Capacity Analysis and Facility Requirements

Introduction

The capacity analysis for Boulder Municipal Airport is composed of two distinct elements: the ability of airport facilities to accommodate existing and projected aircraft operations (airfield capacity) and the ability of airport facilities to accommodate existing and projected ground vehicle operations (airport access capacity). The capacity of an airfield is primarily a function of the major aircraft traffic surfaces (runways and taxiways) that compose the facility and the configuration of those surfaces, but it is also related to, and considered in conjunction with, wind coverage, airspace utilization, and the availability and type of navigational aids. Airport access capacity is a function of the existing and/or future vehicular roadways located in the vicinity of the airport and their interface with the various airport specific access roads.

The capacity of the existing airfield and access facilities is analyzed with respect to the ability of each to accommodate current and forecast demand. This analysis aids in the identification of possible deficiencies in the present and/or future airport physical plant.

Airfield Capacity Methodology

This section addresses the evaluation method used to determine the capability of the airside facilities to accommodate aviation operational demand. Evaluation of this capability is expressed in terms of potential excesses and deficiencies in capacity. The methodology utilized for the measurement of airfield capacity in this study is described in FAA Advisory Circular 150/5060-5, *Airport Capacity and Delay.* From this methodology, airfield capacity is defined in the following terms:

- *Hourly Capacity of Runways:* The maximum number of aircraft that can be accommodated under conditions of continuous demand during a one-hour period.

- *Annual Service Volume (ASV):* A reasonable estimate of an airport's annual capacity (i.e., the level of annual aircraft operations that will result in an average annual aircraft delay of approximately one to four minutes).

The capacity of an airport's airside facilities is a function of several factors. These include the layout of the airfield, local environmental conditions, specific characteristics of local aviation demand, and air traffic control requirements. The relationship of these factors and their cumulative impact on airfield capacity is presented in the following paragraphs.

Airfield Layout

The layout or "design" of the airfield refers to the arrangement and interaction of the airfield components, which include the runway system, taxiways, and ramp entrances. As previously described, Boulder Municipal Airport is currently operated with two runways. The primary runway (Runway 8/26) is oriented in an east-west direction, along with a parallel glider landing strip (Runway 8G/26G), which is similarly oriented and located north of the primary runway. The primary runway facility is served by a full-length south side parallel taxiway (i.e., Taxiway "A") with four (4) connector taxiways. The glider runway does not have a parallel taxiway system.

The majority of the Airport's existing landside facilities is located on the south side of the runway and is generally consolidated on the west end of the Airport. These facilities include the several FBO hangars, T-hangar/executive hangar facilities, apron areas, maintenance facilities, and large aircraft storage hangars. Each of these facilities is located to make efficient use of the existing taxiway system. The north side of the Airport is used exclusively for glider operations, and has storage space for glider and tow plane tiedowns, as well as glider-trailer parking positions.

Environmental Conditions

Climatological conditions specific to the location of an airport not only influence the layout of the airfield, but also impact the utilization of the runway system. Variations in the weather resulting in limited cloud ceilings and reduced visibility typically lower airfield capacity, while changes in wind direction and velocity typically dictate runway usage and influence runway capacity.

Ceiling and Visibility. FAA Advisory Circular 150/5060-5, *Airport Capacity and Delay*, describes three categories of ceiling and visibility minimums for use in both capacity and delay calculations. Visual Flight Rules (VFR) conditions occur whenever the cloud ceiling is at least 1,000 feet above ground level and the visibility is at least three statute miles. Instrument Flight Rules (IFR) conditions occur when the reported cloud ceiling is at least 500 feet, but less than 1,000 feet and/or visibility is at least one statute mile, but less than three statute miles. Poor Visibility and Ceiling (PVC) conditions exist whenever the cloud ceiling is less than 500 feet and/or the visibility is less than one statute mile.

However, meteorological data obtained for Boulder Municipal Airport from the National Climatic Data Center for use in this study, has been categorized in terms that are more specific:

- VFR conditions - ceiling equal to or greater than 1,000 feet above ground level and visibility is equal to or greater than 3 statute miles. These conditions occur at the airport approximately 92.6% of the time annually.

- Below minimums – ceiling less than 1,000 feet and/or visibility less than 3-statute miles. These conditions occur at the airport approximately 7.4% of the time annually.
- VFR minimums to referenced Non-Precision Approach minimums - ceiling less than 1,000 feet and/or visibility less than 3 statute miles, but ceiling equal to or greater than 350 feet and visibility equal to or greater than 1-statute mile. These conditions occur at the airport approximately 3.8% of the time annually.
- VFR minimums to standard Category I ILS minimums - ceiling less than 1,000 feet and/or visibility less than 3 statute miles, but ceiling equal to or greater than 200 feet and visibility equal to or greater than ½-statute mile. These conditions occur at the airport approximately 7.1% of the time annually.

Therefore, in consideration of the Airport's lack of existing approach instrumentation (i.e., only visual approaches are provided to each runway) and historical meteorological records), the Airport can be expected to experience VFR conditions approximately 92.6% of the time, and be below minimums approximately 7.4% of the time. Due to the potential safety enhancement that would be provided by an instrument approach, the implementation of future instrument approach procedures at the Airport will be evaluated in the following alternatives analysis chapter of this document.

Wind Coverage. Surface wind conditions (i.e., direction and speed) generally determine the desired alignment and configuration of the runway system. Runways that are not oriented to take advantage of prevailing winds will restrict the capacity of the airport. Wind conditions affect all airplanes in varying degrees; however, the ability to land and takeoff in crosswind conditions varies according to pilot proficiency and aircraft type. Generally, the smaller the aircraft, the more it is affected by the crosswind component.

To determine wind velocity and direction at Boulder Municipal Airport, wind data to construct the all-weather wind rose was obtained for the period of January 1995-through December 2003 from observations taken at JeffCo Airport, which is located approximately 9 nautical miles to the southeast. This was the nearest site for official historic data available from the National Climatic Data Center, and use of this data source was approved by the FAA and referenced in the previous 1992 Airport Master Plan[2]. There were approximately 48,435 observations available for analysis during this eight-year period. The allowable crosswind component is dependent upon the Airport Reference Code (ARC) for the type of aircraft, which utilize the airport on a regular basis. According to the existing 2001 Airport Layout Plan, the current Airport Reference Code (ARC) for Runway 8/26 is Airport Reference Code (ARC) B-II, which applies to the Beech Super King Air B200. This aircraft has a wingspan of 54.5 feet and an approach speed of 103 knots. There is no ARC designation specified or illustrated for the glider landing strip.

In consideration of the ARC B-II classification, these standards specify that the 13-knot crosswind component be utilized for analysis. In addition, it is recognized that the Airport will also continue to serve a significant number of small single and twin-engine aircraft for which the 10.5-knot crosswind component is considered maximum; therefore, the 13-knot and 10.5-knot crosswind components should be analyzed for Boulder Municipal Airport. The following illustration, entitled *ALL WEATHER WIND ROSE: 13-, & 10.5-KNOT CROSSWIND COMPONENTS*, illustrates the all weather wind coverage provided at Boulder Municipal Airport. It should also be noted the purpose of the analysis of the all weather wind coverage data is to confirm the proper orientation/alignment of the runway and determine whether a crosswind runway facility is needed to achieve the specified FAA guidelines for wind coverage.

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[2] A potential alternative source for local Boulder wind data was provided by the National Center for Atmospheric Research (NCAR) and a comparative all weather wind rose was generated by representatives from the Aeronautics Division of the Colorado Department of Transportation (CDOT). This additional data, which is presented in Appendix Two would imply even better wind coverage at Boulder than was indicated by the JeffCo wind data. However, further review of the NCAR wind data suggests possible concerns regarding its accuracy, and these accuracy issues were expressed by the NCAR representatives in advance of providing their wind data. In addition, the Airport's existing Automated Weather Observing System (AWOS) is another potential source of wind and weather data for the region; however, this data is not currently collected and archived for historical reference.

