intended to represent a reasonable range of possible earthquake levels.

Note 2: Based on USGS 2002 probabilistic ground motions, as referenced in IBC 2006.
Site Class D was selected as representative of the MEM site.

Note 3: The "Major" earthquake level is approximately equivalent to that used in the ASCE31 evaluations (ASCE31 uses 2/3 of the 2475-year ground motions; however as can be seen above 2/3 of the "Severe" ground motions is similar to the "Major" motions).

Note 4: This earthquake level does not have a single representative event, rather it accounts for statistical uncertainty in the level of ground shaking experienced at any given location for any given earthquake, as well as the possibility of earthquakes on previously unknown faults.

2.1 Vulnerability

The seismic vulnerabilities identified in Phase 1 and further investigated by performing more detailed analysis in Phase 2 are briefly summarized below:

Main Terminal (Processor) Building

- The 1 inch wide expansion joints located throughout the terminal structure and at the interfaces with the surrounding structures were provided to accommodate thermal movements. These expansion joints seismically disconnect the different areas of the structure, but not with sufficient gap to enable independent movement. These narrow gaps have many consequences, including "pounding" of the structures in an earthquake. This pounding will result in increased damage and potentially amplify the forces imposed on the structures. Other potential consequences are noted below.

- The potential building displacements are significant; based on a simplified analysis model developed during Phase 2, the roof may deflect by a foot or more in the ASCE31 level (Major) earthquake.

- The octagonal-shaped roof columns above the concourse level (which act primarily as cantilevers) do not have adequate vertical or horizontal reinforcing for the anticipated seismic loads at the Large or greater earthquake levels.

- The roof columns which are restrained by the mezzanine floor will generally see the highest demands, as their vertical span is shorter and therefore they are stiffer than the remaining columns. However the roof columns on the north and south side of the building will also be affected by the mezzanines. Even though they are separated from the mezzanines by a 1 inch gap, this gap is insufficient to avoid pounding between these columns and the mezzanine floor. The effects of pounding at the mid-height of these columns could be severe.

- The roof diaphragms for each of the "A", "B" and "C" sections are not continuous, because of the expansion joints. Increased damage is expected as a result of this, as the different sections of the roof may try to move independently.

- Below the mezzanine and concourse levels, the beam and column moment frames do not have sufficient capacity to resist the anticipated forces at the ASCE31 (Major) level. However, although not detailed for ductile behavior, they generally appear to be flexure controlled (rather than shear controlled), which is preferable. In addition, the masonry infill walls will contribute to the seismic resistance of the structure.

- The “inside” curbside structure at the concourse level is separated from the terminal building by expansion joints and as a result, seismic forces from the combined roof that travel down to the curbside structure can not be transferred back into the terminal building structure. Significant pounding may occur between the curbside structure and the main terminal building at the concourse level. In addition, the butt welds for the curbside roof columns above the concourse level, provided in the 1970 addition, result in a weak link.

- The curbside structure itself has expansion joints at the concourse level and utilizes corbels to support the beams at these joints. These corbels typically have a seat length of approximately 5 inches, which may not be sufficient for the expected movement in the higher levels of earthquake.

Baggage Handling Addition (south section of the Processor Building)

- The original drawings indicate that moment frames are only provided in the north-south direction. In the east-west direction, no lateral system is discernable from the drawings. At the first story, the building is likely to rely primarily on shear resistance from the CMU wall on the south side of the building; above the concourse level, infill walls around the secured areas may provide some initial resistance. However the building is likely to be particularly flexible in this east-west direction.

- Two 1 inch expansion joints are provided across this building in the north-south direction. Similarly, 1 inch joints are provided between this building and the adjacent terminal and concourse structures. Localized damage due to pounding is likely to occur at these joints.

- Where the baggage handling roof and concourse floor were built around the octagonal columns supporting the south side of the main terminal roof, it is not known whether sufficient separation is provided to prevent east-west movements of the baggage handling building from impacting these columns. These columns are not tied to the main terminal at these levels, and therefore could be vulnerable to mid-height shearing effects.

Concourses A, B & C

- The beam and column moment frames at the gate lounge areas do not have sufficient capacity to resist the anticipated forces at the ASCE31 level; in fact they are overstressed even at the Moderate earthquake level, if the contribution of the masonry infill walls is ignored.

- The masonry infill walls are not adequately connected to the structure, nor do they have adequate capacity to resist out-of-plane forces.

- The bridge structures rely upon the gate lounge areas to provide their lateral resistance. Seismic forces in the bridges are transferred to the gate lounge areas through a key-in system, which relies upon the gate lounge slab in this localized area to carry the transfer forces. The adequacy of the gate lounge slab key was not verified during our evaluation.

The Y Renovation at Concourse B was seismically retrofitted to meet near-current code seismic requirements and is expected to perform significantly better in an earthquake than the surrounding "original" concourses.

Non Structural Items

- Damage to services in the tunnels may lead to flooding, fire and ventilation concerns resulting from damaged water lines and potential fire and release of noxious gases from unanchored boilers, inadequately braced gas lines, or other sources.
- Much of the Communications and IS equipment, and the main mechanical and electrical plant (primarily in the basement/tunnels) is largely unrestrained and is expected to suffer damage.
- The linear mechanical and plumbing systems have some nominal bracing but will suffer damage in the larger events.
- Electrical panels are typically nominally anchored to walls however may detach and be severely damaged in larger events.
- As a result of the large displacements anticipated from the terminal roof (refer above) the glass curtain wall is expected to sustain damage including cracking of the glass and damage to the glazing units, even in a minor event.
- Suspended ceilings throughout the facility are un-braced and are expected to suffer increasing damage as ground motions increase.
- The masonry walls throughout the building are typically unreinforced and inadequately restrained.
- The contents and furnishings (including desktop computers etc) are likely to suffer damage even in a minor event.

2.2 Expected Performance As-Is

The expected performance of the "as-is" Terminal and Concourse buildings for each of the four levels of earthquake is summarized as follows:

- In a Moderate earthquake, most buildings are expected to sustain relatively minor damage only, primarily associated with the "architectural" components, such as deformation of the expansion joint covers and surrounding elements, minor cracking of the brick walls and interior drywall finishes, and possible cracking of the glazing at the main terminal. Some cracking may occur in the concrete columns and beams within the main terminal building and concourses, particularly the octagonal columns (supporting the terminal roof) that are restrained or impacted by the mezzanine. At the inner curbside structure and the "bridges" between the parking structure and the curbside structure, some beams supported on corbels, may shift.

  Negligible structural damage is expected for the baggage handling addition, Y Renovation and Regional Jet Addition in a Moderate earthquake.

  However, because of the vulnerabilities associated with the non-structural components, and due to the risks associated with fire and flooding, it is possible that a cascading series of system failures could result in damage that leads to long downtimes even though a only a small amount of direct damage has occurred to the buildings. The linear utility systems in the service tunnels are particularly vulnerable to these risks.

- In a Large earthquake, increased damage is expected for the "architectural" components and some of the unrestrained and partially restrained contents and equipment may be dislodged, breaking various system connections.

The concrete beams and columns within the main terminal and concourses may sustain significant cracking; again this is expected to have a higher concentration in the terminal roof columns restrained or impacted by the mezzanines. There is a possibility that some corbel-supported beams or "bridges" at the inner curbside structure may fall.

Negligible structural damage is expected for the Y renovation and Regional Jet addition in a Large earthquake.

- In a Major earthquake, significant damage is expected for the "architectural" components. In addition to increased incidence of sliding and toppling of unrestrained and partially restrained equipment, the strong vibrations may damage some of the sensitive internal components of the equipment, possibly beyond repair. The baggage handling systems may experience significant damage making repair difficult.

  Concrete beams and columns within the main terminal and concourses will likely sustain significant cracking, with some permanent deformation possible at the columns, particularly the terminal roof columns restrained or impacted by the mezzanines. The stability of these terminal roof columns and the concourse columns at the apron level is uncertain. There is a significant possibility that some corbel-supported beams or "bridges" at the inner curbside may fall.

  The baggage handling addition may sustain some structural damage to the beam-to-column joints and possible permanent deformation in a Major earthquake; however instability is unlikely.

  Some structural damage such as cracking in the concrete beams, columns and walls may occur at the Y renovation and Regional Jet Addition in a Major earthquake.

- In a Severe earthquake, extensive damage is expected for the "architectural" components. Communications IS, Mechanical and Electrical systems are expected to have moved and/or toppled in many locations and leaks/failure of the linear systems may be extensive. Baggage handling systems and jet-ways may also be damaged.

  Extensive structural damage is expected for the columns and beams at the main terminal and concourses. Partial collapse of some terminal roof columns and/or apron level columns at the terminal and concourses may occur. There is a high likelihood that some corbel-supported beams or "bridges" at the inner curbside and parking structure will fall.

  The baggage handling addition will likely sustain structural damage to the beam-to-column joints and permanent deformation in a Severe earthquake.

  Structural damage such as significant cracking in the concrete beams, columns and walls will likely occur at the Y Renovation, secure connectors and regional jet addition in a Severe earthquake.

3.0 SEISMIC UPGRADE RECOMMENDATIONS

3.1 Performance Objectives

Seismic upgrade concepts were considered as part of the *Terminal Development Alternatives,* based on discussions between the Airport Authority, Master Planning and Seismic teams during the workshops. For most areas of the terminal and concourses, mandatory retrofit is not anticipated; hence any seismic retrofit measures will be voluntary. For these areas, a performance objective similar to "Basic Performance" in Phase 1 of the study was used as the basis for identifying retrofit concepts. The results of the BCA appear to support this level of voluntary retrofit with estimated benefits 4-5 times greater than the cost of retrofit[7]. However for the portion of Concourse C beneath the proposed new FIS facility, it was assumed that this area of the building will need to be retrofitted to meet current code requirements (or equivalent).

In summary, the seismic upgrade concepts discussed in the workshop process, and presented in section 3.2 below and the Appendices have been developed based on the following:

- *Existing buildings, excluding the portion beneath the new FIS, where structural alterations are not being completed and seismic retrofit is voluntary have been developed for a "Basic Safety" objective to achieve Life Safety in the 475 year earthquake ("Large")and Collapse Prevention in the 2475 year earthquake ("Severe"). This is described by ASCE41 as "intended to approximate the earthquake risk level to life safety traditionally considered acceptable in the United States". For simplicity this can be thought of as approximately equivalent to design forces developed from 75% of the current code (IBC 2006).*

- *The area of Concourse C that is to support additional loads from the proposed FIS facility at Mezzanine Level (existing roof) is required to be upgraded in accordance with the code and therefore retrofits have been developed to resist 100% of the current code including the additional weight of the new FIS facility.*

- *New Construction will typically be stand alone structures designed in accordance with the current code.*

Note that during Phase 1 of the Seismic Risk Assessment, two Performance Objectives were evaluated, "Basic" and "Enhanced" Performance. The "Enhanced Performance" objective was also considered during Phase 2; however the benefits of going to this increased level did not justify the costs, based on the BCA performed. In addition to the two main objectives a third "Limited Retrofit" option was considered, to evaluate a lesser level of retrofit that could be considered as an alternate to the Basic Safety retrofit, if the costs for the Basic Safety retrofit are prohibitive.

These additional seismic upgrade options along with Benefit Cost Analyses for each of the options are included in the Phase 2 Seismic Risk Assessment[7] to assist with the Airport Authority's assessment and decision on the extent of retrofit to be implemented.

3.2 Preferred Plan

Seismic upgrades have been developed for the Terminal and Concourses to reflect the "Preferred Plan" *Terminal Development Alternative*. These upgrades are documented in Sketches SK13 – SK15 provided in Appendix C and are briefly described below:

Terminal (Processor)

- Provide new reinforced concrete shear walls from the basement up to the underside of the mezzanine floor to adequately brace the building and located to reflect the proposed changes in circulation for the terminal.
- Provide new foundations beneath the new shear walls including micro piles in some locations.
- Improve the confinement and flexural capacity of the 40-inch columns with the addition of vertical and horizontal layers of fiber reinforced polymer (FRP)
- Connect the 40-inch columns to the mezzanine and second floor along the north and south sides of the building
- Provide new corbels/brackets to support the martini roof structure at the top of the columns.
- Connect the different portions of the martini roof structure together.
- Connect the curbside structure to the main terminal structure
- Improve the seating of the curbside beams.
- Brace the unreinforced masonry walls near critical equipment and in areas where the walls can fall more than two stories. Note that allowance to brace the exterior masonry walls is not included in the retrofit allowances provided in this working paper, refer to the Phase 2 Seismic Risk Assessment[7] for further information.
- Seismically restrain suspended ceilings as part of interior renovations within the building.
- Provide seismic restraint of equipment and services including Communications, IS, mechanical and electrical items.

Baggage Handling Addition

- Install new steel braced frames or concrete shear walls.
- Upgrade foundations below the new braced frames/walls
- Seismically restrain ceilings in public areas as part of interior renovations within the building.
- Provide seismic restraint of equipment and services including Communications, IS, mechanical and electrical items.

Concourse A, B and C (except beneath new FIS)

- Install concrete shear walls.
- Strengthen foundations below the new shear walls.
- Connect the various infills and additions together at the 2nd floor and roof levels.
- Brace the unreinforced masonry walls near critical equipment and in areas where the walls can fall more than two stories. Note that allowance to brace the exterior masonry walls is not included in the retrofit allowances provided in this working paper, refer to the Phase 2 Seismic Risk Assessment[7] for further information.
- Seismically restrain suspended ceilings as part of interior renovations within the building.
- Provide seismic restraint of equipment and services including Communications, IS, mechanical and electrical items.

Concourse C beneath new FIS

As provided for Concourse A, B and C above plus:

- Wrap the existing square concrete columns with Fiber Reinforced Polymer (FRP)
- Strengthen the existing roof beams below the FIS facility.
- Widen expansion joints between the building beneath the FIS and the surrounding structures.
- Provide strong backs or similar to increase the out of plane capacity of the existing

unreinforced masonry partition and exterior walls.

Service Tunnels

- Mitigate safety issues related to potential earthquake-triggered flooding and noxious gas release in the tunnels and engineering are beneath the Main Terminal and Concourses.
- Bracing of critical equipment.
- Additional bracing (and possible supplemental vertical support) for the cable trays in the tunnels and potential additional bracing and anchorage of the piping and ducts.

The seismic upgrades outlined above were then separated into each of the PALs to reflect the proposed phasing of the Terminal upgrades developed by Jacobs.

