4. Facility Requirements

4.1 Introduction

The next step in the Airport Master Plan (AMP) process is to determine the future requirements for airport facilities that will allow for appropriate airside and landside development over the 20-year planning period. By comparing the existing conditions of an airport to its predicted growth, an AMP can define requirements for runways, taxiways, aprons, hangars, terminals, and other related airport facilities to accommodate growth over the short-, intermediate-, and long-term planning periods.

An essential element in the process of estimating future airport needs is the determination of an airport's current capability to accommodate anticipated demand. Such "demand-capacity" analyses aid in the identification of airport deficiencies, surpluses, and opportunities for future development. Ultimately, they yield information that is used to design the Airport Layout Plan (ALP) and set the stage for future facility development.

This chapter of the Beverly Regional Airport (the Airport or BVY) AMP identifies facility requirements for the Airport through the year 2039. Existing and future facility requirements and development standards are identified based on current Airport strategic development initiatives and by comparing the Airport's existing facilities to future facility needs that are rooted in the forecasts of aviation demand. The results of this **Facility Requirements** chapter will serve as input into the next chapter, **Alternatives Analysis & Development Concepts**, which will present an examination of development alternatives to meet any current and projected deficiencies. That analysis will ultimately result in the best strategy to meet the needs of the Airport, its users, and the community over the planning period.

The Facility Requirements analysis establishes what airside and landside development should be planned for over the next 20 years.

Note that the Federal Aviation Administration (FAA) provides guidance for the planning and design of airport facilities through Advisory Circulars (AC) that promote airport safety, economy, efficiency, and sustainability. Many of the facility requirements identified for BVY incorporate FAA planning and design standards presented in FAA AC 150/5300-13A, *Airport Design*, and FAA AC 150/5060-5, *Airport Capacity and Delay.* Other FAA ACs and industry principles were used to develop sections of this chapter and are cited throughout the document.

4.2 Airfield Demand Capacity

Airfield Demand Capacity refers to the number of aircraft operations that a given facility can accommodate on either an hourly or yearly basis. (Note that capacity does not relate to the size or weight of aircraft.) The capacity of an airfield is primarily a function of the major aircraft operating infrastructure elements that comprise an airfield (i.e., runways and taxiways), as well as their alignment and configuration. It is also related to and considered in conjunction with wind coverage, airspace utilization, and the availability and type of navigational aids. Each of these components has been examined as part of the airfield demand capacity analysis.

Delays that result from a deficiency in airfield capacity produce real losses with respect to time, money, and productivity.

The definition of airfield capacity can be further refined to be the number of aircraft operations that can be safely accommodated on the runway-taxiway system at a given point in time before an unacceptable level of delay is experienced. The ability of Beverly Regional Airport's current airside facilities to accommodate aviation operational demand is described below and is expressed in terms of potential excesses and deficiencies in capacity. The methodology used for the measurement of airfield capacity in this study is described in FAA AC 150/5060-5, *Airport Capacity and Delay.* This guidance is used in planning to determine the demand for an additional runway. Key terms relative to the discussion of capacity are:

- Demand – the magnitude of aircraft operations to be accommodated in a specified period, provided by the forecasts.
- Capacity – a measure of the maximum number of aircraft operations that can be accommodated on an airport in one hour.
- Annual Service Volume (ASV) – a reasonable estimate of an airport's annual capacity (i.e., level of annual aircraft operations that will result in an average annual aircraft delay of approximately one to four minutes).
- Delay – the difference between the actual time it takes an aircraft to operate on the airfield and the time it would take the aircraft if it were operating without interference from other aircraft or other influences, usually expressed in minutes.

Airfield capacity is defined as the theoretical number of aircraft operations that an airport can accommodate within a given period of time.

There are several factors known to influence airport capacity. Visual Flight Rule (VFR) and Instrument Flight Rule (IFR) hourly capacities are based on the following assumptions:

- Runway-use Configuration. The appropriate runway use configuration (No. 9) was taken from Figure 2-1 in the Advisory Circular.
- Percent Arrivals. Arrivals equal departures.
- Percent of Touch and Go's. Approximately 55%-65% of the total operations are typically considered to be "touch and go" local operations. Based on data from the BVY Air Traffic Control Tower (ATCT), 65% of all operations are currently touch and go's, although that percentage is expected to decrease to 60% over time.
- Taxiways. The Airport has partial parallel taxiways serving both the primary runway and crosswind runway.
- Airspace limitations. BVY has very few airspace procedural conflicts, all of which are addressed by the Airport's dedicated ATCT.
- Runway Instrumentation. The Airport has six published non-precision approach procedures that allow access during inclement weather conditions.
- Mix Index. This index is a mathematical expression used to represent the percentage of operations conducted by various classes of aircraft using the Airport. While BVY regularly serves mid to large corporate aircraft, most operations are projected to remain with smaller aircraft. Therefore, the Mix Index is estimated to fall between 0%-20% (the weighed share of larger aircraft) based on existing fleet usage and will continue to be in this range in future years. This index range is used as a reference for determining the ASV.