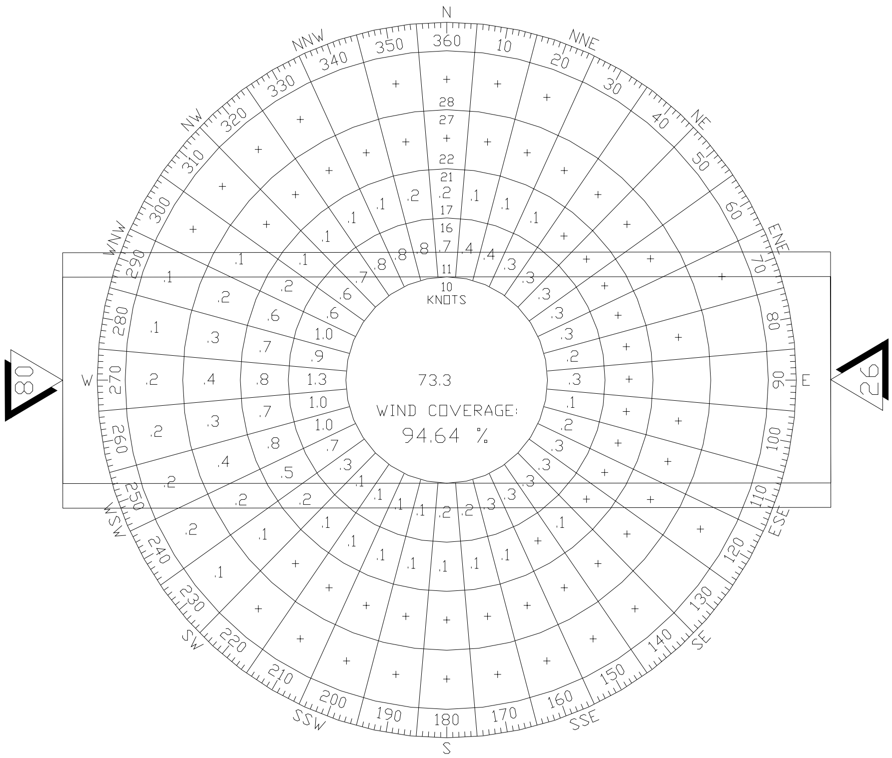
The desirable wind coverage for an airport's runway system is 95%. This means that the runway orientation and configuration should be developed so that the maximum crosswind component is not exceeded more than 5% of the time annually. The following table, entitled *ALL WEATHER WIND COVERAGE SUMMARY*, quantifies the wind coverage offered by the Airport's existing runway system, including the coverage for each runway end. Based on the all weather wind analysis for Boulder Municipal Airport, utilizing the FAA Airport Design Software supplied with AC 150/5300-13, the existing runway configuration provides 94.64% wind coverage for the 13-knot crosswind component and 90.73% for the 10.5-knot crosswind component. Because the wind coverage for the runway is only slightly deficient in consideration of the 13-knot crosswind component, and the fact that there is insufficient airport property to accommodate the siting of a crosswind runway facility, no additional runways will be evaluated from a *wind coverage* standpoint.

Table C1
ALL WEATHER WIND COVERAGE SUMMARY
Boulder Municipal Airport Master Plan Update

Runway Designation	13-Knot Crosswind & 5-Knot Tailwind Component	10.5-Knot Crosswind & 5-Knot Tailwind Component
Runway 8/26	94.64%	90.73%
Runway 8	66.64%	64.47%
Runway 26	79.00%	75.84%

Source: Wind analysis tabulation provided by Barnard Dunkelberg & Company utilizing the FAA Airport Design Software supplied with AC 150/5300-13.

Figure C1
ALL WEATHER WIND ROSE: 13 & 10.5-KNOT CROSSWIND COMPONENTS
Boulder Municipal Airport Master Plan Update



Source: National Oceanic and Atmospheric Administration, National Climatic Data Center
Station # 72469 – Broomfield, Colorado. Period of Record – January 1995-December 2003. Total Observations: 48,435.

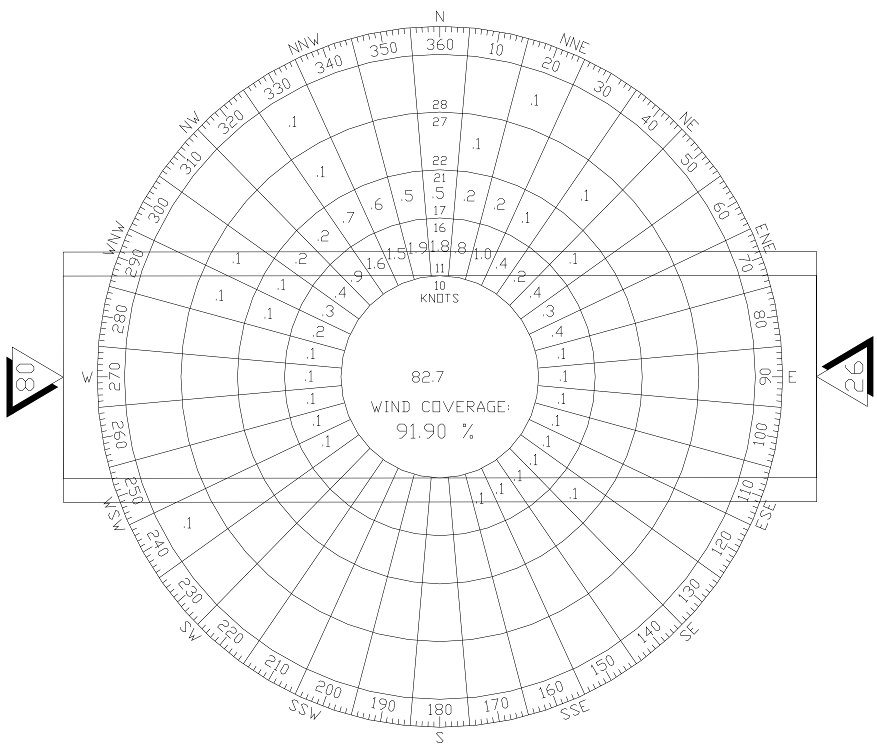
In an effort to evaluate the potential benefits of implementing a future instrument approach procedure at the Airport, an Instrument Flight Rules (IFR) wind rose has been constructed. The following table and illustration quantify the wind coverage offered by each runway end in consideration of future non-precision approach minimums (ceiling less than 1,000 feet and/or visibility less than 3 statute miles, but ceiling equal to or greater than 350 feet and visibility equal to or greater than 1 statute mile).

Table C2
IFR WIND COVERAGE SUMMARY
Boulder Municipal Airport Master Plan Update

Runway Designation	Wind Coverage Provided Under IFR Conditions (1) 13-Knot Maximum Crosswind & 5-Knot Tailwind	Wind Coverage Provided Under IFR Conditions (1) 10.5-Knot Maximum Crosswind & 5-Knot Tailwind
Runway 8/26	91.90%	87.23%
Runway 8	48.07%	46.49%
Runway 26	55.34%	52.24%

Source: Wind analysis tabulation provided by Barnard Dunkelberg & Company utilizing the FAA Airport Design Software supplied with AC 150/5300-13.
(1) Ceiling of less than 1,000 feet, but equal to or greater than 350 feet and/ or visibility less than 3 statute miles, but equal to or greater than 1 statute mile.

Figure C2
IFR WEATHER WIND ROSE: 13- & 10.5-KNOT CROSSWIND COMPONENTS
Boulder Municipal Airport Master Plan Update



Source: National Oceanic and Atmospheric Administration, National Climatic Data Center
Station # 72469 – Broomfield, Colorado. Period of Record – January 1995-December 2003. Total Observations: 47,919.

From this IFR wind coverage summary, it can be determined that Runway 26 provides slightly better wind coverage for each crosswind component. The information provided by this analysis will be incorporated into the formulation of various future airside development alternatives and the ultimate development recommendations for the Airport.

Characteristics of Demand

Certain site-specific characteristics related to aviation use and aircraft fleet makeup impact the capacity of the airfield. These characteristics include runway use, aircraft mix, percent arrivals, touch-and-go operations, and exit taxiways.

Aircraft Mix. The capacity of a runway is dependent on the type and size of the aircraft that utilize the facility. Aircraft are categorized into four classes: Classes A and B consist of small single-engine and twin-engine aircraft (both prop and jet), weighing 12,500 pounds or less, which are representative of the general aviation fleet. Class C and D aircraft are large jet and propeller aircraft typical of those utilized by the airline industry and the military. Aircraft mix is defined as the relative percentage of operations conducted by each of these four classes of aircraft. In consideration of the forecasts presented in the previous chapter, an aircraft mix table has been generated. The following table, entitled *AIRCRAFT CLASS MIX FORECAST, 2002-2022,* presents the projected operational mix for the selected forecasts.

Table C3
AIRCRAFT CLASS MIX FORECAST, 2002-2022
Boulder Municipal Airport Master Plan Update

	VFR Conditions			IFR Conditions		
Year	**Class A & B**	**Class C**	**Class D**	**Class A & B**	**Class C**	**Class D**
2003 (1)	99.0%	1.0%	---	0.0%	0.0%	---
2008	99.0%	1.0%	---	50.0%	50.0%	---
2013	99.0%	1.0%	---	50.0%	50.0%	---
2018	99.0%	1.0%	---	50.0%	50.0%	---
2023	99.0%	1.0%	---	50.0%	50.0%	---

Class A - Small Single Engine, < 12,500 pounds
Class B - Small Twin-Engine, < 12,500 pounds
Class C - 12,500 - 300,000 pounds
Class D - > 300,000 pounds
(1) Existing percentage breakdown was estimated by Barnard Dunkelberg & Company

Percent Arrivals. Runway capacity is also significantly influenced by the percentage of all operations that are arrivals. Because aircraft on final approach are typically given absolute priority over departures, higher percentages of arrivals during peak periods of operations reduce the Annual Service Volume (ASV). The operations mix occurring on the runway system at Boulder Municipal Airport reflects a general balance of arrivals to departures; therefore, it will be assumed in the capacity calculations that arrivals equal departures during the peak period.

Touch-And-Go Operations. A touch-and-go operation refers to an aircraft maneuver in which the aircraft performs a normal landing touchdown followed by an immediate takeoff, without stopping or taxiing clear of the runway. These operations are normally associated with training activity and are included in local operations figures when reported by an air traffic control tower. According to FAA *Form 5010*, local operations are estimated to represent approximately 72% of the total annual operations being conducted at the Airport, and both flight training and glider operations represent a majority of this activity. It is anticipated that the level of flight training will remain through the planning period, and the Airport will continue to be a center for sport aviation enthusiast and training with some business-related itinerant general aviation operations in the future and that the percentage of touch-and-go operations is expected to remain relatively consistent throughout the planning period.