PAL 1 (0-5 years)
- Retrofit the North end of concourse C
- Address tunnel safety issues.
- Provide anchorage and/or bracing to key Communications, IS and Electrical Equipment

PAL 2 (5-10 years)
- Retrofit the south end of concourse C including the new FIS facility
- Retrofit the central and east portions of the processor building (terminal B and C)
- Retrofit the Baggage Handling Addition

PAL 3 (10-20 years)
- Retrofit Concourse A and B (excluding the "Y" renovation)
- Retrofit the west portion of the processor building (terminal A)

Order of Magnitude cost estimates for the above works were prepared by Connico and are included in Appendix B of this working paper. Further discussion and explanation of the cost estimates is also provided in section 12 of the Phase 2 Seismic Risk Assessment Report[7]

3.3 Preferred Long Term Vision

The preferred long term development strategy for the Terminal and Concourse is titled the "Preferred Long Term Vision". As the entire terminal and concourses are seismically upgraded as part of the Preferred Plan, only limited seismic upgrades are required in the Preferred Long Term Vision. Sketch SK18 in Appendix B shows the required upgrades, these generally include:

- Additions adjacent Concourse B will be seismically tied to the existing structure and the bracing provided within the new buildings will be adequate to upgrade the entire building (new and old) to 100% of the current code.
- Floor beams in concourse B, beneath the proposed moving walkway, will require strengthening.
- The moving walkways adjacent the existing portions of Concourse A and B will be self supporting standalone structures to prevent the need to upgrade the bracing in the existing concourses to accommodate the weight of the new additions.
- The connector between concourse A and C at the north end of the parking garage will be supported by the proposed multi level parking structure. Allowance should be made in the new parking structure to support the seismic and gravity loads for the future connector.

4.0 REFERENCES

1. American Society of Civil Engineers [ASCE] (2003), "Seismic Evaluation of Existing Buildings", ASCE Standard ASCE/SEI 31-03.

2. International Code Council (2006), International Building Code 2006.

3. American Society of Civil Engineers [ASCE] (2006), "Seismic Rehabilitation of Existing Buildings", ASCE Standard ASCE/SEI 41-06.

4. American Society of Civil Engineers [ASCE] (2005), "Minimum Design Loads For Buildings and Other Structures", ASCE Standard ASCE/SEI 7-05.

5. Thornton Tomasetti (2008), "Memphis International Airport Seismic Risk Assessment Phase 1"

6. International Code Council (2003), International Existing Building Code 2003.

7. Thornton Tomasetti (2009), "Memphis International Airport Seismic Risk Assessment Phase 2"

ATTACHMENT 1: Preferred Plan: Seismic Upgrade Sketches

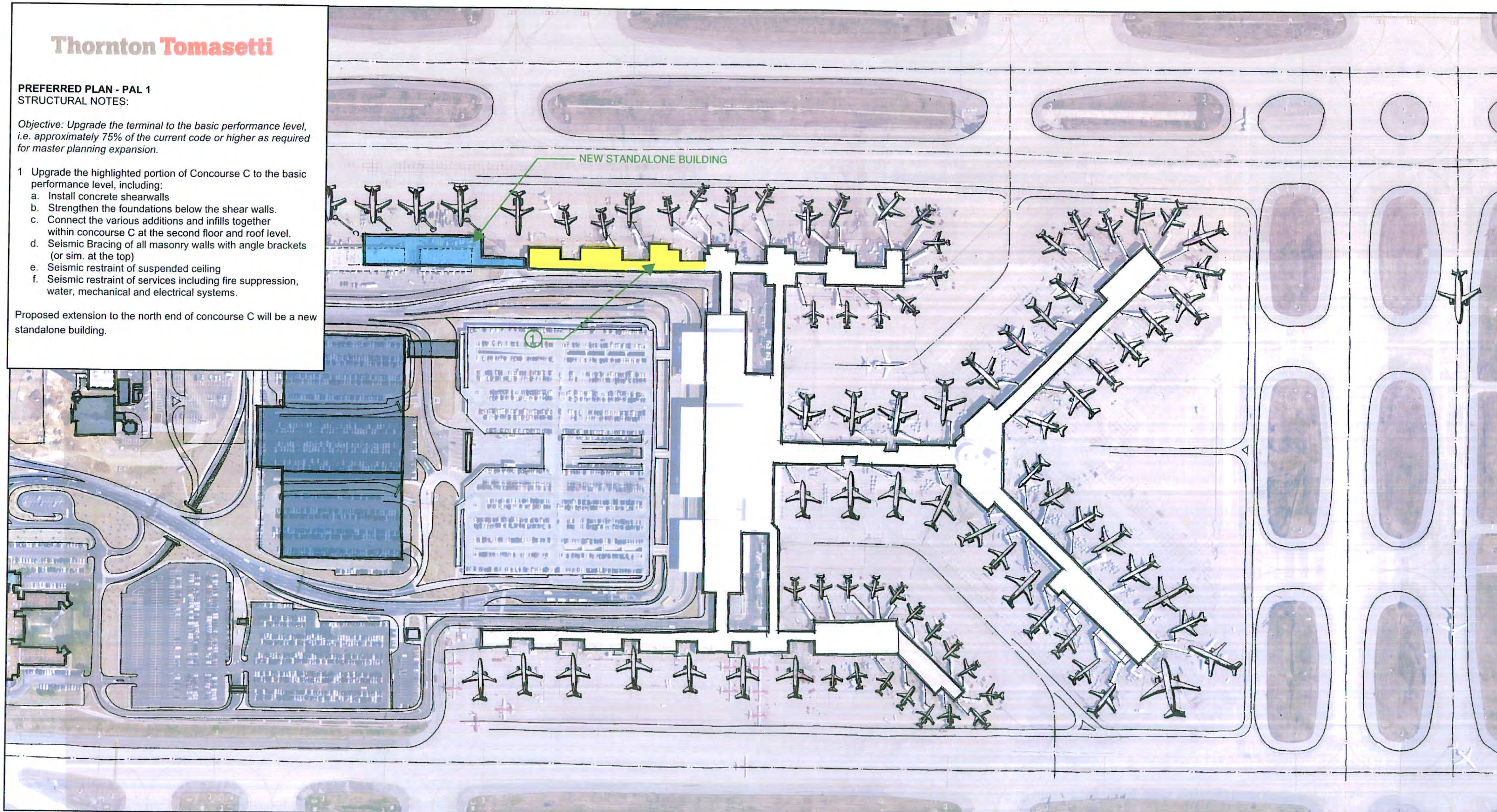
Thornton Tomasetti

PREFERRED PLAN - PAL 1
STRUCTURAL NOTES:

Objective: Upgrade the terminal to the basic performance level, i.e. approximately 75% of the current code or higher as required for master planning expansion.

1 Upgrade the highlighted portion of Concourse C to the basic performance level, including:
   a. Install concrete shearwalls
   b. Strengthen the foundations below the shear walls.
   c. Connect the various additions and infills together within concourse C at the second floor and roof level.
   d. Seismic Bracing of all masonry walls with angle brackets (or sim. at the top)
   e. Seismic restraint of suspended ceiling
   f. Seismic restraint of services including fire suppression, water, mechanical and electrical systems.

Proposed extension to the north end of concourse C will be a new standalone building.



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LEGEND

- Existing
- Planned new construction
- Interior renovations
- Ongoing Airport projects

* PAL = Planning Activity Level

Linear Frontage

610 LF net gain during PAL 1

10,410 LF total at end of PAL 1

STRUCTURAL KEY:

- Upgrade to 100% of Current Code in this PAL
- Basic Performance Upgrade in this PAL
- Upgrade to 100% of Current Code in previous PAL
- Basic Performance Upgrade in previous PAL

North ←

0 100 200 300 600 Feet

Figure 4.1

PREFERRED PLAN—PAL 1

Terminal Development Alternatives
Master Plan Update
Memphis International Airport

Thornton Tomasetti

Project Name - Memphis Airport

SK-13 r3

Date: 05/15/2009
By: SC/CK
Ref: GG8178

Thornton Tomasetti

PREFERRED PLAN - PAL 2

STRUCTURAL NOTES:

Objective: Upgrade the terminal to the basic performance level, i.e. approximately 75% of the current code or higher as required for master planning expansion.

1 Upgrade the highlighted portion of Concourse C to the basic performance level, including:
   a. Install concrete shearwalls
   b. Strengthen the foundations below the shear walls.
   c. Connect the various additions and infills together within concourse C at the second floor and roof level.
   d. Seismic Bracing of all masonry walls with angle brackets (or sim. at the top)
   e. Seismic restraint of suspended ceiling
   f. Seismic restraint of services including fire suppression, water, mechanical and electrical systems.

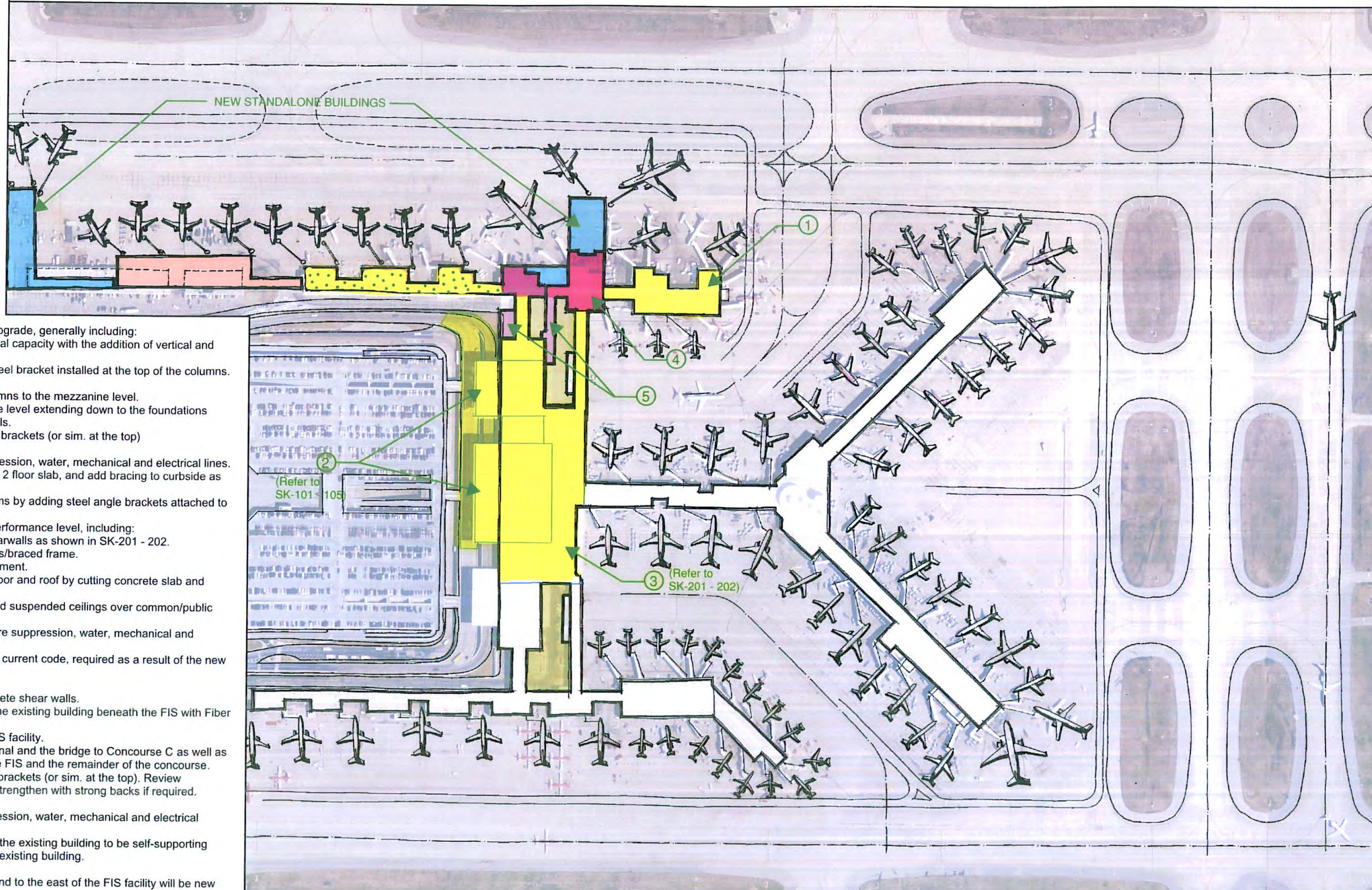
2 Upgrade Processors B & C to basic performance upgrade, generally including:
   a. Improve 40-inch column confinement and flexural capacity with the addition of vertical and horizontal bands of FRP.
   b. Support Concrete martini roof with fabricated steel bracket installed at the top of the columns.
   c. Connect the roof elements together.
   d. Provide a robust connection of the 40-inch columns to the mezzanine level.
   e. Install concrete shearwalls below the mezzanine level extending down to the foundations
   f. Strengthen the foundations below the shear walls.
   g. Seismic Bracing of all masonry walls with angle brackets (or sim. at the top)
   h. Seismic restraint of suspended ceiling
   i. Seismic restraint of services including fire suppression, water, mechanical and electrical lines.
   j. Connect the curbside structure to the main level 2 floor slab, and add bracing to curbside as required.
   k. Increase the seating length of the curbside beams by adding steel angle brackets attached to the corbels.

3 Upgrade the Baggage Handling Addition to basic performance level, including:
   a. Install new steel braced frames or concrete shearwalls as shown in SK-201 - 202.
   b. Strengthen foundations beneath new shear walls/braced frame.
   c. Seismically restrain the baggage handling equipment.
   d. Widen the existing expansion joints at second floor and roof by cutting concrete slab and relocating steel beams as required.
   e. Seismically restrain all existing partition walls and suspended ceilings over common/public areas.
   f. Provide Seismic restraint of services including fire suppression, water, mechanical and electrical systems.

4 Upgrade Concourse C beneath the proposed FIS to current code, required as a result of the new FIS. This will include:
   a. New concrete shear walls or braces.
   b. Provide new foundations beneath the new concrete shear walls.
   c. Wrap the existing 11.5-inch square columns in the existing building beneath the FIS with Fiber Reinforced Polymer (FRP) wrap.
   d. Strengthen the existing roof beams below the FIS facility.
   e. Widening of expansion joints between the Terminal and the bridge to Concourse C as well as between the portion of Concourse C beneath the FIS and the remainder of the concourse.
   f. Seismic Bracing of all masonry walls with angle brackets (or sim. at the top). Review out-of-plane capacity of the masonry walls and strengthen with strong backs if required.
   g. Seismic restraint of suspended ceiling.
   h. Seismic restraint of services including fire suppression, water, mechanical and electrical systems.

5 New FIS and concourse in-fills not constructed over the existing building to be self-supporting "green field" buildings structurally separate from the existing building.