Considering these factors under optimum conditions, BVY would have a VFR hourly capacity of 98 operations, and an IFR capacity of 59 operations. Based on annual forecast figures presented in **Chapter 3**, the Airport should not experience peak hour activity near this level throughout the forecast period.

Further, by applying methodologies found in the Advisory Circular on capacity and demand, the ASV for BVY has been calculated to be a maximum of 230,000 annual operations. (It should also be noted that the capacity of the Airport is enhanced by the presence of the ATCT.)

The forecast for annual operations is expected to increase from 66,949 (2019) to 83,571 operations by the end of the forecast period (2039). **Table 4-1** compares BVY's 2019 and expected forecasted demand to its estimated capacity.

Table 4-1: Aviation Demand Capacity Analysis

	2019	2024	2029	2039
Capacity - ASV	230,000	230,000	230,000	230,000
Demand - Aircraft Operations	66,949	70,765*	74,800*	83,571*
Percent of Capacity	29.1%	30.7%	32.5%	36.3%

*Forecasted Operations, see Chapter 3.

According to the FAA, the following guidelines should be used to determine when airport capacity improvements should be enacted as demand reaches designated airfield capacity levels.

- 60% of ASV: Threshold at which planning for capacity improvements should begin.
- 80% of ASV: Threshold at which planning for improvements should be complete and construction should begin.
- 100% of ASV: The airport has reached the total number of annual operations (demand) it can accommodate, and capacity-enhancing improvements should be made to avoid extensive delays.

According to FAA's standards, BVY should start planning for capacity improvements when airport operational levels reach 138,000 operations (60% of ASV) and should initiate construction of those improvements at 184,000 operations (80% of ASV).

Based on the range of forecasts presented in **Chapter 3, Forecast**, it is not anticipated that BVY will exceed any of the hourly or annual capacities in any given year during the 20-year planning period.

Conclusion: Since aircraft operations forecasted over the 20-year planning period will not exceed 60% of the ASV, planning for additional airfield capacity will not be required during this planning period.

4.3 Airfield Facility Requirements

Airfield facilities generally include those that support the transition of aircraft from air to ground and the subsequent movement of those aircraft to parking/hangar areas (and vice versa). This section describes the airside facilities required to accommodate the current and projected general aviation activity at Beverly Regional Airport throughout the planning period.

Areas of focus include FAA airport design classifications, dimensional standards, runway/taxiway design standard requirements, airfield pavement, visual and navigational aids, and airspace requirements.

4.3.1 Airport Design Requirements

The FAA defines a wide variety of airport dimensional design requirements to promote safety and efficiency at airports across the United States. These requirements for an airport can change over time as FAA standards evolve, local airport operational patterns chance and develop, or other factors are introduced. So, it is important that a Master Plan review the critical design criteria to ensure compliance and/or to identify areas of potential improvement. This section reviews standards included in FAA AC 150/5300-13A relevant to BVY's current and projected design aircraft and operational patterns. (Note that current conditions and required improvements will be shown on the ALP prepared for this Airport Master Plan.)

Critical Design Aircraft Classification

The basis for the FAA airport design standards is the critical design aircraft, defined as the largest aircraft or family of aircraft anticipated to utilize a given airport on a regular basis. The FAA defines "regular basis" as conducting at least 500 annual itinerant and local operations, excluding touch-and-go operations (with an "operation" being defined as either a takeoff or a landing). Historically the Airport has experienced the full range of general aviation aircraft types, ranging from smaller piston-engine aircraft to larger corporate jets. More recently, as economic development has occurred around the Airport and as Boston Logan International (BOS) and Laurence G. Hanscom Field (BED) have become more congested, BVY has been experiencing increasing growth in the size of aircraft basing and operating at the Airport.

As described in **Chapter 3**, the future critical design aircraft for BVY's primary runway (RW 16-34) will remain in the same aircraft category as the existing but change to the more appropriate Cessna Citation Latitude (a mid-sized corporate jet). The future design aircraft for the crosswind runway (RW 9-27) will remain a Dassault Falcon 900 (also a mid-sized corporate jet). Additionally, and as detailed in **Chapter 3**, it must also be recognized that it is very likely that the design aircraft for Runway 16-34 will ultimately transition to a more demanding aircraft category represented by a late model Bombardier Challenger 300 (a larger mid-sized corporate jet).