Runway Use. The use configuration of the runway system is determined by the number, location, and orientation of the active runway(s) and relates to the distribution and frequency of aircraft operations to those facilities. Both the prevailing winds and existing operational preferences at Boulder Municipal Airport combine to dictate the utilization of the existing runway system. According to observations by airport management, which coincides with the recommended noise abatement procedures, Runway 8 is the primary use runway end. It is estimated that approximately 85% of the Airport's operations are conducted to the east utilizing Runway 8, with 15% being conducted to the west utilizing Runway 26. It should also be noted that this existing runway utilization breakdown dictates the utilization rates of existing flight patterns, and this information will be incorporated into the modeling of the new noise contours for the Airport.

Exit Taxiways. The capacity of a runway system is greatly influenced by the ability of an aircraft to exit the runway as quickly and safely as possible. Therefore, the quantity and design of the exit taxiways can directly influence aircraft runway occupancy time and the capacity of the runway system.

Due to the location of the existing exit taxiways serving the runway system at Boulder Municipal Airport, the number of available exit taxiways for use in the capacity calculation is adequate. Based upon the mix index of aircraft operating at the airport under VFR conditions, the capacity analysis, as described in the FAA Advisory Circular 150/5060-5, *Airport Capacity and Delay*, gives credit to only those runway exit taxiways located between 2,000 and 4,000 feet from the landing threshold. Therefore, landings to Runway 8 received an exit rating of two (2) and Runway 26 received an exit rating of two (2), with four (4) being the maximum and no credit given for an exit within 750 feet of another exit. According to this analysis, two (2) additional exit taxiways would have to be constructed to achieve the maximum credit for each operating configuration. Given the existing close proximity of a third exit taxiway serving Runway 8, and the Airport's existing/projected operational levels, it is unlikely that additional exit taxiways will be needed at the Airport. However, the future location of all taxiway improvements (if any) will be evaluated in conjunction with the formulation of airside development alternatives.

Air Traffic Control Rules

The FAA specifies separation criteria and operational procedures for aircraft in the vicinity of an airport contingent upon aircraft size, availability of radar, sequencing of operations and noise abatement procedures, both advisory and/or regulatory, which may be in effect at the airport. Typically, the impact of air traffic control on runway capacity is most influenced by aircraft separation requirements dictated by the mix of aircraft utilizing the airport. In addition, Boulder Municipal Airport does not have an Air Traffic Control Tower (ATCT); therefore, Denver Approach would provide any future approach and departure control.

Airfield Capacity Analysis

As previously described, the determination of capacity for Boulder Municipal Airport will utilize the throughput method of calculation, described in the FAA Advisory Circular 150/5060-5, *Airport Capacity and Delay*, along with the Airport Design Computer Program that accompanies AC 150/5300-13. Applying information generated from the preceding analyses, capacity and demand are formulated in terms of the following results:

- Hourly Capacity of Runways (VFR and IFR)
- Annual Service Volume (ASV)

The following capacity computations provide assistance in evaluating the ability of the existing airport facilities, both airside and landside, to accommodate forecast demand.

Hourly Runway Capacity

Calculations of hourly runway capacity begin with an evaluation of each possible runway-use configuration at the Airport. With consideration of the airport's aircraft mix index, annual percentage of touch-and-go operations, existing IFR operating conditions (if applicable), and taxiway exit rating, an hourly capacity was calculated. For all runway use configurations, the airport's base VFR hourly capacity was determined to be approximately 104 operations, with no operations being recorded for the IFR hourly capacity (the Airport is not currently provided with an instrument approach procedure).

Annual Service Volume

After determining the hourly capacity for each potential runway use configuration, a weighted hourly capacity of the entire airport can be calculated. The weighted hourly capacity takes into consideration not only the aircraft mix index, but also the percent utilization of each possible runway use configuration. The weighted hourly capacity for

Boulder Municipal Airport for 2003 was determined to be approximately 45 operations per hour. This weighted hourly capacity can then be used in calculating the ASV for the airport. The ASV is calculated using the following formula:

$$ASV = C_W \times D \times H$$

C_W weighted hourly capacity
D ratio of annual demand to average daily demand
H ratio of average daily demand to average peak hour demand

In consideration of the existing runway configuration, runway utilization patterns and 2003 operation counts (i.e., 68,262), Boulder Municipal Airport has been determined to have a daily demand ratio (D) of 310 operations and an hourly demand ratio (H) of 10.01 operations, and thus, an ASV of approximately 139,848 operations.

Conditions that are involved with the determination of the weighted hourly capacity and the daily demand are not forecast to change significantly in the future; however, the ASV calculation does reflect the addition of an instrument approach procedure at the Airport between the five and ten year planning horizon. It should also be noted that the instrument approach is not being considered for the Airport as a capacity enhancement project, but instead as an access and safety enhancement for those pilots that need to operate at the Airport under IFR or marginal VFR conditions. The hourly ratio, as specified in the formula, is the inverse of the daily operations that occur during the peak hour. In other words, as operations increase, the peak periods tend to spread out, increasing the hourly ratio (H). As the hourly ratio increases, the ASV will also increase. As presented in the following table, even without additional runway or taxiway facilities, the addition of an instrument approach procedure would potentially increase the ASV at Boulder Municipal Airport to approximately 184,382 operations by the year 2023. It should also be emphasized that the estimated ASV for the Airport only represents a projected operational capability for the facility, and not an expectation or desire by the City of Boulder.

For comparison purposes, this ASV tabulation should also be compared with the long-range planning figures for hourly capacity and ASV that are presented in FAA Advisory Circular 150/5060-5. Based on a single runway use configuration with a specified mix index ranging from 0 to 20, the VFR and IFR hourly capacities are projected at 98 and 59 operations respectively, with a projected ASV of 230,000 operations per year. As can be noted, the projected ASV at Boulder Municipal Airport is somewhat restricted due to a variety of factors, which include the lack of IFR hourly capacity at the Airport due to the absence of an instrument approach procedure and the close proximity of adjacent terrain that would limit the ceiling and visibility minimums that could be achieved. Given the projected operational levels at the Airport, which includes the full range of general aviation operations scenarios that were presented in the previous chapter, adequate airfield capacity will be available at the facility beyond the twenty-year planning period of this document, and it should be noted that the addition of an instrument approach procedure is reflected in the ASV calculation for the years 2013, 2018, and 2023.

Table C4
AIRFIELD CAPACITY FORECAST SUMMARY, 2003-2023
Boulder Municipal Airport Master Plan Update

Year	Annual Operations	Design Hour Operations	Annual Service Volume (ASV)
2003	68,262	10	139,848
2008	68,270	10	139,865
2013	74,235	10	181,931
2018	80,721	10	182,609
2023	87,774 [1]	10	184,382

Source: Barnard Dunkelberg and Co.
[1] Projected operational counts varied between 78,459 and 108,417 for the various forecast scenarios.

Ground Access Capacity

The capacity of the landside access system is a function of the maximum number of vehicles that can be accommodated by a particular ground access facility. At Boulder Municipal Airport, this relates primarily to the access roadway system capacity, which is the number of vehicles that can utilize a certain roadway section in a given time period. Thus, the analysis for Boulder is focused on Airport Road (i.e., the primary access road that extends northward from Valmont Road) and the internal access roadway system that extends northward from Airport Road.

Due to the fact that the aviation forecasts for Boulder demonstrate that the Airport's classification and operational levels will not exceed those that were recorded in the 1990's, it is projected that the Airport's current roadway system capacity will be adequate through the planning period of this document. In addition, the 2003 City of Boulder (COB) Transportation Master Plan (TMP) analyzed these same roadway facilities and did not recommend any additional improvements or projects.

Capacity Summary

This section has analyzed the capacity of existing facilities at Boulder Municipal Airport. Both adequate airfield and ground access facilities are critical components in the ability of the Airport as a whole to efficiently serve the public. Capacity deficiencies that cause delays associated within one area will often be reflected in the ability or inability of the entire facility to function properly. Based upon the airside and landside capacity evaluations that have been presented, no additional runway facilities will be required at the Airport to increase operational capacity, and the Airport's current roadway system capacity will be adequate through the planning period of this document, requiring only minor access roadway development to serve existing undeveloped areas of the Airport.

The following facility requirements section will delineate the various facilities required to properly accommodate future demand. That information, in addition to the capacity analysis, will provide the basis for formulating the alternative planning scenarios for the Airport, ensuring that the new recommended master plan can adequately accommodate the long-term aviation development requirements of the Airport.

Facility Requirements

In efforts to identify future demand at the airport for those facilities required to adequately serve future needs, it is necessary to translate the forecast aviation activity into specific types and quantities. This section addresses the actual physical facilities and/or improvements to existing facilities needed to safely and efficiently accommodate the projected demand that will be placed on the airport. This section consists of two separate analyses: those requirements dealing with *airside* facilities and those dealing with *landside* facilities.