Proposed extensions to the north end of concourse C and to the east of the FIS facility will be new standalone buildings.



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LEGEND

- Existing
- Completed in prior PAL
- Completed in this PAL
- Renovated in this PAL
- FIS facility (to be completed in this PAL)
- In-line baggage system
- Ongoing Airport projects

Linear Frontage

715 LF net gain during PAL 2

11,125 LF total at end of PAL 2

* PAL = Planning Activity Level

STRUCTURAL KEY:

- Upgrade to 100% of Current Code in this PAL
- Basic Performance Upgrade in this PAL
- Upgrade to 100% of Current Code in previous PAL
- Basic Performance Upgrade in previous PAL

North

0 100 200 300 600 Feet

Figure 4.2

PREFERRED PLAN—PAL 2

Terminal Development Alternatives
Master Plan Update
Memphis International Airport

Thornton Tomasetti

Project Name - Memphis Airport

SK-14 r3

Date: 05/15/2009
By: SC/CK
Ref: GG8178

Thornton Tomasetti

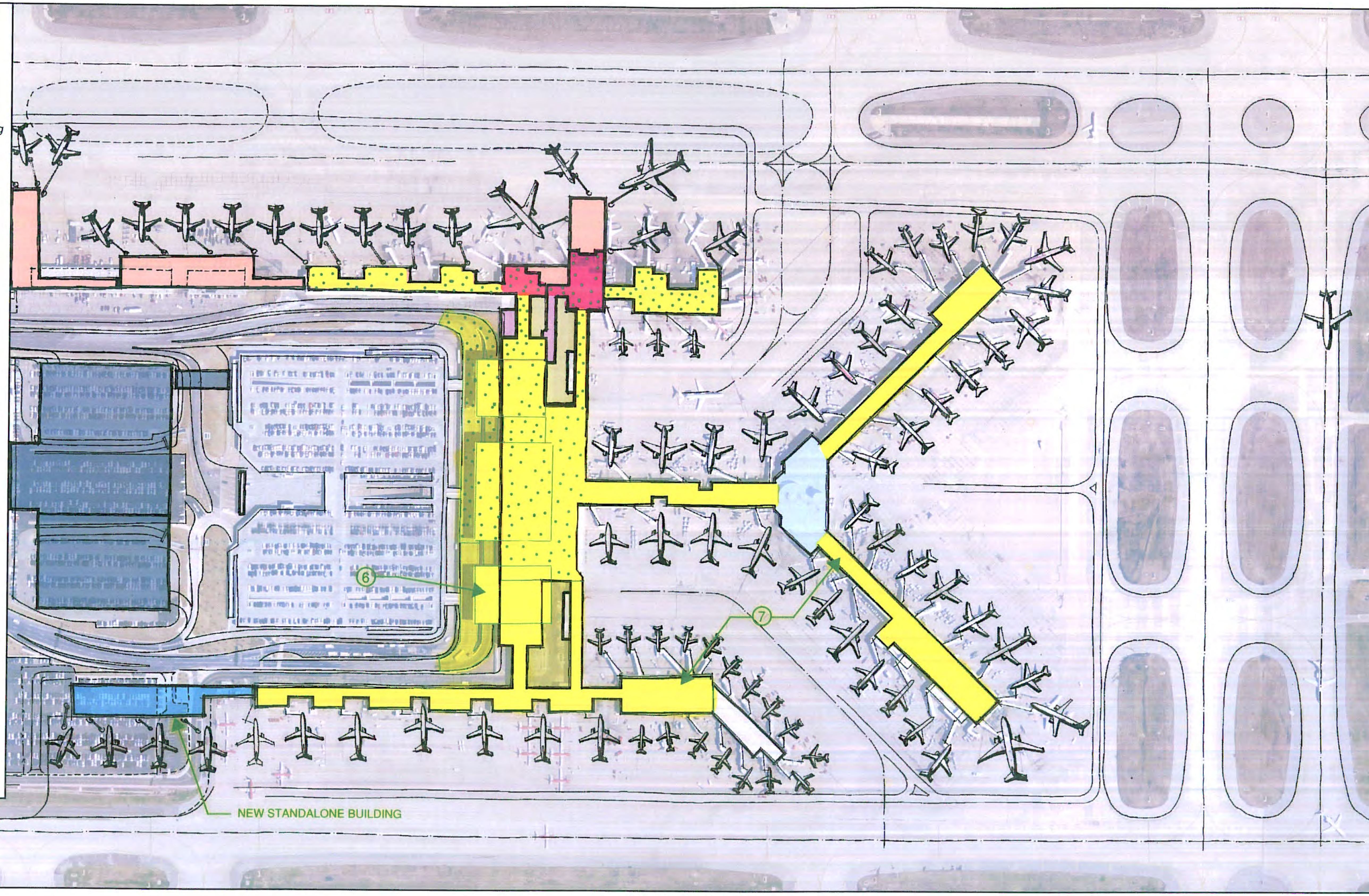
BASELINE C - PAL 3
STRUCTURAL NOTES:

Objective: Upgrade the terminal to the basic performance level, i.e. approximately 75% of the current code or higher as required for master planning expansion.

6 Upgrade Processor A to basic performance, generally including:
  a. Improve 40-inch column confinement and flexural capacity with the addition of vertical and horizontal bands of FRP.
  b. Support Concrete roof with fabricated steel bracket installed at the top of the columns.
  c. Connect the roof elements together.
  d. Provide a robust connection of the 40-inch columns to the mezzanine level
  e. Install concrete shearwalls below the mezzanine level extending down to the foundations
  f. Strengthen the foundations below the shear walls.
  g. Seismic Bracing of all masonry walls with angle brackets (or sim. at the top)
  h. Seismic restraint of suspended ceiling
  i. Seismic restraint of services including fire suppression, water, mechanical and electrical systems.
  j. Connect the curbside structure to the main level 2 floor slab, and add bracing to curbside as required.
  k. Increase the seating length of the curbside beams by adding steel angle brackets attached to the corbels.

7 Upgrade the highlighted portion of Concourses A and B to basic performance upgrade, including:
  a. Install concrete shearwalls.
  b. Strengthen the foundations below the shear walls.
  c. Connect the various additions and infills together within concourses A and B at the second floor and roof level.
  d. Seismic Bracing of all masonry walls with angle brackets (or sim. at the top).
  e. Seismic restraint of suspended ceiling
  f. Seismic restraint of services including fire suppression, water, mechanical and electrical systems.

Proposed extension to the north end of concourse A will be a new standalone building.



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LEGEND

- Existing
- Completed in prior PAL
- Completed in this PAL
- Renovated in this PAL
- FIS facility (completed in prior PAL)
- In-line baggage system
- Ongoing Airport projects

Linear Frontage

600 LF net gain during PAL 3

11,725 LF total at end of PAL 3

* PAL = Planning Activity Level

STRUCTURAL KEY:

- Upgrade to 100% of Current Code in this PAL
- Basic Performance Upgrade in this PAL
- Upgrade to 100% of Current Code in previous PAL
- Basic Performance Upgrade in previous PAL

North ←

0 100 200 300 600 Feet

Figure 4.3
PREFERRED PLAN—PAL 3
Terminal Development Alternatives
Master Plan Update
Memphis International Airport

Thornton Tomasetti

Project Name - Memphis Airport

SK-15r2

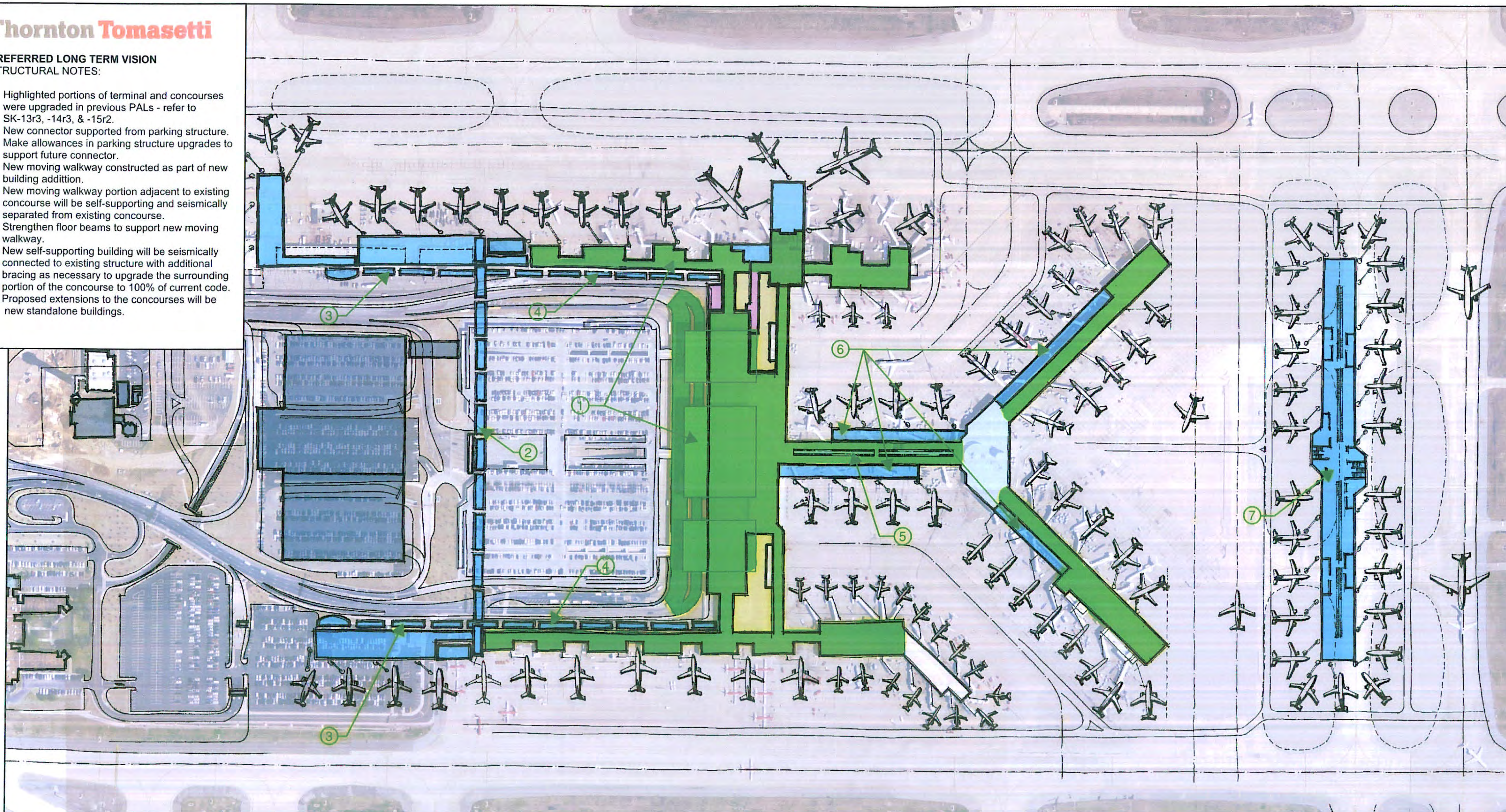
Date: 05/15/2009
By: SC/CK
Ref: GG8178

ATTACHMENT 2: Preferred Long: Term Vision Seismic Upgrade Sketches

Thornton Tomasetti

PREFERRED LONG TERM VISION
STRUCTURAL NOTES:

1. Highlighted portions of terminal and concourses were upgraded in previous PALs - refer to SK-13r3, -14r3, & -15r2.
2. New connector supported from parking structure. Make allowances in parking structure upgrades to support future connector.
3. New moving walkway constructed as part of new building addittion.
4. New moving walkway portion adjacent to existing concourse will be self-supporting and seismically separated from existing concourse.
5. Strengthen floor beams to support new moving walkway.
6. New self-supporting building will be seismically connected to existing structure with additional bracing as necessary to upgrade the surrounding portion of the concourse to 100% of current code.
7. Proposed extensions to the concourses will be new standalone buildings.



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LEGEND

- Existing
- Planned new construction
- FIS facility
- Interior renovations
- In-line baggage system
- Ongoing Airport projects

* PAL = Planning Activity Level

STRUCTURAL KEY:

- Upgraded in previous PALs

NOTE:
Existing terminal processor and concourses to be renovated.
(See phasing plans for extent of work and timeline.)

North ←

0 100 200 300 600 Feet

Figure 7.0

PREFERRED LONG-TERM VISION
Terminal Development Alternatives
Master Plan Update
Memphis International Airport

Thornton Tomasetti

Project Name - Memphis Airport

SK-18r2

Date: 05/15/2009
By: SC/CK
Ref: GG8178

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FINAL WORKING PAPER

RECOMMENDED DEVELOPMENT PLAN MASTER PLAN UPDATE

Memphis International Airport

Prepared for

Memphis-Shelby County Airport Authority
Memphis, Tennessee

January 2010

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FINAL WORKING PAPER

RECOMMENDED DEVELOPMENT PLAN MASTER PLAN UPDATE

Memphis International Airport

Prepared for

Memphis-Shelby County Airport Authority
Memphis, Tennessee

January 2010

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APPENDIX

TABLES

FIGURES

RECOMMENDED DEVELOPMENT PLAN

This Working Paper describes the Recommended Development Plan for Memphis International Airport (the Airport). Included herein is a comprehensive summary of (1) the future on-Airport land use plan; (2) projects included in the Recommended Development Plan, including phasing and implementation strategies; and (3) the recommended Capital Improvement Program and Financial Plan, with a particular focus on projects recommended for near-term implementation.

FUTURE LAND USE PLAN

The following section describes the development and selection of the preferred future on-Airport land use plan. The plan identifies land use "envelopes" for accommodating the major Airport functions through 2027, the final year of the 20-year Master Plan Update planning horizon. The purpose of the recommended on-Airport land use plan is to identify the highest and best use of Airport property given other Master Plan recommendations, surrounding off-Airport uses, existing and future infrastructure, and strategic considerations.

Approach

The recommended future land use plan was developed with primary consideration given to existing land uses, leases, and constructability/implementation factors. Priority was given to assigning land uses requiring airfield access to airfield-fronting parcels. Secondary focus was given to optimizing the use of on-Airport, non-airfield fronting land envelopes.

Since FedEx is a commercial tenant, facility requirements were not assessed for FedEx facilities in the Master Plan; and therefore, future land areas for FedEx are uncertain. Considering the historical growth of FedEx's on-Airport leased areas and forecast activity levels, prudent planning suggests that FedEx is likely to request additional acreage at some point during the 20-year planning period. Therefore, some existing facilities adjacent to FedEx leased areas are assumed to be relocated elsewhere on Airport property during the planning period, and many future land use recommendations are related to the re-accommodation of facilities displaced by anticipated FedEx development and property needs.