Based on that selection of critical design aircraft, an appropriate Airport Reference Code (ARC) can be identified. The ARC is a coding system used to relate airport design criteria to the operational and physical characteristics of the types of aircraft intended to operate at that airport. Specifically, the ARC is an airport designation that signifies the airport's highest Runway Design Code (RDC), which itself consists of the following components:

- The Aircraft Approach Category (AAC) (depicted by a letter and based on aircraft approach speed).

- The Airplane Design Group (ADG) (depicted by a Roman numeral and based on aircraft wingspan and tail height).
- Runway Visual Range (RVR) (based on runway visibility minimums).

Table 4-2 presents the Aircraft Approach Categories, Airplane Design Groups and Visibility Minimums as defined by the FAA that comprise the Runway Design Code system, as well as representative aircraft.

Table 4-2: Runway Design Code System (RDC)

Contributing Elements

Aircraft Approach Category (AAC)

Approach Category	Approach Speed
A	< 91 knots
B	91 knots ≤ 121 knots
C	121 knots ≤ 141 knots
D	141 knots ≤ 166 knots
E	166 knots or more

Airplane Design Group (ADG)

Design Group	Wingspan	Tail Height
I	< 49 feet	< 20 feet
II	49 feet ≤ 79 feet	20 feet ≤ 30 feet
III	79 feet ≤ 118 feet	30 feet ≤ 45 feet
IV	118 feet ≤ 171 feet	45 feet ≤ 60 feet
V	171 feet ≤ 214 feet	60 feet ≤ 66 feet
VI	214 feet ≤ 262 feet	66 feet ≤ 80 feet

Runway Visual Range (RVR) - Visibility Minimums

RVR (ft)	Instrument Flight Visibility Category (statute mile)
5000	Not lower than 1 mile
4000	Lower than 1 mile but not lower than ¾ mile
2400	Lower than ¾ mile but not lower than ½ mile
1600	Lower than ½ mile but not lower than ¼ mile
1200	Lower than ¼ mile

Representative Aircraft by RDC

Source: Jviation, FAA AC 150/5300-13A.

Both of BVY's existing runways are currently identified as having an RDC of B-II-5000. As described in **Chapter 3**, existing and projected BVY operational data throughout the planning period indicates that the RDC for both Runway 16-34 and Runway 9-27 should remain as B-II, generally representing mid-sized business class aircraft (see **Figure 4-1**).

Figure 4-1: RDC B-II Aircraft

Source: Jviation.

However, as recognized in **Chapter 3**, it is also understood that the RDC for Runway 16-34 could ultimately transition to that of a C-II. Note that a C-II aircraft is in fact very similar in size to that of a B-II (see **Figure 4-2**) and similarly represents mid-sized business aircraft**.** Based on that potential ultimate change to the RDC, the C-II designation and its potential ultimate implications for BVY will be recognized and considered throughout this analysis.

Figure 4-2: RDC C-II Aircraft

Source: Jviation.

Like runway design, taxiway design standards are based on a combination of the ADG and the Taxiway Design Group (TDG) criteria, also defined in FAA AC 150/5300-13A. The TDG is centered on the ratio of the overall Main Gear Width (MGW) to the Cockpit to Main Gear (CMG) distance of the critical design aircraft. As described in previous sections, the current design aircraft for BVY is the Cessna Citation Latitude and the Dassault Falcon 900, which translate to a TDG classification of 1B and 2, respectively. See **Table 4-3** for a summary of all existing, future, and ultimate Airport Design Standard classifications for BVY based on existing and future conditions (note that as previously discussed, the ultimate conditions are based on a Bombardier Challenger 300 (late model) design aircraft with an RDC of C-II and TDG of 1B.)