Airfield Requirements

The analysis of airfield requirements focuses on the determination of needed facilities and spatial considerations related to the actual operation of aircraft on the Airport. This evaluation includes the delineation of airfield dimensional criteria, the establishment of design parameters for the runway and taxiway system, and an identification of airfield instrumentation and lighting needs.

Airfield Dimensional Criteria

The types of aircraft that currently operate at Boulder Municipal Airport and those that are projected to utilize the facility in the future have an impact on the planning and design of airport facilities. This knowledge assists in the selection of FAA specified design standards for the airport, which include runway/taxiway dimensional requirements; runway length; and runway, taxiway, and apron strength. These standards apply to the "Design Aircraft", which either currently utilizes the airport or which is projected to utilize the airport in the future. As previously mentioned, the Beech Super King Air B200 has been identified as the Airport's "Design Aircraft" for Runway 8/26 with regard to physical dimensions (i.e., 54.5 wingspan) and approach speed (i.e., 103 knots).

According to FAA Advisory Circular 150/5300-13, Airport Design, the first step in defining an airport's design geometry is to determine its Airport Reference Code (ARC). A runway/airport that accommodates aircraft with an approach speed as great as 91 knots, but less than 121 knots and with wingspans as great as 49 feet, but less than 79 feet should be designed utilizing ARC B-II dimensional criteria. In addition, the current Airport Layout Plan specifies the glider runway (Runway 8G/26G) as a non-standard design with the proposed disposition being a non-federal installation/no action.

The previously mentioned aircraft are the Design Aircraft for dimensional criteria only (i.e., runway/taxiway separation, runway/taxiway safety areas, aircraft parking separation, etc.), and is not intended to be used solely to dictate runway length requirements, although it may be used as a guide in the process of determining runway length. The dimensional criteria illustrated in the following tables, entitled *ARC B-II DIMENSIONAL STANDARDS FOR RUNWAY 8/26 (In Feet)* and *ARC B-I SMALL AIRCRAFT ONLY DIMENSIONAL STANDARDS FOR RUNWAY 8G/26G (In Feet)* are those required for the specified Design Aircraft for each runway, in conjunction with specified approach visibility minimums, and includes the existing dimension for the corresponding facility[3].

[3] The Airport's August 2001 ALP documents the design/layout of the glider runway as non-standard condition with no reference to a specified design standard. Consultation with the FAA during this Study confirmed that the status of the glider runway, with respect to FAA design compliance, would remain as depicted on the 2001 version of the ALP.

Table C5
ARC B-II DIMENSIONAL STANDARDS FOR RUNWAY 8/26 (In Feet)
Boulder Municipal Airport Master Plan Update

Item	Existing Dimension	ARC B-II with ≥ ¾ Mile Visibility Minimums (1)	ARC B-II with < ¾ Mile Visibility Minimums (2)
Runway Width	75	75	100
Runway Centerline to Parallel Runway Centerline	**220** (3) (6)	700	700
Runway Centerline to Parallel Taxiway Centerline	**200** (3)	240	300
Runway Centerline to A/C Parking	300	250	400
Runway Centerline to Holdline	**125**	200	250
Runway Safety Area Width	150	150	300
Runway Safety Area Length Beyond Departure Runway End	300 (4)	300	600
Runway Object Free Area Width	**442** (5)	500	800
Runway Object Free Area Length Beyond Departure Runway End	300 (4)	300	600
Runway Obstacle Free Zone Width	400	400	400
Runway Obstacle Free Zone Length Beyond Departure Runway End	200	200	200
Taxiway Width	35	35	35
Taxiway Safety Area Width	79	79	79
Taxiway Object Free Area Width	131	131	131
Taxilane Object Free Area Width	115	115	115
Threshold Siting Criteria	Criteria Met	---	---

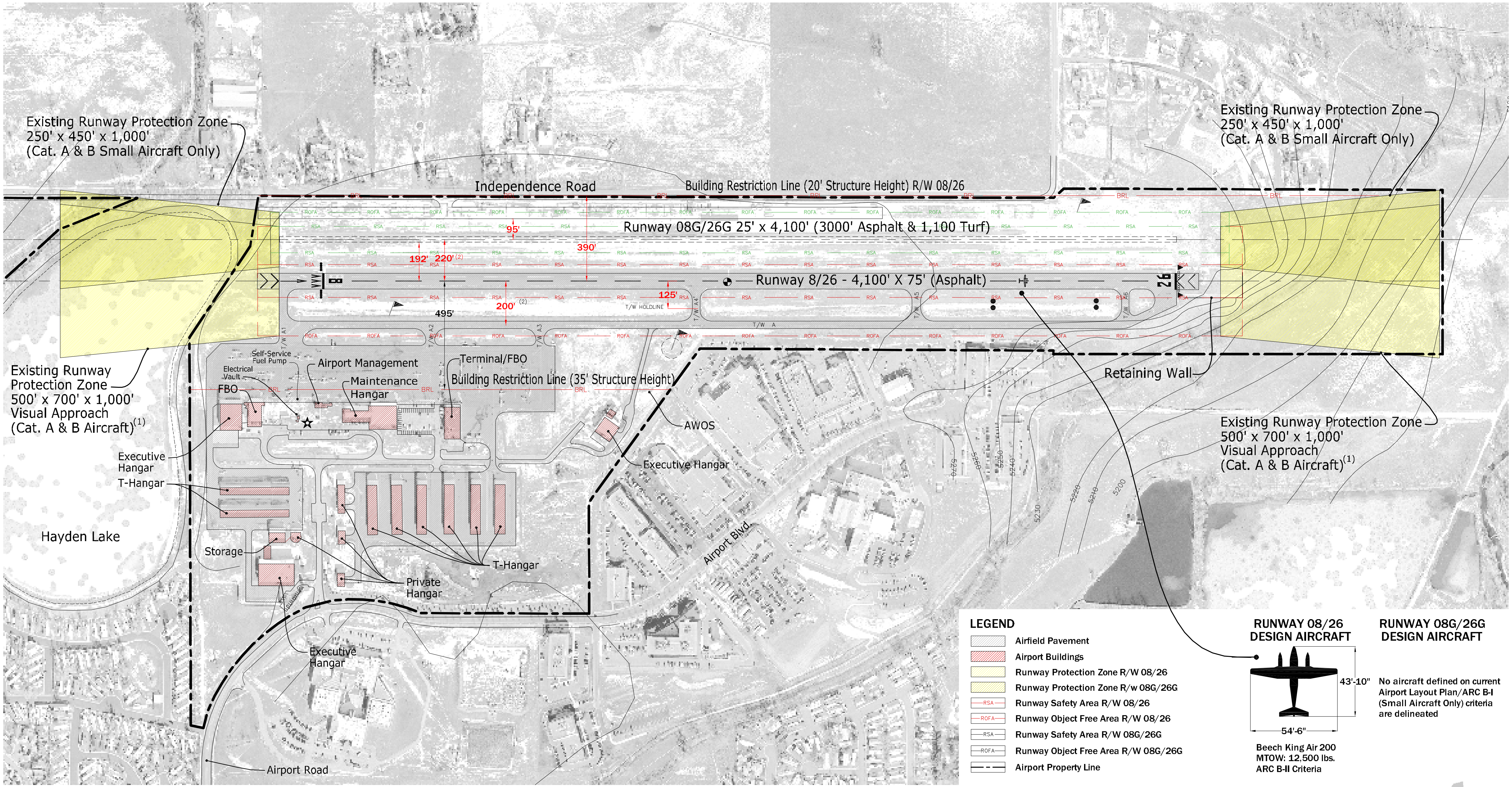
Source: AC 150/5300-13, Federal Aviation Administration.
Existing dimensions in **bold** text reflect current non-standard design conditions.
(1) Existing runway visual approach minimums.
(2) These potential instrument approach minimums cannot be accommodated at the Airport and have only been included for reference.
(3) Existing modification of standards was approved by the FAA in 1994 for these criteria.
(4) Existing design standard is met with a 200-foot displaced threshold to Runway 8 and the application of declared distances criteria.
(5) Existing Runway 8/26 OFA is non-standard due to the proximity of the adjacent glider runway.
(6) FAA determination is required regarding potential operation of existing parallel runways as a single runway (see footnote 2 on previous page).

Table C6
ARC B-I SMALL AIRCRAFT ONLY DIMENSIONAL STANDARDS FOR RUNWAY 8G/26G (In Feet)
Boulder Municipal Airport Master Plan Update

Item	Existing Dimension	ARC B-I Visual Approach Minimums (1)
Runway Width	**25**	60
Runway Centerline to Parallel Taxiway Centerline	NA	150
Runway Centerline to A/C Parking (north side)	**95**	125
Runway Centerline to Holdline	NA	125
Runway Safety Area Width	ND (2)	120
Runway Safety Area Length Beyond Departure Runway End	ND (2)	240
Runway Object Free Area Width	ND (3)	250
Runway Object Free Area Length Beyond Departure Runway End	ND (2)	240
Runway Obstacle Free Zone Width	ND (2)	250
Runway Obstacle Free Zone Length Beyond Departure Runway End	ND (2)	200
Taxiway Width	NA	25
Taxiway Safety Area Width	NA	49
Taxiway Object Free Area Width	NA	89
Taxilane Object Free Area Width	NA	79
Threshold Siting Criteria	Criteria Met	---

Source: AC 150/5300-13, Federal Aviation Administration.
(1) Existing runway approach visibility minimums.
(2) Criteria can be met.
(3) Criteria cannot be met due to adjacent glider landside facilities.
NA: Not Applicable
ND: Not Defined on current ALP

As can be seen in the above tables and delineated in the following illustration, the Runway 8/26 at Boulder Municipal Airport is in non-compliance with the FAA specified dimensional criteria for the runway centerline to parallel runway centerline separation, runway centerline to parallel taxiway centerline separation, runway centerline to holdline separation, and runway object free area width. It should also be noted that the Airport was granted a modification of standards for the runway and taxiway centerline separations, and compliance with the holdline separation criteria is dictated by the runway to taxiway centerline separation. With respect to the glider runway (Runway



NOTES: (1) RPZ dimensions would be maintained in consideration of a potential 1-mile visibility minimums instrument approach.
(2) FAA modification of standards have been obtained for this criteria.
Highlighted dimensions reflect existing non-standard design criteria.