The future on-Airport land use plan focuses on the 20-year planning horizon for the following reasons:

1. Significant airfield and terminal development projects affecting or requiring land use changes are not recommended until the longer-term planning horizon.

2. Facility requirements and recommended airfield and terminal projects do not require land acquisition or significant changes to existing Airport property boundaries.

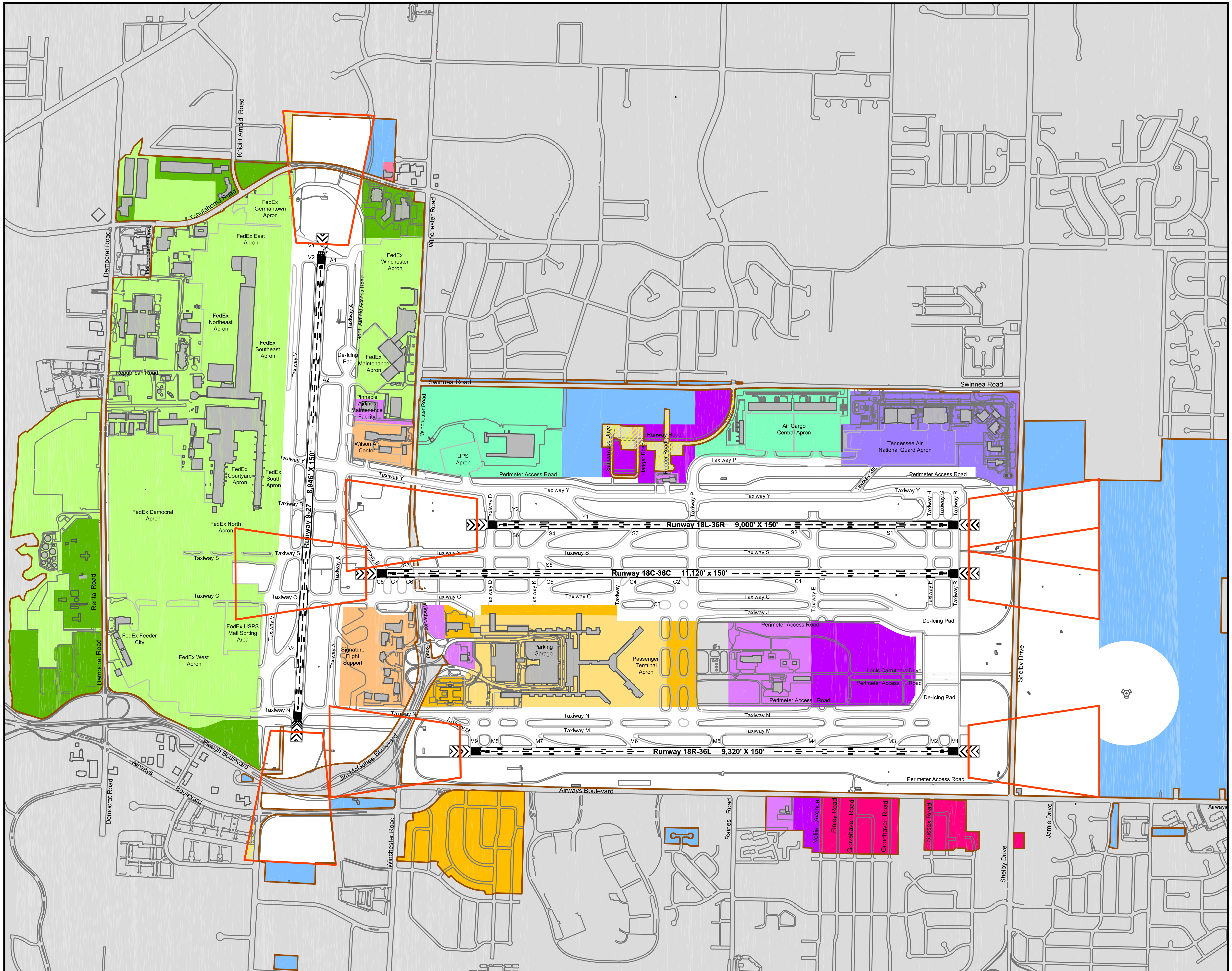
3. Recommended airfield and terminal projects generally occur within existing use envelopes and require only minor changes to land uses surrounding and/or affected by recommended projects.

Future On-Airport Land Uses

The recommended land use plan for the Airport is shown on Figure 1 and described below.

FedEx. It is anticipated that some parcels adjacent to existing FedEx leased areas will need to be relocated during the planning period. These include the rental car facilities north of Democrat Road; the employee parking lot (Authority controlled) north of Democrat Road; non-aviation commercial properties to the east of Tchulaholma Road and directly south of Democrat Road; the Memphis Technical School; and Authority maintenance and office facilities directly north of Winchester Road. In addition to the above, FedEx can also expand on a triangular parcel of land bordered by the Runway 9 RPZ, Taxiway N, and Plough Boulevard. These land envelopes would provide FedEx with 131 additional acres of land and reserve all Authority properties to the north of Winchester Road for FedEx, with the exception of the two general aviation land use envelopes occupied by Signature Flight Support and Wilson Air Center and the Pinnacle Airlines maintenance facility. The timing of these relocations is uncertain and likely to be driven by a combination of Authority and FedEx business objectives.

East Side. The east side of the Airport, defined as the land area bounded by Winchester Road, Swinnea Road, Shelby Drive, and Taxiway Y, should accommodate a mix of air cargo, military, and aviation support functions. All existing air cargo (Cargo Central and UPS) and military land use functions would remain in their existing land use envelopes. The area north of Runway Road and the area currently occupied by the industrial park should be reserved for aviation support facilities. This area is ideal for relocated Authority maintenance facilities and administration offices because it provides potential airfield access and the ability to accommodate all Authority staff currently dispersed in several on-Airport locations into one combined facility. This area is also a potential site for a replacement fuel farm. Approximately 55 acres should be reserved for these future aviation support facilities. Additionally, 57 acres of land on the east side should remain reserved for future development.



LEGEND

- Airport property line
- Runway Protection Zone
- Property acquisition

LAND USES

Existing / Recommended

- Air cargo
- Airfield
- Aviation support
- Commercial aviation
- Commercial development
- FedEx
- General aviation
- Military
- Reserved for future development

N

0' 900' 1,800' 3,600'

Figure 1
RECOMMENDED FUTURE ON-AIRPORT LAND USES

Master Plan Update
Memphis International Airport
December 2009

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South Midfield. The south midfield, defined as the land north of Shelby Drive and between Taxiways J, N, and P provides the largest reserve of airfield-fronting land envelopes of any undeveloped site at the Airport. As such, approximately 130 acres will be retained as is or converted to aviation support because of its airfield-fronting location. The replacement fuel farm could potentially be located in this area. At the north end of the south midfield, 22 acres of land directly to the south of existing Taxiway P will be reserved as airfield land for replacement of Taxiways T and P to accommodate a future satellite concourse as discussed in conjunction with the airfield and terminal development alternatives analyses.

Passenger Terminal Area. Expanded commercial aviation functions (including the passenger terminal, public parking, and rental car facilities) will be expanded within the passenger terminal area. The existing Radisson Hotel and former air cargo warehouses (totaling 16 acres) north of the passenger terminal should be reclaimed to accommodate future terminal support facilities. Additionally, expansions on the east side of the passenger terminal will require 11 acres to be converted from airfield to commercial aviation use. Support functions occupying 11 acres will be reserved for the new ATCT and structural response fire station.

McKellar Park. Approximately 800 acres of open space exist south of the Airport in the area formerly occupied by McKellar Park. This area was acquired by the Authority for noise mitigation purposes in the 1990's. Avigation easements restricting development in McKellar Park are in place to prohibit construction of buildings or facilities which might obstruct approaches. Approximately 300 acres of McKellar Park are delineated as airfield, encompassing the RPZs for Runways 36L, 36C, 36R and appropriate clearance for the existing VOR. Remaining areas are reserved for future development. However, it remains imperative that future development be compatible with the runway approaches. The potential for using areas within McKellar Park for de-icing treatment and/or storage facilities is being explored in the Authority's ongoing Glycol Management Study.

West Side. The Authority owns several parcels of land on the west side of Airways Boulevard south of Winchester Road. It is recommended that the northernmost 48-acre parcel, be reserved for future ground transportation facilities supporting the passenger terminal. The existing project center should remain as aviation support, and the parcel directly to the south should be reserved as aviation support as a potential site for a replacement fuel farm. The remaining 37 acres should be converted to non-aviation commercial uses.

A comparison of existing and future land uses is provided in Table 1. The recommended future land use plan maintains existing concentrations of land uses and makes targeted changes to optimize the location of certain facilities. Once implemented, FedEx land areas would total 1,095 acres and would dominate Authority-owned lands north of Winchester Road with the exception of two parcels maintained for general aviation uses. Required expansions to the passenger terminal and public parking facilities would occur within the existing Passenger

Terminal Area and overflow onto a single parcel on the west side of the Airport. Aviation support facilities that currently exist adjacent to FedEx would be re-accommodated along the east side and/or in the south midfield.

Table 1

EXISTING AND FUTURE ON-AIRPORT LAND USE AREAS
Master Plan Update
Memphis International Airport

	Existing areas		Future areas		
Land use	Acres	% of total	Acres	% of total	Change
Airfield	2,109	41%	2,102	41%	(7)
Reserved	1,285	25	1,019	20	(266)
FedEx	939	18	1,095	21	156
Commercial aviation *(a)*	180	4	273	5	93
Air cargo *(b)*	179	4	179	4	--
Aviation support	172	3	222	4	50
Military	122	2	122	2	--
General aviation	78	2	78	2	--
Commercial development	55	1	60	1	5
Total	5,119	100%	5,150 *(c)*	100%	31

(a) Includes passenger terminal, public and Authority-controlled parking, and rental car functions.
(b) Excludes FedEx land areas.
(c) Includes recommended property acquisitions totaling 31 acres.

Source: Jacobs Consultancy, November 2009.

RECOMMENDED DEVELOPMENT PLAN

This section describes the Recommended Development Plan for the Airport through 2027, the final year of the 20-year Master Plan planning horizon. Recognizing uncertainties associated with long-range aviation demand forecasting, three planning activity levels (PALs)* were identified to represent future levels of activity at which key improvements would be necessary. Because activity levels could deviate from calendar-based forecasts for any number of reasons, the use of PAL "triggers" allows planning recommendations to be tied to demand activity as is occurs, rather than arbitrary calendar years. For this Master Plan Update, PAL 1, PAL 2, and PAL 3 generally correspond to aviation activity forecasts for 2012, 2017, and 2027, respectively.

*A summary of aircraft operations and enplaned passengers associated with each PAL is provided in the Aviation Demand Forecasts Report – Jacobs Consultancy, July 2008.

The specific improvements included in the Recommended Development Plan will enable the Airport to continue to fulfill and enhance its role as FedEx's primary sorting hub and as an important passenger connecting hub in the Delta Air Lines route system. The plan incorporates the recommended airfield and passenger terminal development alternatives identified in the *Airfield Alternatives Working Paper* and *Terminal Development Alternatives Working Paper* previously prepared for the Master Plan Update. Ground transportation and aviation support projects were also identified to accommodate projected demand, changing land uses, or relocation or replacement of facilities.

Projects included in the Recommended Development Plan are depicted on Figure 2 and discussed in the following sections. The numbering of projects described in the text corresponds to the project depicted on Figure 2.

Airfield Projects

In general, the future airfield remains largely unchanged, with no major airfield infrastructure required in the planning period. Recommended projects focus on providing targeted enhancements to airfield operations.

1. **Angled M6 Exit Taxiway**. Taxiway M6, an exit taxiway for Runway 36L, would be realigned from a 90-degree exit to an angled exit to decrease runway occupancy times and enhance capacity during periods of mixed operations. The realigned Taxiway M6 is sited approximately 5,200 feet from the runway threshold on the same alignment as Taxiway S3 on Runway 36R. The project is recommended for implementation in PAL 1 because it could be utilized immediately to increase runway capacity during mixed operations. This improvement will provide even greater benefits in the future with the expected increase in periods of mixed operations at the Airport.

2. **Consolidated Deicing Pad and South Side Cross Field Taxiways**. The existing Taxiway J and N deicing pads would be joined to create a centralized deicing pad that could simultaneously park four ADG IV aircraft. Additional aircraft could be accommodated on the existing deicing pads adjacent to the proposed pad. This project will facilitate collection and treatment of glycol to comply with Tennessee Department of Environmental Conservation permits. This project would necessitate re-grading Louis Carruthers Drive and placing it in a tunnel beneath the new centralized deicing pad. Dual ADG V taxiways would be provided on the deicing pad. Since a need was not established for additional cross field taxiway capability, the final location of the deicing pad is contingent on the findings of the Authority's ongoing Glycol Management Study. The deicing pad is recommended for implementation at PAL 2, although the results of additional ongoing studies outside of the Master Plan Update may require implementation at PAL 1. .

3. **Taxiway C Extension and Taxiway J Realignment.** Taxiway C will be extended southward to join with existing Taxiway J, which will be realigned by adding pavement north of the Taxiway J deicing pad. Extending Taxiway C and realigning Taxiway J will increase the number of taxiways on which departures can queue while waiting to depart Runway 36C. Once complete, air traffic controllers would have the flexibility to feed departures onto the runway from multiple points on both the east and west sides of the runway, allowing flexibility to separate aircraft by size or departure fix. This project is included at PAL 3 because it would be triggered by a change in scheduled activity that would result in more overlap between passenger and air cargo departure activity, which is not expected to occur until the second half of the planning period. If NextGen air traffic control technologies make the use of glideslope antennas obsolete, Taxiway C could be extended directly south to Taxiway R on its current alignment.

4. **Runway 18C Departure Hold Pad**. A departure hold pad to the west of Taxiway C between C6 and C8, will be constructed to provide air traffic controllers with flexibility to re-sequence departure queues on Taxiway C. Runway 18C is the primary departure runway in south flow and the hold pad will allow aircraft that require additional time due to mechanical problems, air traffic control ground holds, or other issues a convenient place to park without blocking runway access. The hold pad would be sized to accommodate two ADG-III (e.g., Airbus A320) aircraft simultaneously. Construction of the East Lot in 2010 for vehicular parking will temporarily eliminate use of the a portion of the former air cargo apron at the north end of Taxiway J as a hold pad until at least completion of the new parking garage and perhaps even longer depending on Authority objectives. However, the Master Plan recommended hold pad is scheduled for PAL 3, as alternative area to the north of the East Lot could be made available to stage departures until northward terminal development on Concourse C will permanently eliminate these apron areas.