Table 4-3: BVY Design Aircraft Classifications

	Existing	Future[1]	Ultimate[2]
Runway Design Code (RDC) – RW 16-34	B-II-5000	B-II-5000	C-II-5000
Runway Design Code (RDC) – RW 9-27	B-II-5000	B-II-5000	B-II-5000
Airport Reference Code (ARC)	B-II	B-II	C-II
Taxiway Design Group (TDG)[3]	2	2	2

Source: FAA AC 150/5300-13A.
[1] The future critical design aircraft for Runway 16-34 is the Cessna Citation Latitude. The future critical design aircraft for Runway 9-27 is the Dassault Falcon 900.
[2] The "ultimate" classifications are recommended for long-term considerations. These are not endorsed by the FAA which cannot issue approvals beyond the "future" planning range. For BVY, the ultimate condition is based on a Bombardier Challenger 300 (late model) design aircraft with an RDC of C-II. Note that this aircraft also has a TDG of 1B, which is less than that of the Dassault Falcon 900 (a TDG 2). Since both are designated design aircraft for RW 16/34 and RW 9/27 respectively, the TDG of the more demanding design aircraft was utilized in the ultimate condition.
[3] The TDG is based on the Dassault Falcon 900 and applies to all taxiways at BVY.

It should be recognized that since the future ARC and RDC recommendations provided above are consistent with the existing conditions at the Airport, most safety or design-related criteria will not change. Additionally, the ultimate ARC, RDC, and TDG have been established to preserve for potential development that could occur beyond the 20-year planning period and reflect accommodating the largest existing aircraft currently being utilized for general aviation. Note that the more demanding

TDG of various design aircraft (i.e., Cessna Citation Latitude, Bombardier Challenger 300 (late model), and Dassault Falcon 900) has been utilized. Therefore, a TDG of 2 should be maintained through and beyond the 20-year planning period.

FAA Airport Design Standards

FAA airport design standards include requirements for physical runway and taxiway characteristics as well as safety-related areas and setbacks. As described in FAA AC 150/5300-13A, *Airport Design*, these standards are established for individual airport facilities (e.g., runways, taxiways, etc.) based on several variables that can include RDCs, TDGs, instrument approach minimums, etc. The FAA requires airports to meet these standards to help ensure safe and efficient operations.

Note that any condition on an airport that does not meet FAA design criteria is considered to be "non-standard" and subject to correction. When local airport conditions are such that a non-standard condition cannot be corrected, it is at the discretion of the FAA to issue a Modification of Standards (MOS) on a case-by-case basis. However, it is very difficult to justify an MOS since design standards are rooted in ensuring safety; thus, FAA mandates that all MOS be reviewed every five years to reassess their applicability and justification. Currently, BVY does not have an MOS.

Table 4-4 and **Table 4-5** provide summaries for BVY's compliance with critical airport design standards with respect to its existing runways and its primary taxiways. Since the RDC for both runways will remain a B-II and the Airport is currently in compliance, there are no deficiencies. Following the tables are brief overviews of the relevant airport design standards as well as existing conditions.

Table 4-4: FAA Runway Design Standards for BVY

Runway Design Standards	FAA Design Standard *RDC = B-II; ≥ 1-Mile Vis* (Existing/Future Conditions)	Runway 16-34 (Existing Condition)	Runway 9-27 (Existing Condition)	FAA Design Standard *RDC = C-II; ≥ 1-Mile Vis* (Ultimate Condition)
Runway Width	75'	100'	100'	100'
Runway Shoulder – Width – Surface	 10' Turf/Stabilized Soil	 10' Turf/Stabilized Soil	 10' Turf/Stabilized Soil	 10' Turf/Stabilized Soil
Runway Safety Area (RSA) – Width – Length	 150' 300'	 150' 300'	 150' 300'	 400' 1,000'
Runway Object Free Area (ROFA) – Width – Length	 500' 300'	 500' 300'	 500' 300'	 800' 1,000'
Runway Object Free Zone (ROFZ) – Width – Length beyond RW end	 400' 200'	 400' 200'	 400' 200'	 400' 200'
Precision Object Free Zone (POFZ) – Width – Length	 800' 200'	N/A	N/A	N/A
Runway Centerline to: – Parallel Taxiway Centerline – Aircraft Parking Area – Holding Position Markings	 240' 250' 200'	 240' 250' 200'	 240' 250' 200'	 400' 500' 250'

Source: Jviation, FAA AC 150/5300-13A, *Airport Design*.
Note: Items shown in **bold red** are existing conditions that are non-compliant with the FAA design standards.