0' 100' 200' 400' 600'
GRAPHIC SCALE IN FEET

Figure C3 Existing Runway Dimensional Critieria Map

Runway 8G/26G), the current airport layout plan does not identify specific dimensional criteria for the facility, therefore the runway was evaluated in consideration of ARC B-I Small Aircraft Only dimensional standards. As can be noted from Table C6, the glider runway does not meet standards for runway width, runway centerline separation to aircraft parking, and runway object free area width. However, consultation with the FAA during this Airport Master Plan Update confirmed that the status of the glider runway, with respect to FAA design compliance, would remain as depicted on the 2001 version of the ALP unless the use/role of the Airport is modified due to a change in the airport's design aircraft.

Runways

In consideration of the forecasts of future aviation activity, the adequacy of the runway system must be analyzed from several perspectives. These include runway orientation and airfield capacity, which were analyzed in the previous section, as well as runway length, pavement strength and runway visibility, which will be evaluated in the following text. The analysis of these various aspects pertaining to the runway system will provide a basis for recommendations of future improvements.

Runway Orientation. Boulder Municipal Airport currently operates with two runways, Runway 8/26 and Runway 8G/26G, which are oriented in an east-west direction. As presented in a previous section, the existing runway configuration is only slightly deficient (i.e., 94.64%) in consideration of the 13-knot crosswind component, with 95% being the desired wind coverage for an airport's runway system. Due to the fact that there is insufficient airport property to accommodate the siting of a crosswind runway facility, no additional runways will be evaluated from a *wind coverage* standpoint.

Airfield Capacity. The evaluation of airfield capacity, as presented in previous sections, indicates that the Airport will not exceed the capacity of the existing runway/taxiway system before the end of the planning period.

Under existing operating conditions, with the addition of a non-precision instrument approach procedure, the Airport's Annual Service Volume (ASV) for the year 2023 was projected to be 184,382 operations. FAA planning standards indicate that when sixty percent (60%) of the ASV is reached (i.e., 110,629 operations), the Airport should start planning ways to increase capacity if feasible, and when eighty percent (80%) of ASV is reached (147,506 operations), construction of facilities to increase capacity should be initiated if feasible. These conditions should be monitored as *trends* and not just as one-time occurrences. This trend monitoring will provide lead-time in recognizing demand for facilities before the need occurs and will help to keep expenditures within budgetary constraints.

During 2003, aircraft operations at Boulder Municipal Airport totaled 68,262, which is substantially short of the sixty percent (60%) level of the ASV. In addition, 87,774 annual operations are forecast to occur at the Airport by the end of the planning period, which is also well below the sixty percent (60%) level of the ASV. Therefore, no additional runway facilities will be required at the Airport to increase operational capacity, nor does the City of Boulder wish to increase its capacity.

Runway Length. The determination of runway length requirements for Boulder Municipal Airport is based on several factors. These factors include:

- Airport elevation;
- Mean maximum daily temperature of the hottest month;
- Runway gradient;
- Critical aircraft type expected to use the airport; and,
- Stage length (i.e., the distance flown) of the longest nonstop trip destination.

The runway length operational requirements for aircraft are greatly affected by elevation, temperature and runway gradient. The calculations for runway length requirements at Boulder Municipal Airport are based on an elevation of 5,288.0 feet AMSL, 87.5 degrees Fahrenheit NMT (Mean Normal Maximum Temperature), and a maximum difference in runway elevation at the centerline of 9.2 feet.

Generally, for design purposes, runway length requirements at general aviation airports are premised upon a combination of the general aviation fleet that are operating or are projected to operate at the airport in the future. For Boulder, this fleet is dominated by small aircraft weighing less than 12,500 pounds maximum takeoff weight (MTOW), with a few larger aircraft (i.e., the business jets that operate at the Airport) weighing less than 20,000 pounds MTOW. As can be seen in the following table, entitled *RUNWAY TAKE-OFF LENGTH REQUIREMENTS*, there are four (4) runway lengths shown for small aircraft type runways. Each of these provides the required length to accommodate a certain type of aircraft that will utilize the runway. The lengths range from 4,710 to 6,600 feet in length, with the runway length shown for small aircraft seating more than ten (10) passengers being 6,600 feet.

There are four (4) different lengths given for large aircraft under 60,000 pounds. The specified large aircraft runway lengths pertain to those general aviation aircraft, generally jet-powered, of 60,000 pounds or less maximum certificated take-off weight. The requirements of the large aircraft fleet range from 6,790 feet to 11,090 feet in length. Each of these lengths provides a runway sufficient to satisfy the operational requirements of a certain percentage of the fleet at a certain percentage of the useful load, (i.e., 75 percent of the fleet at 60 percent useful load). The useful load of an aircraft is defined as the difference between the maximum allowable structural gross weight and the operating weight empty. In other words, it is the load that can be carried by the aircraft composed of passengers, fuel, and cargo. Generally speaking, the following aircraft comprise 75 percent of the large aircraft fleet weighing less than 60,000 pounds: Learjets, Sabreliners, Citations, Falcons, Hawkers, and the Westwind.

Table C7
RUNWAY TAKE-OFF LENGTH REQUIREMENTS
Boulder Municipal Airport Master Plan Update

	Length (Feet)	
Aircraft Category	**Dry**	**Wet**
Runway 8/26 (Existing)	4,100	4,100
Airplanes less than 12,500 lbs. with less than 10 seats		
75% of Small Aircraft Fleet	4,710	4,710
95% of Small Aircraft Fleet	6,520	6,520
100% of Small Aircraft Fleet	6,600	6,600
Airplanes less than 12,500 lbs. with 10 or more seats	6,600	6,600
Airplanes greater than 12,500 lbs. and less than 60,000 pounds		
75% of fleet at 60% useful load	6,790	6,790
75% of fleet at 90% useful load	8,690	8,690
100% of fleet at 60% useful load	11,090	11,090
100% of fleet at 90% useful load	11,090	11,090

Source: FAA Advisory Circular 150/5300-13, *Airport Design*.
Lengths based on 5288' AMSL, 87.5° F NMT and a maximum difference in runway centerline elevation of 9.2'.

An important factor to note when considering the generalized large aircraft runway take-off length requirements presented in the previous table is that the actual length necessary for a runway is a function of elevation, temperature, and aircraft stage length. As temperatures change on a daily basis, the runway length requirements change accordingly. The cooler the temperature, the shorter the runway necessary; therefore, for example, if an airport is designed to accommodate seventy-five percent (75%) of the fleet at ninety percent (90%) useful load, this does not mean that at certain times a larger business jet cannot use the airport or that aircraft cannot use it with heavier loadings than that represented by ninety percent (90%) of the maximum useful load.

Following an examination of the various runway lengths provided in the previous table, it should be noted that Runway 8/26, with an existing length of 4,100 feet, is approximately 600 feet deficient in accommodating 75% of the small aircraft fleet. As mentioned previously pilots operating from Boulder routinely adjust the operating weight of their aircraft based upon the specific payload requirements of their flight and the runway length available for takeoff. In addition, the specific performance capabilities of general aviation aircraft are documented through the aircraft certification process and defined by Federal Aviation Regulation (FAR) Part 23. Therefore, both takeoff and landing procedures conducted at Boulder must comply with these regulations to ensure the safety of these operations. Based on the Airport's existing and projected operational activity, coupled with the facilities existing site constraints (i.e., steep topography and adjacent lake), it is concluded that the existing runway length is adequate and should be maintained at 4,100 feet. In addition, the length of the existing glider runway, which also measures 4,100 feet, should also be maintained with no plans for extension.

Runway Pavement Strength. As identified in the *INVENTORY* chapter of this document, Runway 8/26 is rated in excellent condition, with an existing gross weight bearing capacity of 16,000 pounds single wheel and 30,000 pounds dual-wheel main gear configuration. According to the existing and projected operational fleet mix, this pavement strength is adequate to accommodate the existing and projected general aviation aircraft fleet at the airport. However, all existing airfield pavement should be tested periodically to properly ascertain existing pavement strengths.

Runway Line of Sight and Gradient. According to existing runway line-of-sight standards, any two (2) points located five feet (5') above the runway centerline must be mutually visible for the entire length of the runway. If the runway has a full-length parallel taxiway, the visibility requirement is reduced to a distance of one-half the runway length. Boulder Municipal Airport complies with the runway line-of-sight standards for the entire length of the runway.