5. **Seismic Retrofit of Airfield Structures over Winchester Road**. Four airfield structures over Winchester Road will be modified per retrofit designs by the Seismic Risk Assessment team, including the structures supporting (1) Taxiway Y; (2) Runway 18C-36C and Taxiways C and S; (3) the terminal access roadways; and (4) Taxiway N. These retrofits are scheduled for implementation in PAL 1 to improve structural performance and reliability in the event of seismic activity.

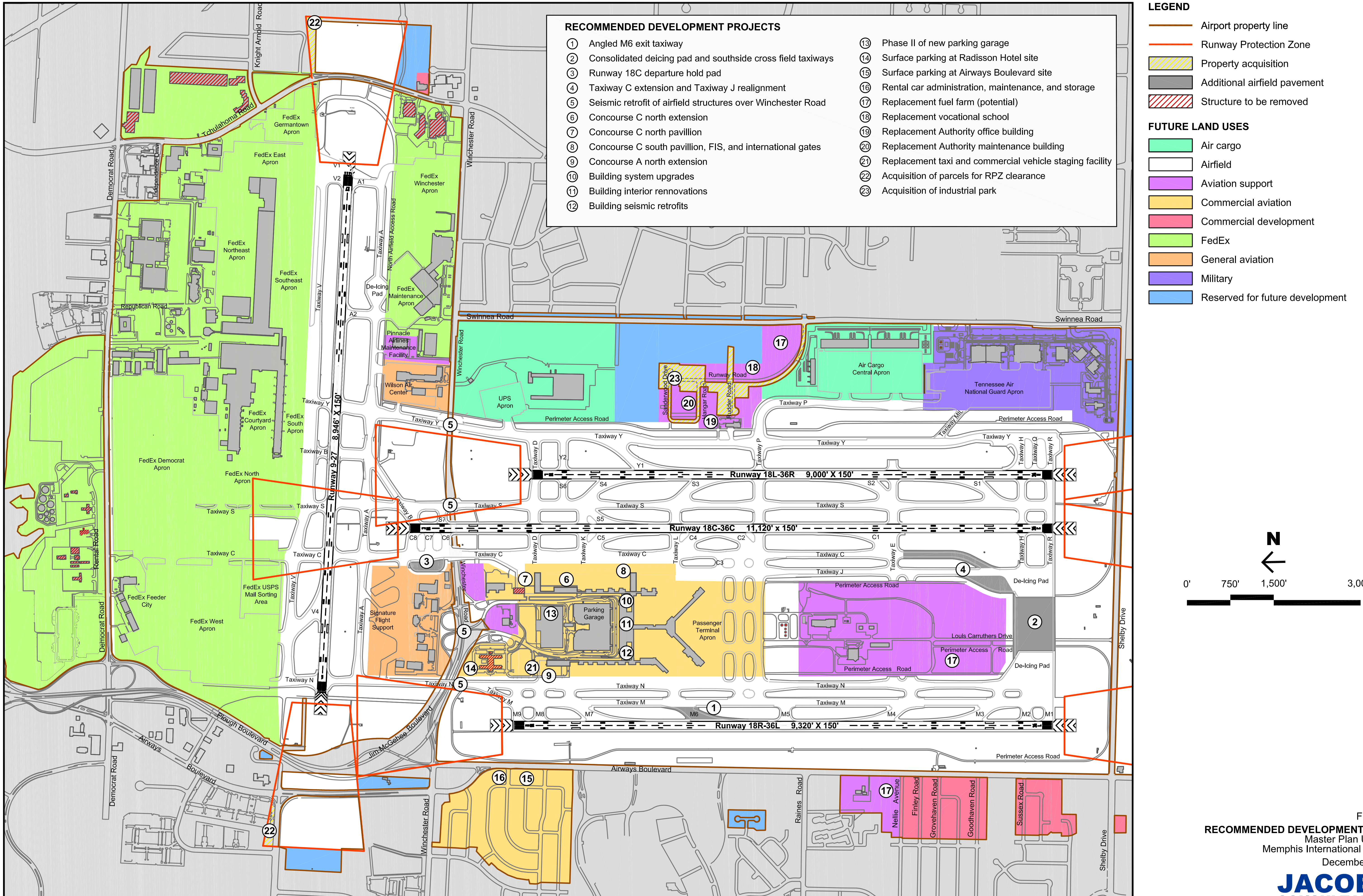

Figure 2
RECOMMENDED DEVELOPMENT PLAN
Master Plan Update
Memphis International Airport
December 2009

JACOBS CONSULTANCY

Passenger Terminal Projects

The Recommended Development Plan includes projects in the passenger terminal complex to provide additional aircraft gates and holdrooms; replace and enlarge the Federal Inspection Station (FIS) facility; improve levels-of-service; modernize mechanical, electrical, and plumbing systems; and address seismic vulnerabilities.

6. **Concourse C North Extension**. Concourse C would be extended to the north, providing 610 feet of additional gate frontage with passenger holdrooms and amenities on the second level and airline operations space on the ground level. While not explicitly required to meet the forecast demand for gates, this addition provides the Airport with greater flexibility to reconstruct the aprons surrounding the terminal. This extension provides approximately 40,000 additional square feet of finished terminal area (passenger holdrooms, restrooms, circulation, and/or concessions) and 40,000 square feet of shell space for airline operations. The Concourse C north extension is planned for PAL 1 to provide sufficient gate capacity to allow reconstruction of existing terminal aprons.

7. **Concourse C North Pavilion**. The expansion of aircraft gates to the north end of Concourse C will continue through construction of a pavilion, aligned perpendicular to the runways, providing 760 feet of additional gate frontage, 41,250 additional square feet of finished terminal area (passenger holdrooms, restrooms, circulation, and/or concessions), and 33,750 additional square feet of shell space for airline operations. The Concourse C pavilion is scheduled for PAL 2 to meet terminal requirements.

8. **Concourse C South Pavilion, FIS, and International Gates**. A second pavilion will be constructed off of what is currently the passenger holdroom for Gates C12A and C12B of similar size to the pavilion on the north. In addition to providing 325 feet of additional gate frontage, new passenger holdrooms, and expanded airline operations space, this pavilion would also provide new international arrivals gates and accommodate the parking of both narrow and widebody aircraft. A "fill in" of the concourse between the new pavilion and the holdrooms to the north (Gates C14A and C14B) would also be constructed to provide space for additional passenger amenities at the concourse level and baggage handling space at the apron level. Lastly, the three gates on the south face of Concourse C (Gates C1, C2, and C3) would be removed and the apron service road moved north of its existing location to allow for an additional taxilane, easing the demand for the existing single-taxilane between Concourses B and C. The gate removal and ensuing taxilane construction results in the loss of 370 feet of gate frontage

   In addition, construction of a new FIS facility, operationally and functionally split between a new mezzanine level on Concourse C and the ground level of Terminal C, would be implemented during PAL 2. These expansions and improvements would add 22,000 square feet of finished terminal area along Concourse C (passenger holdrooms, restrooms, circulation, and/or concessions), 16,000 square feet of shell space for airline operations on the apron level, 17,000 square feet of immigration processing on the mezzanine level above existing Concourse C, and 15,000 square feet for immigration processing on the ground level to the east side of the main terminal building. This project is planned for PAL 2 based on requirements for international gates and FIS facilities.

9. **Concourse A North Extension**. Concourse A will be extended to the north, providing 600 feet of additional gate frontage, passenger holdrooms and amenities, and airline operations space. This extension provides approximately 40,000 additional square feet of finished terminal area (passenger holdrooms, restrooms, circulation, and/or concessions) and 40,000 square feet of shell space for airline operations. The Concourse A north extension is planned for implementation in PAL 3 to meet corresponding terminal requirements.

10. **Building System Upgrades**. Improvements to the terminal's mechanical, electrical, and plumbing systems are required to support expansion and renovation projects that add overall area and building volume. These projects are also required to replace aged equipment over the 20-year planning period when existing components reach the end of their useful lives. Maintaining the existing building systems in a state of good repair provides not only level-of-service benefits to passengers and tenants but also reductions in operating and maintenance costs. Upgrades are scheduled to be phased by terminal and concourse throughout the planning period.

11. **Building Interior Renovations**. Refurbishments and renovations to the terminal building are integrated as a part of the recommended plan, including replacement of ceiling tiles, carpeting, lighting, and re-painting as appropriate. These renovations are scheduled to be phased by terminal and concourse throughout the planning period.

12. **Building Seismic Retrofits**. Seismic retrofit recommendations to the Main Terminal building and concourses are included in the preferred plan to address seismic vulnerabilities. The recommendations not only minimize the risk to public life and safety caused by potential structural failures but also minimize the potential downtime of key facilities following a seismic event and enable the Airport to regain functionality as quickly as possible. On the concourses, seismic recommendations include strengthening of foundations, installation of shearwalls, and bracing of plumbing and electrical conduits. Retrofits are timed to coincide with the aforementioned interior renovation work at various locations, during which ceilings, floorings, and other finishes will enable access to structural components of

the building. These retrofits constitute an upgrade to approximately 75% of the current building code, exceeding the minimum requirements for structural upgrades. Retrofits are scheduled to be phased by terminal and concourse throughout the planning period.

Ground Transportation Projects

Recommended ground transportation projects allow projected increases in public parking demand to be accommodated on Airport property and facilitate implementation of other recommended projects and land use changes.

13. **Phase II of New Parking Garage*.** The full build-out of the new parking garage (Phase I construction to begin in early 2010) will provide a total net increase of 1,000 public parking spaces (250 spaces per level on four levels). The total footprint of the garage will be 277,000 square feet. Phase II expansion would not require major improvements in elevators and pedestrian circulation, as the majority of that infrastructure will be provided in Phase I construction. However, implementation of Phase II will require construction to be phased to maintain traffic on the adjacent and lower levels of the curbside. The Phase II build out is planned for implementation in PAL 3 to accommodate forecast demand for public parking.

14. **Surface Parking at Airways Boulevard Site**. A surface parking lot and 900,000 square-foot pay plaza accommodating 2,600 spaces is recommended to the west of Airways Boulevard and south of Winchester Road. This site will be used to accommodate employee parking in the event that the existing employee parking lot off of Democrat Road is required by FedEx for expansion. Development of the Airways employee lot is planned for PAL 2, although the exact timing is dependent on FedEx's plans for acquiring the Democrat Road lot.

15. **Surface Parking at Radisson Hotel Site**. Removal of the existing Radisson Hotel structure and ancillary facilities and construction of 1,170 spaces of public surface parking and adjacent pay plaza is recommended in PAL 2 to meet public parking demand requirements.

16. **Rental Car Administration, Maintenance, and Vehicle Storage**. Facilities for rental car operators are recommended to replace existing facilities north of Democrat Road when this area is needed for FedEx expansion. This project will augment the space rental car operators will utilize at the consolidated rental car and quick turn-around facility. These facilities will require a site to the west of Airways Boulevard and south of Winchester

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*Following the conclusion of the Master Plan Update analyses, the Authority decided to execute Phase I and Phase II of the New Parking Garage project simulataneously.

Road of approximately 60 acres. Facilities will include approximately 6,000 vehicle storage spaces and a building for administrative office space. Development of the rental car facilities is planned for PAL 2, but is dependent on FedEx's needs for additional land areas north of Democrat Road.

Airport Support Projects

Development of airport support facilities are necessitated by future FedEx expansion and terminal development. All aviation support projects are anticipated for implementation in PAL 3, subject to terminal development projects and FedEx land requirements.

17. **Replacement Fuel Farm.** A replacement fuel farm serving the passenger terminal will be constructed when required for future terminal development or when the Authority and tenant airlines decide to decommission the existing fuel farm to increase storage capacity or address seismic vulnerabilities. The replacement fuel farm will have a gross capacity of 1.75 million gallons of storage in above-ground tanks and require a site of 1.7 acres. Potential sites for a replacement fuel farm are as follows: (1) south midfield area adjacent to Taxiway N; (2) east of Taxiway P to the north of Cargo Central; and (3) west of Airways Boulevard to the south of Raines Road. The alternative locations are shown in Figure 2 and will be examined in further detail when replacement is imminent. In addition to the sites noted above, it is possible that fuel storage for the passenger terminal complex will be accommodated at the WestPac fuel storage facility that serves the FedEx operation.

18. **Replacement Technical School**. The existing technical school will be relocated, when FedEx expansion requires the existing site to the west of Tchulaholma Road and north of Winchester Road, to a site currently occupied by the industrial park between Taxiway Y and Swinnea Road. Existing light industrial buildings on the site will be demolished, allowing a 4.5 acre site for the school with a building of approximately 47,000 feet.

19. **Replacement Authority Office Building**. Authority office space would be relocated and expanded so that the majority of Authority staff can be housed in a single location to the west of Taxiway Y currently occupied by the industrial park. Existing light industrial buildings on the site will be demolished, allowing a 10 acre site for the office building containing an approximately 128,000 square foot building.

20. **Replacement Authority Maintenance Building**. The airfield maintenance facility would be relocated, when FedEx needs require the existing site to the west of Tchulaholma Road and north of Winchester Road, to a site adjacent to the Aircraft Rescue and Fire Fighting facility (east of Taxiway Y). This facility will encompass a site of approximately 16 acres with a

replacement building of 80,000 square feet. Extensive grading and earthworks will be required to bring the site up to airfield elevation.

21. **Replacement Taxi and Commercial Vehicle Staging Facility**. The existing taxi staging area, currently to the north of Concourse A, will be relocated north of the future terminal development. The facility will consist of an approximately 30,000 square foot vehicle parking area and a small structure with restroom, kitchen, and lounge areas totaling approximately 200 square feet. This facility would be constructed on areas currently occupied by public surface parking.

Property Acquisitions

While property acquisition is not required to accommodate planned facility requirements, the following targeted parcels are recommended to be acquired during the planning period to meet strategic development objectives.

22. **Acquisition of Parcels for Runway Protection Zone Clearance**. Runway Protection Zones (RPZs) associated with Runways 9 and 27 both encompass non-compatible land uses. For both runway ends, it is recommended that the Authority work to acquire the parcels within the RPZ that contain places of public assembly. This includes the commercial parcel to the west of the Airport and several light industrial/commercial parcels to the east of the Airport totaling seven acres. Once acquired, these parcels should be cleared in accordance with FAA guidance.