Taxiways

Taxiways are constructed primarily to enable the movement of aircraft between the various functional areas on the airport and the runway system. Some taxiways are necessary simply to provide access between aircraft parking aprons and runways, whereas other taxiways become necessary to provide more efficient and safer use of the airfield. As described earlier, the taxiway system at Boulder Municipal Airport is adequate to accommodate the required taxiway exit standards from a capacity standpoint.

Taxiway improvements that will be considered for development at Boulder Municipal Airport will include the future extension of access taxiways and/or taxilanes to serve additional hangar development and expansion areas on the Airport. On a related note, the existing access taxiway system will be evaluated with respect to the interaction of the existing taxiway and roadway system on the Airport. Every effort should be made to physically separate the airport roadways from the taxiways to prohibit unauthorized vehicles from accessing the Airport's aircraft movement areas to assist in the safety and security of the Airport.

Instrumentation and Lighting

Electronic landing aids, including instrument approach capabilities and associated equipment, airport lighting, and weather/airspace services, were detailed in the *INVENTORY* chapter of this document. The Airport is not presently equipped with an instrument approach procedure; however, the future implementation of a non-precision approach will be examined in the alternatives analysis chapter of the document due to its potential impact on the Airport's specified design and FAR Part 77 airspace criteria.

Within the near future, Global Positioning System (GPS) approaches are expected to be the FAA's standard approach technology. With GPS, the cost of establishing new or improved instrument approaches at many airports has been significantly reduced. With respect to future instrument flight procedures (IFPs), the FAA's Aviation System Standards (AVN) branch designs and develops IFPs, as well as operates a fleet of flight inspection aircraft for airborne evaluation of electronic navigational signals. The Flight Procedures Division of AVN maintains production schedules for the IFPs, which include LNAV, LNAV/VNAV, LPV, ILS, etc.

It should be noted that the Colorado Department of Transportation (CDOT) Division of Aeronautics has completed a multi-phase planning study to evaluate the implementation or enhancement of stand alone GPS instrument approaches at many Colorado airports. Phase One of the study included the establishment of new survey monuments, along with a cursory review/assessment of the instrument approach procedure capability for each of the airports. Based upon this cursory Phase One assessment for Boulder Municipal Airport, it was determined that Runway 26 could likely be equipped with a GPS Area Navigation (RNAV) procedure that would provide LNAV/VNAV minimums as low as a 532-foot ceiling and ¾-mile visibility. Phase Two of the study included a detailed obstruction survey of each of the runways being considered for a new instrument approach procedure and the surveys were prepared by a registered surveyor in accordance with the accuracy standards specified by FAA 405, *Standards for Aeronautical Surveys and Related Products*. Phase Three of the study will include the design and development of the approach procedures by the FAA Flight Procedures Division of AVN.

Based upon the Airport's existing site development constraints and IFR wind coverage analysis, it is recommended that a future approach procedure with vertical guidance (APV) (i.e., an LNAV/VNAV procedure) be evaluated for Boulder that could provide visibility minimums as low as 1-mile. According to Appendix 16 of AC 150/5300-13, an LNAV/VNAV procedure with these specified minimums would require a minimum 3,200-

foot runway length, but would not require an approach lighting system. In addition, the runway should comply with standard runway markings, standard holding position signs, provide clear obstacle free zones, and have imaginary surfaces free of obstructions. As noted in the previous section, Runway 8/26 does not comply with current standards for runway centerline to holdline separation, and a final determination on this criteria must be received from the FAA to facilitate the assessment of the approach.

Visual Landing Aids (lights). Presently, the runway at Boulder Municipal Airport is equipped with Medium Intensity Runway Lights (MIRL) edge lights, and a 4-box visual approach slope indicator (VASI) serving Runway 26. In conjunction with the examination of improved instrument approaches described above, improved airport lighting may also need to be evaluated. The type of airport lighting will be dependent on the type of instrument approach capabilities being proposed and will be examined in the following chapter.

Runway Protection Zones (RPZs). The function of the RPZ is to enhance the protection of people and property on the ground off the end of runways. This is achieved through airport control of the property within the RPZ area. This control can be exercised through either fee-simple ownership or the purchase of an RPZ easement. The RPZ is trapezoidal in shape and centered about the extended runway centerline. Its inner boundary begins 200 feet beyond the end of the area usable for take-off or landing. The dimensions of the RPZ are functions of the type of aircraft that regularly operate at the airport, in conjunction with the specified visibility minimums of the instrument approach (if applicable).

In consideration of the existing visual approaches and the potential instrument approach minima for Runway 26, and the type of aircraft each runway is designed to accommodate, it is projected that the existing RPZ dimensions will be maintained for each runway[4] for the balance of the 20-year planning period. The following table, entitled *RUNWAY PROTECTION ZONE DIMENSIONS*, lists existing RPZ dimensional requirements, along with the requirements for improved approach capabilities.

[4] The RPZ dimensions for visual approaches and non-precision approaches with 1-mile approach visibility minimums are the same for Category B aircraft.

Table C8
RUNWAY PROTECTION ZONE DIMENSIONS
Boulder Municipal Airport Master Plan Update

Item	Width at Runway End (feet)	Width at Outer End (feet)	Length (feet)
Existing RPZ Dimensions:			
Runway 8	500	700	1,000
Runway 26	500	700	1,000
Runway 8G [(1)]	250	450	1,000
Runway 26G [(1)]	250	450	1,000
Required RPZ Dimensions for Various Visibility Minimums:			
Visual and not lower than 1-mile, Small Aircraft Exclusively	250	450	1,000
Visual and not lower than 1-Mile (Statute), Approach Categories A & B	500	700	1,000
Visual and not lower than 1-Mile (Statute), Approach Categories C & D	500	1,010	1,700
Not lower than 3/4-Mile (Statute), All Aircraft	1,000	1,510	1,700
Lower than 3/4-Mile (Statute), All Aircraft	1,000	1,750	2,500

Source: FAA Advisory Circular 150/5300-13, "Airport Design."
[(1)] RPZs are not currently delineated on the existing ALP for the glider runway.

Future Lighting. Based on the potential 1-mile approach visibility minimums being considered for Boulder, an approach lighting system will not be required or recommended for the Airport.

Glide path indicator lights are a system of lights that provide visual vertical approach slope guidance to aircraft during an approach to the runway. Precision approach path indicators (PAPIs) or Visual Approach Slope Indicators (VASIs) are designed for day and nighttime use during VFR (i.e., good weather) conditions. The Precision Approach Path Indicators (PAPIs) are the currently recognized replacement equipment for VASIs, and are recommended for future installation to serve each runway end. However, according to airport management, the FAA has indicated that VASIs would likely continue to be identified as the appropriate equipment for installation at Boulder in consideration of specific design and engineering criteria associated Boulder's existing airfield layout.

Runway End Identifier Lights (REILs) are a system of lights that provide an approaching aircraft a rapid and positive identification of the approach end of the runway. Since an approach lighting system will not be required to achieve a potential 1-mile approach visibility minimum at Boulder, it is recommended that REILs be evaluated for installation to serve each runway end. Prior to the installation of the REILs, a light emission study should be conducted in consideration of the City of Boulder's existing lighting ordinance to determine if additional shielding of the lights would be required.

As mentioned previously, Runway 8/26 is equipped with Medium Intensity Runway Lights (MIRLs). These lights should be maintained in conjunction with any proposed instrument approach procedure enhancements. In addition, Medium Intensity Taxiway Lights (MITLs), which are presently in place on Taxiway "A", should be maintained on the existing parallel taxiway system.

Landside Requirements

Landside facilities are those facilities that support the airside facilities, but are not actually a part of the aircraft operating surfaces. These consist of such facilities as terminal buildings, hangars, aprons, access roads and support facilities. Following a detailed analysis of these facilities that are to be examined for Boulder, current deficiencies can be noted in terms of accommodating both existing and future aviation needs at the Airport.

General Aviation Requirements

Aircraft based at Boulder Municipal Airport are stored in one of three areas: large storage hangars, T-hangars, or apron tiedowns. Currently, 234 aircraft are based at the Airport[5]. Over the course of the twenty-year planning period, the number of based aircraft at the Airport is forecast to increase by as many as 64 new aircraft, which would only represent a return to early 1990 aircraft basing levels. In consideration of present day and future basing practices by aircraft owners, it is anticipated that an increasing percentage of the based aircraft fleet at Boulder will be stored in hangars.

Tiedown Storage Requirements/Based Aircraft. Aircraft tiedowns are provided for those aircraft that do not require, or do not desire, to pay the cost for hangar storage. Space calculations for these areas are based on 360 square yards of apron for each aircraft to be stored on the apron. This amount of space allows for aircraft parking and circulation between the rows of parked aircraft. Based upon existing aircraft storage practices and strong demand for new hangar facilities, it is projected that a significant number of

[5] Subsequent to the preparation of these forecasts in the summer of 2004, which have been approved by the FAA, the Airport recorded 190 total based aircraft for the year 2005 and a breakdown of these aircraft by type was presented in Table B2 of the previous chapter.

existing based aircraft that are currently stored on the apron would prefer to have hangar storage. As a result, it is anticipated that the based aircraft apron requirements will generally decline through the planning period as additional hangar storage facilities are constructed at the Airport, with the excess apron then being available for transition to itinerant aircraft apron.