23. **Industrial Park Acquisitions**. The industrial park along Swinnea Road contains a mix of light-industrial uses and is surrounded by Authority-owned property. It is recommended that the parcels within the industrial park not currently owned by the Authority (approximately 30 acres) be acquired during the planning period. These parcels are of strategic importance since they (1) are located proximate to the airfield (despite grade differences); (2) provide the Authority with complete ownership of land to the west of Swinnea Road; and (3) create a large single parcel of land that could be redeveloped in the future.

Baseline Projects

The Authority has several ongoing or planned projects that occur within the planning period but were not recommended as part of the Master Plan Update. These projects are described in the Authority's Airport Capital Improvement Program (ACIP Data Sheets, dated May 2009), and include the following:

- New parking garage, Phase I
- Reconstruction of Runway 9-27 and associated taxiways
- Taxiway Alpha East reconstruction
- Taxiway Victor East reconstruction
- Taxiway fillet modifications for the Boeing 777

- Public access improvements – moving walkway for the new garage
- Airport signage modification
- East Airport Operations Area (AOA) gate entrance relocation and East Lot
- Airfield Lighting Control System (ALCS) replacement
- Glycol environmental control facility
- Passenger terminal apron reconstruction
- Terminal escalator replacement
- Hurricane Creek improvements north of Runway Road
- Second Hurricane Creek taxiway crossing

Baseline projects will be depicted on the Airport Layout Plan (ALP), and their projected costs are accounted for in the financial plan and Capital Improvement Program since the Authority has committed funding to them.

IMPLEMENTATION PLAN

The following describes the estimated costs and phasing for the Recommended Development Plan and other implementation factors.

Cost Estimates and Phasing

Project cost estimates for the Recommended Development Plan are summarized in Table 2. In total, the plan is estimated to cost approximately $660 million over the 20-year planning period. Table 2 also presents a phasing plan for the Recommended Development Plan.

Cost estimates were developed considering (1) a 34% general contractor's markup for escalation, construction contingencies, and design evolution; and (2) a 23% owner soft costs for project management, planning, and design. The estimates presented in Table 2 were prepared in current 2009 dollars.

The cost estimates were adjusted to include an inflationary increase of 3.0% per year through the anticipated year of project implementation for financial planning purposes. Cost estimates for the Baseline projects were developed and provided by the Authority and stated in nominal dollars, so no further adjustments were required.

Environmental/NEPA Considerations

The National Environmental Policy Act (NEPA) of 1969 requires airports operating under the FAA's authority to conduct environmental analyses to address potential environmental effects of major airport actions. Given their magnitude and potential impacts to the natural environment, the following Recommended Development Plan projects may be subject to environmental review under NEPA and will require an FAA determination prior to implementation.

- Consolidated Deicing Pad and South Side Cross Field Taxiways [#2]
- Rental Car Administration, Maintenance, and Vehicle Storage [#16]
- Replacement Fuel Farm [#17]

Table 2

RECOMMENDED DEVELOPMENT PLAN COSTS ESTIMATES
Master Plan Update
Memphis International Airport

Project *(a)*	Recommended project	Cost *(b)*
PAL 1 (2008 - 2012)		
1	Angled M6 exit taxiway	$ 3.5
5	Seismic retrofit of airfield structures over Winchester Road	2.4
6	Concourse C north extension	55.8
10	Building system upgrades	16.2
11	Building interior renovations	12.4
12	Building seismic retrofits	3.2
22	Acquisition of parcels for Runway Protection Zone clearance *(c)*	1.7
23	Industrial Park acquisitions *(d)*	12.2
	Subtotal	$107.4
PAL 2 (2013 - 2017)		
2	Consolidated deicing pad and south-side cross-field taxiways	$ 36.6
7	Concourse C north pavilion	58.7
8	Concourse C south pavilion, FIS, and international gates	79.0
10	Building system upgrades	9.1
11	Building interior renovations	35.6
12	Building seismic retrofits	28.3
15	Surface parking at Airways Boulevard site	17.9
16	Rental car administration, maintenance, and storage	38.3
23	Industrial Park acquisitions *(d)*	12.1
	Subtotal	$315.6
PAL 3 (2018 - 2027)		
3	Runway 18C departure hold pad	$ 6.4
4	Taxiway C extension and Taxiway J realignment	4.3
9	Concourse A north extension	54.7
10	Building system upgrades	17.4
11	Building interior renovations	28.8
12	Building seismic retrofits	28.8
13	Phase II of new parking garage	24.2
14	Surface parking at Radisson Hotel site	8.8
17	Replacement fuel farm	6.1
18	Replacement technical school	11.4
19	Replacement Authority office building	34.1
20	Replacement Authority maintenance building	12.1
21	Replacement taxi and commercial vehicle staging facility	1.3
	Subtotal	$238.4
	Recommended Development Plan Total	**$661.4**

(a) Corresponds to the project numbering on Figure 2, Recommended Development Plan.
(b) Presented in millions of constant 2009 dollars.
(c) Includes land and building costs.
(d) Includes land, building, immovable fixtures, relocation, and miscellaneous costs.

Source: Jacobs Consultancy, Thornton Tomasetti, and Connico, Inc., October 2009.

The following additional projects included in the Recommended Development Plan may or may not require environmental review depending on sponsorship (Authority-sponsored versus Federal or state), funding sources, potential environmental impact, and potential impact to operations:

- Taxiway and hold pad improvements, including angled M6 exit taxiway, Taxiway C extension and Taxiway J realignment, and Runway 18C hold pad
- Concourse C passenger terminal building improvements
- Surface parking improvements
- Land acquisitions

The requested federal action necessitating NEPA review for the above projects will be FAA approval to remove conditional ALP approvals and/or airspace approval for those projects resulting in changes to airspace procedures, including changes to existing FAR Part 77 or TERPS surfaces. Depending on the funding source used for each project, additional federal actions may include requests for federal funding.

It is expected that NEPA review of any of the above projects can be accomplished through the completion of an Environmental Assessment (EA) rather than a more comprehensive Environmental Impact Statement (EIS). However, it is unknown at this time whether the projects can be assessed under a single comprehensive EA or multiple individual EAs. Projects that have independent utility can be assessed separately in an EA. The decisions on independent versus a "packaged" NEPA review should be made in consultation with FAA and will be influenced by implementation timing, funding sources, and funding availability.

Upon completion of the Master Plan Update and approval of the ALP, a proposed near-term environmental strategy is provided below:

1. Develop an implementation strategy on specific near- and mid-term projects given sponsorship decisions and funding sources.
2. Conduct coordination meetings with the FAA to discuss the environmental approval process, obtain confirmation that projects can be assessed with an EA rather than the more comprehensive EIS, and determine whether projects should be evaluated in a "packaged" format or evaluated individually.
3. Initiate the NEPA process, including refinement of the scope, purpose and need, alternatives, and stakeholder coordination, etc.

FINANCIAL PLAN

This section describes the Financial Plan prepared for the Master Plan Update. The Financial Plan was prepared to determine the financial feasibility of the Authority's overall long-term development program, and is inclusive of the Authority's Baseline projects (consisting of ongoing, committed, or planned projects occurring during the planning period) and the first two PALs of the Recommended Development Plan. Improvements recommended in PAL 3 were not included in the Financial Plan because of uncertainties regarding actual implementation dates and future costs.

The financial feasibility specifically considers the effects of the capital program on Authority operations, including airline cost per enplaned passenger (CPE). In general, the analysis presented herein indicates that funding the Recommended Development Plan and Baseline projects is feasible, although changes in key assumptions could affect this conclusion. The Authority does, however, have the flexibility to adjust the timing of projects, and to develop alternative financing plans, which would allow a similar development plan to progress under various changed assumptions.

An overview of the Authority's financial structure and existing financial position is provided in Appendix A.

Assumptions

The Financial Plan was developed using information and assumptions that provide a reasonable basis for analysis at a master plan-appropriate level of detail. Some of the assumptions may not be realized, and unanticipated events and circumstances may occur. Therefore, actual results may vary from those projected, and such variations could be material.

The Financial Plan is not intended to be used to support the sale of bonds or to obtain any other forms of financing. More detailed cost estimates and financial analysis will be required if and when the Authority decides to pursue the sale of bonds or other forms of financing. Some projects included in the Recommended Development Plan may be postponed or eliminated if forecast aviation demand is not achieved, construction costs rise significantly, or if projected funding is not available. Similarly, projects may be undertaken earlier than indicated if demand requires earlier implementation and funding is available.

The following overarching assumptions guided development of the Financial Plan:

- The Authority currently does not impose a passenger facility charge (PFC) and will not implement such a charge in the future. Thus, PFC revenues would not be available to fund future Airport development and there are no assumed losses of AIP entitlement grants.*

- The rate-making formula of the current Airline Agreement will remain in effect through the planning period and that the same allocation formulas used by the Authority to calculate terminal building rentals, landing fees, and apron fees in FY 2010 are appropriate for allocating revenues, operating expenses, and outstanding debt service requirements for future years. The estimated debt service requirement for future bonds was allocated to the appropriate cost centers consistent with the net bond proceeds by project.

- Although development of certain facilities can be accomplished by third-party developers leasing ground from the Authority (the "ground lease" approach) the Financial Plan assumes the Authority would develop all projects identified in the Recommended Development Plan.

- Because the financial contribution of the Authority's two general aviation reliever airports is insignificant, the Financial Plan focuses exclusively on Memphis International Airport.

Additional details and assumptions on specific funding applications are discussed in relevant sections below.

Potential Funding Sources

The following potential sources of funding were considered for the Financial Plan:

- **Federal Airport Improvement Program.** Federal grants-in-aid under the Airport Improvement Program (AIP) can be used to fund most Airport improvements, particularly airfield capacity enhancement projects. There are three types of Federal AIP grants:

  – AIP entitlement grants are annual amounts calculated based on the number of enplaned passengers and a legislated per passenger formula.

  – AIP cargo entitlement grants are similar grants calculated based on the landed weight of all-cargo aircraft and a legislated per pound formula.

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*Under Vision 100, the Authority would forego 50% of its AIP entitlement grants if it were to levy a $3.00 PFC or 75% of its AIP entitlement grants if it were to increase the PFC level to $4.50. Certain legislative proposals to reauthorize the AIP program include raising the PFC level to as much as $6.00, with large- and medium-hub airports (e.g., Memphis) forgoing all AIP entitlement grants in exchange for the higher threshold of PFC.

– AIP discretionary grants are awarded at the discretion of the FAA's based on its determination of priorities for projects at the Airport in relation to funding priorities for the national airport system.

In FY 2009, the Authority was eligible to receive approximately $8.6 million in AIP passenger entitlement grants and $15.1 million in AIP cargo entitlement grants. Apportioned funds, if unspent from previous years, can be carried over for 2 years.

- **State Grants**. State grants, administered by the Aeronautics Division of the Tennessee Department of Transportation (TDOT), are provided to the Authority on an annual basis, although funding sources vary year-by-year. TDOT funds its grant program primarily from a tax on the sale of aviation fuels. FedEx provides the largest single source of aviation fuel tax payments to TDOT. Except for routine expenditures, grant applications are reviewed by the Tennessee Aeronautics Commission, which is a five member board charged with policy planning and with regulating changes in the state airport system plan.
- **Customer Facility Charge.** Revenues from a Customer Facility Charge (CFC) are derived by the imposition of charges on rental car customers and provide funding to certain eligible and approved rental car projects.
- **Internal funds.** Internally generated cash flows can be used to fund improvements if available, and to the extent permitted under the Airline Agreement.
- **Bond proceeds.** Proceeds from bonds can supplement the above sources for funding future development projects.

The amount of funding available from each of the above sources and the application of available funding to future projects is described in the following sections.

Application of Funding Sources

This section describes the application of funding sources to Baseline and Recommended Development Plan projects. Since certain sources of funds, such as AIP grants and CFC revenues, have restrictions on how they can be used, aligning the source of capital funds with allowable and optimal uses is essential for maximizing financial capacity. In general, specific funding sources for projects were determined considering the following:

- The Baseline projects were reviewed to confirm that existing funding commitments were accounted for and that these commitments did not conflict with the funding assumptions for projects in the Recommended Development Plan.

- Projected funding available from AIP, TDOT, and CFC sources takes into account key factors affecting future funding levels, including future AIP authorizations and forecast passenger and cargo activity at the Airport.

- Based on FAA classifications, the Airport is a medium-hub airport, and therefore, the Authority must provide a 25% local match of eligible project costs. Furthermore, the Airport's medium-hub status makes terminal projects ineligible for AIP discretionary grants.

- Each funding source was matched to the best use in a given year, taking into consideration debt coverage requirements, fund balance requirements, and future funding needs.

Table 3 presents the estimated funding sources for projects included in the Financial Plan. Estimated project costs total $924 million consisting of $445 million in costs for Baseline projects (48%) and $479 million in costs for the Recommended Development Plan through PAL 2 (52%). About 10% of the costs of Baseline projects and 89% of the costs of the Recommended Development Plan are to be financed with new additional bonds, and the balance are to be funded with grants and other non-debt sources of funds.

Table 4 presents the sources and uses of funds by year through FY 2020. The analysis indicates that to finance the Recommended Development Plan the Authority would have to rely on the proceeds of Bonds starting in FY 2010 and in each year thereafter through FY 2017. The annual requirement for bond proceeds range from $22 million in FY 2012 to $95 million in FY 2014.

The amount of funding available from the various funding sources and the application of that funding to specific projects is summarized in the following sections.