Tiedown Storage Requirements/Itinerant Aircraft. In addition to the needs of the based aircraft tiedown areas addressed in the preceding section, transient aircraft also require apron parking areas at Boulder Municipal Airport. This storage is provided in the form of transient aircraft tiedown space. In calculating the area requirements for these tiedowns, typically, an area of 400 square yards per aircraft is used. As previously described, it's projected that the forecast decreasing demand for based aircraft apron would be available for use to accommodate the forecast increase in demand for itinerant aircraft apron through the planning period.

The accompanying table shows the type of facilities and the number of units or acres needed for that facility in order to meet the forecast demand for each development phase. It is expected that most of the owners of aircraft that will be newly based at the Airport will desire some type of indoor storage facility. The actual type of hangar storage facility to accommodate based aircraft has been identified as T-hangars, executive hangars, and larger corporate and/or FBO type hangars, although the actual number, size, and location of these hangars will depend on user needs and financial feasibility.

Access and perimeter roadway locations, auto parking requirements, and land requirements are not included in this tabulation because the amount of land necessary for these facilities will be a function of the location of other facilities, as well as the most effective routing of roadways. The following table, entitled *GENERAL AVIATION FACILITY REQUIREMENTS, 2003-2023,* depicts the area required for general aviation landside facilities during all stages of development. Based upon the assessment of projected hangar and apron needs at the Airport, it appears that the Airport has adequate space to accommodate the forecast demand for these facilities through the planning period of this document. In addition, this will assist in the preparation of detailed facility staging plan that is presented in later chapters of this document.

Table C9
GENERAL AVIATION FACILITY REQUIREMENTS, 2003-2023
Boulder Municipal Airport Master Plan Update

Facility	2003[1]		2008	2013	2018	2023
			Total Number Required (In yd²)			
Itinerant GA Apron ($yd.^2$) (1)	---		10,409	11,520	12,746	14,338
Based A/C GA Apron ($yd.^2$) (1)	---		33,000	28,380	23,430	21,120
Total Apron ($yd.^2$) (1)	44,444	(2)	43,409	39,900	36,176	35,458
Glider Storage ($yd.^2$)	23,000	(3)	19,977	21,554	23,131	24,709
Hangar Space						
T-hangars (no./$yd.^2$)	80/41,900		95/49,760	115/60,240	140/73,340	160/83,820
Exec./Corp. (no./$yd.^2$)	7/4,667		11/7,335	11/7,335	11/7,335	11/7,335
Total ($yd.^2$)	114,011		117,813	129,029	139,982	151,322

Source: Barnard Dunkelberg & Company projections based on FAA AC 150/5300-13
(1) Does not differentiate between based and/or itinerant apron.
(2) Total reflects currently paved apron area. An additional unpaved/grass apron area consisting of approximately 8,400 square yards is available for use.
(3) Total reflects unpaved area currently designated for storage, with additional expansion area available to the east.

Ground Access Requirements

Ground access facility requirements, based upon the previously presented demand and capacity analysis, have been developed for the vehicular access roadway system that presently serves the Airport. The capacity analysis presented in the previous chapter indicated that the two-lane airport access road (Airport Road), with additional dedicated turning lanes and Independence Road, which serves the north side of the Airport, would have adequate capacity to accommodate the anticipated airport-generated and background traffic through the planning period. However, the demand placed on these roadways should be analyzed periodically to determine if facility improvements are needed. In addition, opportunities to provide a more direct access route between the north and south sides of the Airport will be investigated in the forthcoming alternatives evaluation section of this document.

Support Facilities Requirements

In addition to the aviation and airport access facilities described above, there are several airport support facilities, which have quantifiable requirements and which are vital to the efficient and safe operation of the airport. The support facilities at Boulder Municipal Airport that require further evaluation include the fuel storage facility.

Fuel Storage Facility. Between the years 1999 and 2003, there was an average of 156,192 gallons of fuel sold per year at Boulder Municipal Airport. Based on 2003 total operation counts, this equates to approximately 2.3 gallons per operation. As operations increase, fuel storage requirements can be expected to increase proportionately. By increasing the ratio of gallons sold per operation to adjust for the slight percentage increase in itinerant aircraft forecast to operate at the Airport, an estimate of future fuel storage needs can be calculated as a two-week supply during the peak month of operations. As can be seen in the following table, entitled *FUEL STORAGE REQUIREMENTS, 2003-2023*, it appears that the Airport's fuel storage requirements can be accommodated through the year 2023 utilizing existing storage facilities.

Table C10
FUEL STORAGE REQUIREMENTS, 2003-2023
Boulder Municipal Airport Master Plan Update

	2003	2008	2013	2018	2023
Average Day of Peak Month Operations	220	220	239	260	283
Two Week Operations	3,080	3,080	3,346	3,640	3,962
Gallons Per Operation (1)	2.3	3.0	3.5	4.0	5.0
Fuel Storage (gallons)	30,000 (2)	9,240	11,711	14,560	19,810

(1) A projected increase in the ratio of gallons of fuel sold per operation is a result of the projected increase in the number of intinerant aircraft operations forecast to occur at the Airport.
(2) Existing fuel storage capacity (20,000 gallons avgas & 10,000 gallons Jet A).

Planning Issues Identification/Verification

As referenced in the *INVENTORY OF EXISTING CONDITIONS* chapter of this document, identification of the current and future airport planning issues, which may influence the use of a public facility, is an important step in the planning process. A preliminary list of these issues was identified at the conclusion of that chapter, and that list has continued to evolve and expand in response to input that has been received throughout the planning process.

The following updated list identifies those issues that will be considered in the preparation of the airside and landside plan alternatives for Boulder Municipal Airport, and ultimately provide the basis for the formulation of the future plans for the facility. These issues, which have been organized into airside and landside categories, are represented on the following illustrations, entitled *AIRPORT PLANNING ISSUES MAP* and *EXISTING AIRPORT TRAFFIC PATTERNS MAP.* It should also be noted that some of the issues are referenced in more than one category due to their complexity or boundary relationships, and the existing airport traffic pattern graphic has been included separately to provide a point-of-beginning for discussions concerning potential opportunities to modify flight tracks in consideration of aircraft overflights.

Airside Issues:

- Maintain Airport Infrastructure Development
- Verify Airport Design Standards
- Evaluate Future Instrument Approach Procedure
- Reevaluate Existing Airport Flight Patterns to Minimize Overflights of Existing Residential Development
- Evaluate Airport Environmental Issues (i.e., Aircraft Noise, Overflight of Raptor Nesting Areas, Prairie Dog Habitat Expansion).

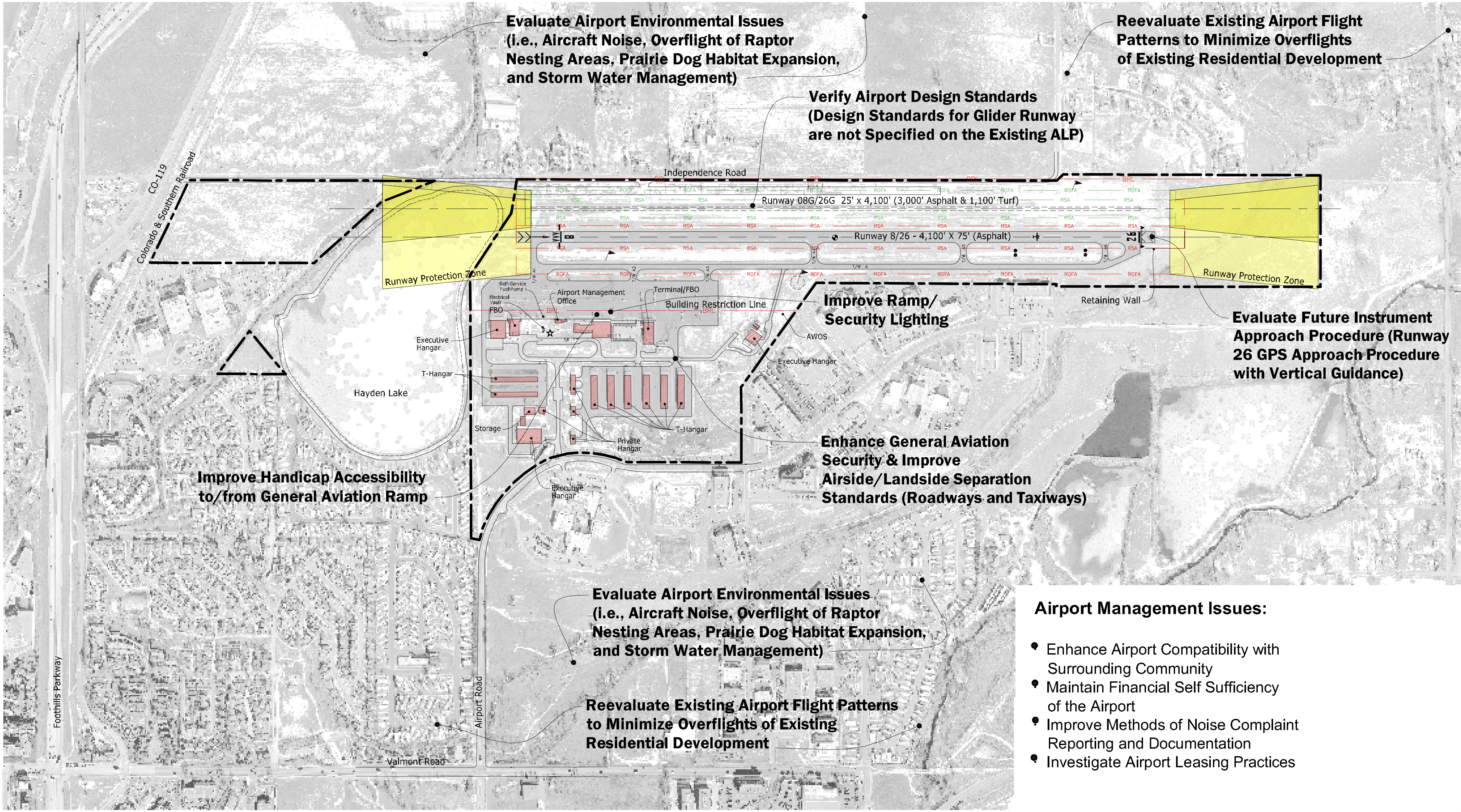
Landside Issues:

- Maintain Airport Infrastructure Development
- Enhance General Aviation Security
- Maintain Financial Self Sufficiency of the Airport
- Verify Airport Design Standards
- Evaluate Self-Service Fueling Facility[6]
- Improve Ramp/Security Lighting
- Improve Handicap Accessibility to/from General Aviation Ramp
- Evaluate Options to Improve Vehicular and/or Pedestrian Access between North and South Side of the Airport
- Evaluate Airport Environmental Issues (i.e., Aircraft Noise, Overflight of Raptor Nesting Areas, Prairie Dog Habitat Expansion, and Storm Water Management)
- Improve Airside/Landside Separation Standards (Roadways and Taxiways)

Airport Management Issues:

- Enhance General Aviation Security
- Enhance Airport Relationship with Surrounding Community
- Maintain Financial Self Sufficiency of the Airport
- Improve Methods of Noise Complaint Reporting and Documentation
- Investigate Airport Leasing Practices

[6] A new self-service fueling facility was installed at the Airport in 2005.



Airport Management Issues:

- Enhance Airport Compatibility with Surrounding Community
- Maintain Financial Self Sufficiency of the Airport
- Improve Methods of Noise Complaint Reporting and Documentation
- Investigate Airport Leasing Practices

Figure C4 Airport Planning Issues Map

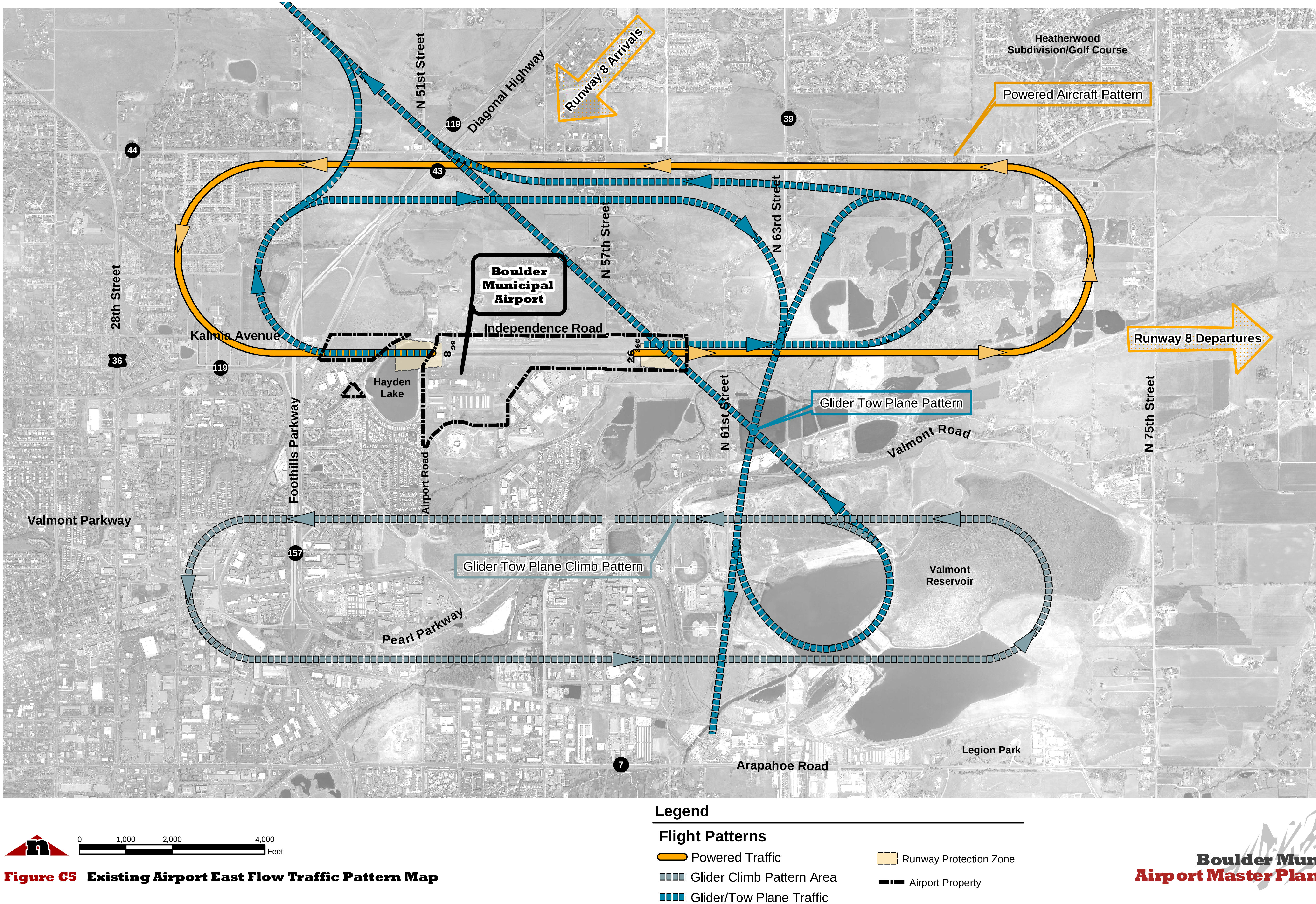


Figure C5 **Existing Airport East Flow Traffic Pattern Map**

Source: Aerial Photography USGS 2002 Urban Area Digitial Ortho Photo Quarter Quad. Traffic Patterns: Boulder Soaring Club Representative

- Reevaluate Existing Airport Flight Patterns to Minimize Overflights of Existing Residential Development
- Evaluate Airport Environmental Issues (i.e., Aircraft Noise, Overflight of Raptor Nesting Areas, Prairie Dog Habitat Expansion, and Storm Water Management).

Summary

The need for facilities, which have been identified in this chapter, can now be utilized to formulate the overall future Master Plan of the Airport. The following table summarizes the projected facility requirements necessary to accommodate the projected operational demands through 2023. The formulation of this plan will begin by establishing goals for future airport plans and an analysis of plan alternatives whereby demand for future airport facilities can be accommodated. These alternatives will be presented in the following chapter, entitled *ALTERNATIVES ANALYSIS*.

Table C11
FACILITY REQUIREMENTS SUMMARY, 2003-2023
Boulder Municipal Airport Master Plan Update

Facility	2003[1]	2008	2013	2018	2023
Dimensional Standards					
Runway 8/26	ARC B-II	same	same	same	same
Runway 8G/26G	ARC B-I/Sm. Aircraft Only[2]	same	same	same	same
Runway Length/Width					
Runway 8/26	75' x 4,100'	same	same	same	same
Runway 8 G/26G	25' x 4,100'	60' x 4,100' [3]	same	same	same
General Aviation Apron Requirements (In $yds.^2$)					
Itinerant ($yd.^2$)	---	10,409	11,520	12,746	14,338
Based ($yd.^2$)	---	33,000	28,380	23,430	21,120
Subtotal ($yd.^2$)	44,444 [4]	43,409	39,900	36,176	35,458
Glider Storage ($yd.^2$)	23,000 [5]	19,977	21,554	23,131	24,709
General Aviation Aircraft Storage Facilities (No./$yds.^2$)					
T-hangars (no./$yd.^2$)	80/41,900	95/49,760	115/60,240	140/73,340	160/83,820
Exec./Corp. (no./$yd.^2$)	7/4,667	11/7,335	11/7,335	11/7,335	11/7,335
Aviation Fuel Storage Requirements					
AVGAS (gallons)	20,000	same	same	same	same
Jet A (gallons)	10,000	same	same	same	same

(1) Actual.

(2) Existing dimensional criteria to be verified through FAA consultation.

(3) A potential future requirement to increase runway width is to be evaluated in the *Planning Concepts and Alternatives Analysis* chapter of this document.

(4) Total reflects currently paved apron area. An additional unpaved/grass apron area consisting of approximately 8,400 square yards is available for use.

(5) Total reflects unpaved area currently designated for storage, with additional expansion area available to the south.