Table 3

FUNDING SOURCES OF CAPITAL PROJECTS

(dollars in thousands)
Master Plan Update
Memphis International Airport

		Project Funding through FY 2017								
	Estimated	AIP Grants			CFC	Capital	Bonds			
Project	Project Cost	Ent.	Disc.	State	PAYGO	Funds	Prior	New	Other	Total
Baseline Projects (FY 2009 and Beyond)										
New parking garage phase I	$151,740	$ 9,885	$ --	$ 50,000	$20,528	$ --	$37,631	$ 33,696	$--	$151,740
Runway and taxiway	99,185	48,889	25,500	--	--	24,796	--	--	--	99,185
Apron construction	100,000	75,000	--	25,000	--	--	--	--	--	100,000
Glycol facility	66,500	29,375	10,000	27,125	--	--	--	--	--	66,500
Other projects	27,574	12,431	--	--	--	4,143	--	11,000	--	27,574
Subtotal Baseline	$444,998	$175,580	$35,500	$102,125	$20,528	$28,939	$37,631	$ 44,696	$--	$444,998
Recommended Development Plan thru PAL 2 *(a)*										
Airfield										
Angled M6 exit taxiway	$ 3,824	$ --	$ 2,868	$ --	$ --	$ --	$ --	$ 956	$--	$ 3,824
Consolidated deicing pad and southside crossfield taxiways	42,946	12,500	19,709	--	--	--	--	10,736	--	42,946
Seismic retrofits of airfield structures	2,546	--	1,910	--	--	--	--	637	--	2,546
Subtotal airfield	$ 49,316	$ 12,500	$24,487	$ --	$ --	$ --	$ --	$ 12,329	$--	$ 49,316
Terminal										
Concourse C north extension	$ 59,236	$ --	$ --	$ --	$ --	$ --	$ --	$ 59,236	$--	$ 59,236
Concourse C north pavilion	67,070	--	--	--	--	--	--	67,070	--	67,070
Concourse C south pavilion, FIS, and international gates	92,149	--	--	--	--	--	--	92,149	--	92,149
Building system upgrades	27,746	--	--	--	--	--	--	27,746	--	27,746
Interior renovations	46,460	--	--	--	--	--	--	46,460	--	46,460
Seismic retrofits	37,047	--	--	--	--	--	--	37,047	--	37,047
Subtotal terminal	$329,709	$ --	$ --	$ --	$ --	$ --	$ --	$329,709	$--	$329,709
Ground transportation										
Surface parking at Airways Boulevard site	$ 22,543	$ --	$ --	$ --	$ --	$ --	$ --	$ 22,543	$--	$ 22,543
Rental car administration, maintenance, and vehicle storage	48,172	--	--	--	13,068	--	--	35,104	--	48,172
Subtotal ground transportation	$ 70,715	$ --	$ --	$ --	$13,068	$ --	$ --	$ 57,647	$--	$ 70,715
Property acquisition										
RPZ clearance	$1,777	$ --	$ 1,333	$ --	$ --	$ --	$ --	$444	$--	$ 1,777
Industrial park	27,251	--	--	--	--	--	--	27,251	--	27,251
Subtotal property acquisition	$ 29,029	$ --	$ 1,333	$ --	$ --	$ --	$ --	$ 27,696	$--	$ 29,029
Total Recommended Development Plan thru PAL 2	$478,769	$ 12,500	$25,820	$ --	$13,068	$ --	$ --	$427,380	$--	$478,769
GRAND TOTAL	$923,767	$188,080	$61,320	$102,125	$33,597	$28,939	$37,631	$472,076	$--	$923,767

(a) Project costs have been escalated to year of construction assuming an annual rate of 3%.

Source: Jacobs Consultancy, based on data provided by Memphis-Shelby County Airport Authority, October 2009.

Table 4

SUMMARY OF CAPITAL PROJECT FUNDING
(for the 12 months ending June 30; dollars in thousands)
Master Plan Update
Memphis International Airport

	PAL 1			PAL 2					Total
	thru 2010	2011	2012	2013	2014	2015	2016	2017	PAL 1 & PAL 2
Baseline Projects									
FAA AIP Grants									
Entitlement	$ 47,997	$ 13,277	$20,690	$ 9,702	$ 21,459	$ 19,861	$21,197	$ 21,396	$175,580
Discretionary	14,360	11,140	--	1,219	996	4,495	1,609	1,682	35,500
State Grants	30,000	20,000	6,437	4,946	6,429	14,411	9,855	10,047	102,125
CFC									
PAYGO	12,317	8,211	--	--	--	--	--	--	20,528
Capital Funds	18,807	6,821	460	400	2,450	--	--	--	28,939
Bonds									
Prior	22,579	15,052	--	--	--	--	--	--	37,631
New	29,017	15,678	--	--	--	--	--	--	44,696
Others	--	--	--	--	--	--	--	--	--
Total Baseline Projects	$175,078	$ 90,180	$27,587	$16,267	$ 31,333	$ 38,767	$32,662	$ 33,124	$444,998
Recommended Development Plan thru PAL 2									
FAA AIP Grants									
Entitlement	$ --	$ --	$ --	$ 2,398	$ 2,470	$ 7,632	$ --	$--	$ 12,500
Discretionary	647	2,527	2,937	3,781	3,894	12,034	--	--	25,820
State Grants	--	--	--	--	--	--	--	--	--
CFC									--
PAYGO	--	--	--	--	--	--	2,552	10,516	13,068
Capital Funds	--	--	--	--	--	--	--	--	--
Bonds									
Prior	--	--	--	--	--	--	--	--	--
New	27,537	48,350	22,450	72,058	95,498	67,682	29,071	64,734	427,380
Others	--	--	--	--	--	--	--	--	--
Total Recommended Development Plan	$ 28,184	$ 50,877	$25,387	$78,237	$101,862	$ 87,348	$31,624	$ 75,250	$478,769
GRAND TOTAL	$203,261	$141,058	$52,974	$94,504	$133,196	$126,114	$64,286	$108,374	$923,767

Source: Jacobs Consultancy, based on data provided by Memphis-Shelby County Airport Authority, October 2009.

AIP Grants. Future entitlement and discretionary AIP grants are projected to provide about $12.5 million and $24.8 million, respectively, of pay-as-you-go funding capacity for the Recommended Development Plan. Future AIP funding is based on the following specific assumptions:

- Annual AIP appropriation will stay above $3.2 million and the existing grant formula will remain in effect throughout the forecast period.
- AIP entitlement grants through 2020 will be fully committed to the Baseline projects, except for $12.5 million planned for the consolidated deicing pad and south-side cross-field taxiway project. Otherwise, no AIP entitlement grants will be available to fund the Recommended Development Plan.
- AIP discretionary grants of $24.8 million will be available for various airfield projects in the Recommended Development Plan, although no airfield capacity projects will qualify for a Letter of Intent (LOI). If AIP discretionary grants are not available, it will be necessary to defer such projects until funds become available or there is agreement to fund such projects from bond proceeds or other sources.

An LOI represents the FAA's intention to obligate funds from future federal budget appropriations and thus provides a predictable funding schedule for AIP discretionary grants. The Authority was granted an LOI in 2002 by the FAA for $75.4 million of discretionary grants to fund construction of Taxiway Y and reconstruction of Runway 18R-36L and Taxiway M. The Authority, which has already collected a substantial amount of this LOI, expects to collect the remaining amount by 2011.

State Grants. It was assumed that the Authority would receive $9 million per year in TDOT grants and that all TDOT grants would be fully committed to the Baseline projects and not available to fund projects included in the Recommended Development Plan.

CFC Revenues. Effective April 2007, the Authority re-instituted collection of a CFC at a rate of $4.00 per transaction day per vehicle to be collected from the customers of all rental car companies operating at or serving the Airport with the proceeds to be utilized to fund the construction of facilities for rental car companies. The rental car facilities constitute a Baseline Project. For purposes of this Financial Plan, it was assumed that CFC revenues would be used to pay a portion of the debt service on the 2010 Bonds as well as funding $10.4 million of cost of rental car projects in the Recommended Development Plan on a pay-as-you-go basis.

Internally Generated Funds. Under the Airline Agreement, the Authority retains $1 million per year as cash flow for its discretionary use. The Authority plans to retain a portion of these moneys as liquidity for fluctuations in cash flow and to use the remainder to fund capital outlay. Additionally, grant reimburse-ments of bond-funded projects has enabled the Authority to accumulate moneys for capital expenditures in various capital funds. The Authority has allocated virtually all available moneys in the capital funds to the Baseline projects. For the purpose of this analysis, it was assumed that no moneys from the capital funds would be available to fund projects in the Recommended Development Plan.

Revenue Bond Financing. Remaining project costs not funded through AIP grants, TDOT grants, CFC revenues, or internally generated funds would be financed through the issuance of Bonds. Bond issues would be required to finance a portion of the Baseline projects and to fund approximately 90% of the costs of the Recommended Development Plan.

The Authority's financial operations are governed by a Bond Resolution (see Appendix A). Under the Bond Resolution, bonds are secured by and payable from a pledge and lien on Authority revenues after the payment of the costs of operation and maintenance. The Authority may grant as additional security a pledge of and lien on all or a portion of CFC and PFC revenues (if any).

The issuance of additional bonds is limited by the Authority's ability to meet the requirements of the Additional Bonds Test and the Rate Covenant of the Bond Resolution (see Appendix A). Bond financing capacity is constrained by these requirements and by the intention of the Authority to control costs. Thus, bond financing capacity and expectations about revenues and costs of operation and maintenance may influence the scope and timing of projects.

Bond funding of projects included in Tables 3 and 4 is based on the following assumptions:

- Majority-in-interest (MII) approval will be obtained for Baseline projects to be financed with the proceeds of bonds; and MII approval, if necessary, will be obtained for all projects in the Recommended Development Plan to be financed with the proceeds of bonds.

- All bonds will be issued under the Bond Resolution; no general obligations bonds will be issued by the City of Memphis.

- Bonds will be issued in FY 2010 in the aggregate principal amounts of $53.1 million to finance the net project costs of the Baseline projects.

- Bonds will be issued in FY 2011 in the aggregate principal amount of $124.0 million to finance the net project costs of the PAL 1 projects.

- Bonds will be issued in FY 2013 and FY 2015 in the aggregate principal amounts of $211.3 million and $216.8 million, respectively, to finance the net project costs of the PAL 2 projects.

Consideration of Costs and Revenues

The following summarizes costs and revenues associated with implementation of Baseline projects and the Recommended Development Plan.

Debt Service Requirements. The debt service requirement represents the scheduled annual principal and interest payments on the outstanding bonds and the additional bonds to be issued by the Authority to finance the Baseline projects and Recommended Development Plan. Requirements for debt service are based on the following assumptions:

- The annual debt service requirement on future bonds was calculated assuming (1) bonds are to be amortized over a 30-year period from the date of issuance; (2) level annual debt service for each issue; (3) a coupon rate of 6.0%; and (4) earnings rates of 2.0% in the construction and capitalized interest funds and 4.0% in the Bond Reserve Account. The actual structure and sizing of future bond issues will depend on municipal market conditions at the time of issuance.

- The annual debt service requirement excludes capitalized interest, accrued interest on the date of issuance (if any), and certain CFC revenues identified by the Authority for deposit annually to the Bond Fund to pay interest and principal on outstanding bonds.

- The debt service requirement for each future issue of bonds was calculated as level annual debt service. The debt service requirement for each future issue was layered onto the structure created by the then outstanding bonds. There was no attempt to create level annual debt service in the aggregate over a 30-year period even though the front-loaded structure of currently outstanding debt would enable the Authority to use longer maturities to fill in the backend of the schedule and thereby level the debt.

As a result of project bond issues, the annual debt service requirement is projected to increase during the planning period, which will also result in increases to airline costs. The debt service coverage calculation shown in Table 5 was developed in accordance with the Bond Resolution, and net revenues are projected to be 1.25 times the debt service requirement. Based on this result, the Authority would comply with the Rate Covenant each year during the forecast period.

Table 5

SUMMARY OF FINANCIAL ANALYSIS

(for the 12 months ending June 30; dollars in thousands except ratios)
Master Plan Update
Memphis International Airport

		Actual	Budget	Forecast									
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Revenues													
Passenger airline revenues													
Landing fees	$ 10,654	$ 9,628	$ 9,570	$ 11,632	$ 11,573	$ 12,515	$ 12,438	$ 13,544	$ 12,578	$ 12,886	$ 14,107	$ 13,904	$ 14,197
Terminal rents	13,832	13,450	12,997	14,256	11,511	18,806	18,839	37,288	36,564	37,630	55,137	53,624	54,603
Other airline rentals	501	436	491	533	554	576	599	623	648	674	701	729	758
Subtotal	$ 24,987	$ 23,514	$ 23,058	$ 26,421	$ 23,638	$ 31,897	$ 31,877	$ 51,455	$ 49,791	$ 51,189	$ 69,945	$ 68,257	$ 69,558
FIS fee/Debt service rental	6,642	6,830	6,707	6,747	6,786	6,815	6,844	6,873	6,903	6,934	6,966	6,999	7,032
Total passenger airline payments	$ 31,629	$ 30,344	$ 29,765	$ 33,167	$ 30,424	$ 38,712	$ 38,720	$ 58,328	$ 56,694	$ 58,124	$ 76,911	$ 75,256	$7 6,590
Cargo landing fee	28,722	27,187	27,531	27,620	27,480	29,716	29,533	32,159	29,867	30,597	33,497	33,013	33,709
Cargo rental	4,956	5,584	6,197	6,259	6,322	6,385	6,449	6,513	6,578	6,644	6,711	6,778	6,845
Airline revenues	$ 65,307	$ 63,115	$ 63,493	$ 67,047	$ 64,226	$ 74,813	$ 74,702	$ 97,001	$ 93,139	$ 95,365	$117,118	$115,047	$117,145
Terminal	8,954	8,406	9,697	10,088	10,493	10,858	11,240	11,638	12,054	12,489	12,942	13,416	13,911
Ground transport	23,740	20,970	21,390	22,027	22,674	23,807	24,355	24,921	25,505	26,112	27,437	28,099	28,786
Aviation and airfield	5,713	6,527	5,747	5,819	5,946	6,079	6,178	6,334	6,361	6,493	6,643	6,767	6,911
Other	2,003	1,955	1,923	1,926	1,929	2,066	2,069	2,072	2,076	2,079	2,083	2,087	2,090
GA	1,304	1,201	1,521	1,521	1,521	1,521	1,521	1,521	1,521	1,521	1,521	1,521	1,521
Non-Operating Revenues	21,897	22,068	20,982	16,346	14,789	15,589	17,545	18,084	22,065	21,709	21,709	25,812	25,812
Total revenues	$128,918	$124,242	$124,751	$124,773	$121,577	$134,732	$137,609	$161,571	$162,721	$165,768	$189,453	$192,749	$196,176
Expenses													
Operating and maintenance expenses	$ 54,434	$ 52,752	$ 57,639	$ 60,144	$ 63,050	$ 66,454	$ 69,112	$ 73,246	$ 76,176	$ 79,223	$ 82,392	$ 85,688	$ 89,116
Net revenues	$ 74,484	$ 71,490	$ 67,113	$ 64,629	$ 58,527	$ 68,278	$ 68,497	$ 88,325	$ 86,544	$ 86,544	$107,061	$107,061	$107,061
Debt service requirements													
Outstanding Bonds	$ 55,322	$ 55,236	$ 53,501	$ 51,703	$ 45,845	$ 44,398	$ 44,573	$ 44,677	$ 43,253	$ 43,253	$ 43,253	$ 43,253	$ 43,253
2010 Gross Debt Service	--	--	--	--	3,907	3,907	3,907	3,907	3,907	3,907	3,907	3,907	3,907
Offset by CFC Revenues	--	--	--	--	(2,930)	(2,930)	(2,930)	(2,930)	(2,930)	(2,930)	(2,930)	(2,930)	(2,930)
2011 Bonds	--	--	--	--	--	--	--	--	--	--	--	-	-
PAL 1	--	--	--	--	--	9,248	9,248	9,248	9,248	9,248	9,248	9,248	9,248
PAL 2A	--	--	--	--	--	--	--	15,758	15,758	15,758	15,758	15,758	15,758
PAL 2B	--	--	--	--	--	--	--	--	--	--	16,413	16,413	16,413
Subtotal	$ 55,322	$ 55,236	$ 53,501	$ 51,703	$ 46,822	$ 54,622	$ 54,798	$ 70,660	$ 69,236	$ 69,236	$ 85,648	$ 85,648	$ 85,648
Coverage	$ 1.35	$ 1.29	$ 1.25	$ 1.25	$ 1.25	$ 1.25	$ 1.25	$ 1.25	$ 1.25	$ 1.25	$ 1.25	$ 1.25	$ 1.25
Passenger airline cost per enplaned passenger	$ 5.89	$ 6.10	$ 5.24	$ 5.70	$ 5.11	$ 6.41	$ 6.31	$ 9.35	$ 8.94	$ 9.02	$ 11.74	$ 11.30	$ 11.31

Source: Jacobs Consultancy, November 2009.

Operations and Maintenance Costs. The costs of operations and maintenance were projected by analyzing historical trends in expenses by cost center. Operations and maintenance costs were projected using the FY 2010 budget as a base taking into account management plans, facility development plans, expected increases in inflation, and other assumptions. It was assumed that overall operations and maintenance costs will increase 4.0% per year on average over the FY 2010 budget. The incremental operations and maintenance costs are estimated to be $500,000 per year for the parking garage; $200,000 per year for other Baseline projects; $0.9 million per year for PAL 1 projects; and $1.4 million per year for PAL 2 projects.

Future Revenues. Future revenues must be sufficient to provide for payment of the (1) cost of operation and maintenance; (2) debt service requirement on the outstanding bonds and additional bonds; (3) debt service on General Obligation Bonds issued for the Airport; and (4) other subordinated indebtedness. Sources of airline and non-airline revenues are summarized below:

- **Non-airline Revenues** – The principal sources of non-airline revenues include parking fees, rental cars, concessions, non-airline rents, and interest on Authority fund balances. Non-airline revenues were projected by analyzing the trend in revenue by line item and cost center and comparing those revenues to passenger activity. In order to best match historical trends, individual revenues were projected either by using revenue per enplaned passenger adjusted for inflation (2.5%), or the entire line item adjusted to reflect expected future adjustments (1.0%). In cases of long-term leases, revenues were projected based on the lease terms and expectations for any renewals. Parking revenue was adjusted to reflect an anticipated rate increase of 5% every 5 years.

- **Airline Revenues** – Airline revenues are generated primarily through landing fees and terminal rents, as determined by applying the provisions of the Authority's Airline Agreement (see Appendix A) to projected non-airline revenues, airline cost center expenses, and debt service. The Airline Agreements, which expired in 2007, have been renewed and are to expire in 2010. The Authority and signatory airlines could continue to renew and extend the Airline Agreement. It was assumed in the financial projections that the provisions of the Airline Agreement will continue in effect during the forecast period, although that assumption is subject to change as a result of any lease renegotiation.

Effect on Airline Costs Per Enplaned Passenger

The last line of Table 5 summarizes passenger airline costs expressed on a per enplaned passenger basis (CPE). The forecasts were based on the assumption that the terms of the current Airline Agreement relating to the calculation of airline rentals, fees, and charges will extend through the forecast period and that the airlines collectively will make all payments required by such terms.

Airline payments to airports (landing fees, terminal rentals, apron fees, and other payments) represent a relatively small percentage of an airline's overall cost structure. Nevertheless, required airline payments, which must ostensibly be recovered through airfares (and ancillary revenues), can affect airline business decisions, particularly in areas where there is competition among airports or attractive alternate travel modes. Airline payments at a given airport may affect airline decision-making regarding expanding service or continuing to provide service at that airport.

Airline costs per enplaned passenger are commonly used as a summary measure of "affordability" of an airport and its proposed capital improvement program. Comparisons of airline costs per enplaned passenger among individual airports are difficult, as they can be calculated in various ways and the services provided at an airport in exchange for the airline payments vary greatly throughout the industry. Nonetheless, comparisons are frequently used to gauge the reasonableness of capital improvement programs.

For the Authority, the ultimate gauge is the willingness of an MII of the Signatory Airlines to approve the projects to be financed with the proceeds of bonds. This approval of the Signatory Airlines signifies that the CPE associated with the approved program is, in the view of such airlines, reasonable and thus the program itself is "affordable."

Appendix A

AUTHORITY FINANCIAL STRUCTURE

Appendix A

AUTHORITY FINANCIAL STRUCTURE

This follows summarizes the Authority's financial structure and existing financial position.

ENABLING AND GOVERNING LEGISLATION

The Memphis-Shelby County Airport Authority (the Authority) was created in 1969 pursuant to the Metropolitan Airport Authority Act (the 1969 Enabling Act). In accordance with the 1969 Enabling Act, the City of Memphis (the City) entered into an agreement dated May 26, 1970 with the Authority (the 1970 Transfer Agreement), which transferred all airport properties, functions, and outstanding obligations to the Authority. The Authority owns and operates the Memphis International Airport (the Airport) and two general aviation reliever airports – Charles W. Baker Airport and General DeWitt Spain Airport. The Authority is governed by a seven-member Board of Commissioners (the Board). The Board appoints a president who directs the management and operation of the Authority's three airports (collectively, the Airports System). The Authority operates as a financially self-sufficient enterprise. Separate accounts are maintained for each of the three airports.

Provisions of the 1970 Transfer Agreement require the Authority to prepare an annual operating budget that must be filed with the City. A five-year capital improvement program, including modifications and reasons therefore is also required to be submitted each year. Although the budgets are required to be filed with the City, the Board is responsible for approving the budget and any subsequent revisions. The Board establishes policies, rules, and regulations and approves contracts. The Board is also responsible for certain strategic business arrangements and other administrative and managerial functions, such as negotiation of airline agreements, regulation of aeronautical rates and charges, compliance with grant assurances, development of marketing and development policies, and preparation of long-range plans.

The financial operations of the Authority are governed by the following documents:

- The 1969 Enabling Act and 1970 Transfer Agreement
- Resolution No. 88-3227 adopted by the Board on January 29, 1988, as amended (the Basic Resolution) and various Supplemental Resolutions adopted by the Board in connection with the issuance of multiple series of Airport Revenue Bonds (the collectively with the Basic Resolution, the Bond Resolution).
- Use and lease agreements with various airlines; and concession agreements and leases with other tenants at the Airport (including those associated with food and beverage, merchandise, rental cars, automobile parking, ground transportation, and other services)

- Federal statutory and constitutional provisions, including but not limited to the Aviation and Transportation Security Act, the Anti-Head Tax Act of 1973, the Airport and Airways Improvement Act of 1982, the Interstate Commerce Clause of the United States Constitution, Vision 100 – Century of Aviation Reauthorization Act of 2003 (Vision 100), and subsequent extensions

- U.S. Department of Transportation policies mandated by the FAA Authorization Act of 1994 related to airport rates and charges, rules for resolving disputes, and revenue diversion

- Various policies adopted by the Authority

Key governing documents mentioned above are discussed in more detail below.

BOND RESOLUTION AND RATE COVENANT

The Bond Resolution sets forth the covenants of the Authority with respect to: (1) establishing rates, fees, and charges as provided under the Rate Covenant; (2) issuing additional bonds; and (3) paying the costs of operation and maintenance and debt service requirement, among other expenses.

In the Bond Resolution, Section 5.2 (the Rate Covenant), the Authority covenants to impose and collect rates, rentals, fees, and other charges from users and tenants of the Airport so as to produce revenues sufficient to ensure that the Airport "shall be and always remain financially self-sufficient and self-sustaining." Specifically, the Authority covenants to collect rates and charges sufficient to pay (1) debt service on outstanding Bonds; (2) debt service on outstanding City of Memphis General Obligation Bonds issued for the Airport; (3) costs of operation and maintenance of the Airport; and (4) all other charges and obligations payable from Airport Revenues. The Rate Covenant further requires that net revenues (i.e., revenues less the costs of operation and maintenance) must equal at least 125% of the debt service requirement of all outstanding bonds.

The Authority may issue additional bonds provided, among other things, that net revenues for a period after the project(s) being financed with the additional bonds are placed in service are forecast to be not less than 125% of the debt service requirement on bonds then outstanding and such additional bonds.

AIRLINE AGREEMENT

The Authority has entered into Airport use and lease agreements (collectively, the Airline Agreement) with various airlines (the Signatory Airlines) serving the Airport. The Signatory Airlines include American Airlines, Delta Air Lines, FedEx, and Northwest Airlines, among others.* The Airline Agreement, originally set to expire by its terms on June 30, 2007, has been extended twice and is now to expire on June 30, 2010.

The Airline Agreement establishes procedures for the annual review and adjustment of Signatory Airline terminal building rentals, aircraft landing fees, and apron use fees according to a "residual cost" formula so as to ensure that the Rate Covenant of the Bond Resolution is met and 125% coverage of bond debt service by net revenues is provided. Signatory Airline rentals and fees are calculated according to a "residual cost" formula to ensure that the Authority generates sufficient revenues to accomplish the following:

- Pay debt service on all outstanding bonds and City of Memphis General Obligation Bonds issued for the Airport

- Provide for at least 125% debt service coverage on Bonds as required by the Rate Covenant

- Pay the costs of operation and maintenance (including making provision for required capital outlays)

- Make agreed-upon contributions to the Discretionary Account.

The discretionary account is a creation of the Airline Agreement, which permits the Authority, after satisfying all requirements of the Bond Resolution, to retain up to $1.0 million in revenues annually for any legal airport purpose. Remaining revenues are treated as revenues in the subsequent fiscal year and taken into account in the calculation of Signatory Airline rentals and fees.

Under the residual cost formula, revenues from all sources other than Signatory Airline rentals and fees are credited against the requirements to determine the amount of Signatory Airline rentals and fees to be paid. The accumulated surplus in the Revenue Fund, after all other required payments have been made, may be

*In April 2008, Northwest announced that it would become known at Delta Air Lines (Delta) once the merger with Delta was completed. In October 2008, Delta completed its merger with Northwest to form the world's largest passenger airline. Northwest, a wholly-owned subsidiary of Delta, will continue to operate as an independent airline until the U.S. Department of Transportation (DOT) combines the operating certificates of the two airlines into a single certificate. For the purpose of this report, we use the terms Delta or Northwest, when referring to activity of the airlines prior to their merger, and Delta/Northwest (DL/NW) when referring to the combined airline following their merger.

included as a credit in the next annual calculation of the net requirements to be met. Amounts accumulated to ensure that the 1.25 debt service coverage requirement of the Rate Covenant is met are to be held in the Coverage Account and rolled over as a credit against required rentals and fees in later years.

Airport Cost Centers

The Airline Agreement defines direct cost centers to be used in accounting for "revenues and expenses and for calculating and adjusting rentals, fees and charges." These direct cost centers include:

- **Terminal Complex Area –** Includes the terminal buildings, access roads, public and employee automobile parking areas, rental car facilities, motels and hotels together with concessions operated in or in conjunction with the terminal buildings.

- **Terminal Aircraft Apron Area –** Areas reserved for the parking, servicing, and ground handling of aircraft at the terminal buildings.

- **Cargo Building Area –** Areas reserved for cargo buildings, staff and customer parking and associated lading docks, aprons, driveways and access gates adjacent and pertinent to air cargo operations.

- **Industrial Park Area –** Areas designated as industrial park areas on the Airport.

- **Landing Field Area –** Areas reserved for landing, taking off, taxiing, and parking of aircraft except as otherwise provided in the forgoing cost centers.

The cost center requirement for rate calculation purposes generally includes the allocable potion of the following costs:

- Cost of operation and maintenance

- Debt service requirement

- General obligation bonds debt service

- Debt service coverage (25% of the debt service requirement to the extent necessary to insure compliance with the rate covenant)

In the computation of landing fees, the Landing Field Area requirement also includes the net costs (or revenues) of the two general aviation reliever airports.

Terminal Building Rentals and Apron Fees

The Signatory Airline terminal building space rentals are calculated by dividing the net rental requirement by the effective square footage of space actually rented by the Signatory Airlines. The net rental requirement is calculated by adding all requirements allocable to the Terminal Complex Area and subtracting all revenues allocable to the Terminal Complex Area.

Different rates apply to different classes of airline space. Signatory Airlines pay for space and facilities used in common or jointly with others, such as inbound baggage and baggage claim areas, according to per-use formulas at rates equivalent to those that apply to preferentially or exclusively leased premises. Airlines not signatory to the Airline Agreement pay terminal building rentals at 125% of the Signatory Airline rates.

Under the terms of supplementary lease agreements, Northwest Airlines is committed to paying additional terminal building rentals to meet the debt service on those Bonds issued by the Authority to finance expansions to the terminal building and other facilities for lease by Northwest.

Under the Airline Agreement, the Signatory Airlines pay fees for the preferential use of passenger terminal apron aircraft parking positions calculated according to a residual cost formula similar to those used to calculate terminal building rentals and landing fees.

Landing Fees

The Signatory Airline aircraft landing fees are calculated by dividing the net landing fee requirement by the forecast of annual Signatory Airline landed weight. In calculating the net landing fee requirement the costs allocable to the Landing Field Area (and all other areas of the Airport except for the Terminal Complex Area, Terminal Aircraft Apron Area, Cargo Building Area, and Industrial Area) are credited with the revenues allocable to the Landing Field Area. Airlines that are not signatory to the Airline Agreement pay landing fees at 125% of the Signatory Airline rate. Regional, foreign flag, and other airlines affiliated with Signatory Airlines pay landing fees at the signatory rate.

Majority-in-Interest Approval

A majority-in-interest is defined in the Airline Agreement as:

- For airfield and cargo projects, at least 51% of the Signatory Airlines that together account for at least 51% of landed weight.
- For terminal building and apron projects, at least 51% of the Signatory Airlines that account for at least 51% of terminal building and apron rentals and fees.
- For any purpose, at least 70% of the Signatory Airlines.

The calculation period for determining shares of landed weight and rentals and fees is the most recent 6 months for which data are available. Airlines affiliated with the Signatory Airlines are not considered in the calculations.

The financing of the Baseline projects with Additional bonds has been approved by a majority-in-interest (MII) of the Signatory Airlines. Assuming a continuation of the same terms and conditions in the existing Airline Agreement, MII approval will also be required to finance of any projects in the Recommended Development Plan with additional bonds.