Table 4-5: Taxiway Design Standards for BVY

Taxiway Design Standards	FAA Standard (TDG 2 / ADG II)	TW A	TW B	TW C	TW D	TW E	TW F	TW G	TW H
Taxiway Type	-	Connector/ Access	Partial Parallel	Connector	Connector	Connector	Connector	Connector	Partial Parallel
– Associated Runway	-	RW 16-34	RW 16-34 RW 9-27	RW 16-34	RW 9-27	RW 9-27	RW 16-34 RW 9-27	RW 16-34	RW 9-27
– Taxiway Width	35'	50'	40'	50'	35'	35'	35'	40'	35'
Taxiway Shoulder – Width – Surface	10' Turf/ Stabilized Soil	10' Turf/ Stabilized Soil	10' Turf/ Stabilized Soil	10' Turf/ Stabilized Soil	10' Turf/ Stabilized Soil	10' Turf/ Stabilized Soil	10' Turf/ Stabilized Soil	10' Turf/ Stabilized Soil	10' Turf/ Stabilized Soil
Taxiway Safety Area Width	79'	79'	79'	79'	79'	79'	79'	79'	79'
Taxiway Object Free Area Width	131'	131'	131'	131'	131'	131'	131'	131'	131'
Taxiway Centerline to: – Parallel Taxiway/Taxilane – Fixed or Movable Object	105' 65.5'	N/A 261'	575' 261'	N/A 261'	N/A 261'	N/A 261'	575' 261'	N/A 261'	N/A 261'
Taxiway Wing Tip Clearance	26'	26'	26'	26'	26'	26'	26'	26'	26'

Source: Jviation; FAA AC 150/5300-13A, *Airport Design.*

Runway Safety Area

The Runway Safety Area (RSA) is a defined surface surrounding the runway that is specifically prepared and suitable for reducing the risk of damage to airplanes in the event of an undershoot, overshoot, or excursion from the paved surface. RSAs are also required to be free of non-frangible objects except when fixed by function. As shown in **Table 4-4**, BVY's RSAs for both runways are currently compliant with FAA design standards for a B-II with 1-mile approach visibility minimums. Since this designation will remain the same for the future condition, no action is required. However, it should be recognized that if the RDC for Runway 16-34 were to be ultimately upgraded to a C-II designation, the RSA for Runway 16-34 would increase in size and the current conditions would become deficient; this would have to be addressed appropriately at that time.

No action is required regarding the RSAs for Runway 16-34 or Runway 9-27.

Runway Object Free Area

The Runway Object Free Area (ROFA) is a two-dimensional FAA-defined runway safety standard that requires the clearing of objects within a specific area around a given runway. This standard requires the clearing of all above-ground objects protruding above the nearest point of the RSA. Exceptions to this requirement include objects that need to be in the ROFA for air navigation or aircraft ground maneuvering purposes. In those cases, objects must meet FAA frangibility requirements. As shown in **Table 4-4**, BVY's existing and future ROFAs meet the design standards for a B-II designation; thus, no action is required. However, if the RDC for Runway 16-34 were to be ultimately upgraded to a C-II designation, the ROFA for Runway 16-34 would increase in size and the current conditions would become deficient; this would have to be addressed appropriately at that time.

No action is required regarding the ROFAs for Runway 16-34 or Runway 9-27.

Runway Obstacle Free Zone (ROFZ)

The Obstacle Free Zone (OFZ) is a volume of airspace intended to protect aircraft in the early and final stages of flight. It must remain clear of object penetrations, except for frangible Navigational Aids (NAVAIDs) located in the OFZ because of their function. For runways serving aircraft with Maximum Takeoff Weight (MTOWs) greater than 12,500 pounds, the OFZ is 400 feet wide and extends 200 feet beyond the end of the runway. As shown in **Table 4-4**, BVY's current and future ROFZs meet airport design standards as would an ultimate C-II RDC.

BVY meets all ROFZ requirements for both runways; no action is required.

Precision Obstacle Free Zone

The Precision Obstacle Free Zone (POFZ) is defined as a volume of airspace above an area beginning at the threshold elevation and centered on the extended runway centerline that is 200 long by 800 feet wide. It exists on runway ends that have a vertically guided approach and is only in effect when the reported ceiling is below 250 feet or visibility is less than ¾ statute mile, and an aircraft is on final approach within two miles of the runway threshold. Only a wing of an aircraft holding on a taxiway waiting for runway clearance may penetrate the POFZ as can airport vehicles up to 10 feet in height that are necessary for maintenance. BVY currently does not have a POFZ nor are any projected to be required in the future.

BVY does not have any POFZ requirements; no action is required.

Runway Protection Zone

A Runway Protection Zone (RPZ) is an area beyond each runway end designed to enhance the protection of people and property on the ground. To ensure that the RPZs are kept clear of incompatible uses, the FAA recommends that the land included in the RPZ should be owned by the Airport or protected via an avigation easement. This gives the Airport the right to control the presence and height of objects as well as the use of the land within the RPZ. The FAA Memorandum, *Interim Guidance on Land Uses Within a Runway Protection Zone*, indicates that existing incompatible land uses within the RPZ should be removed when those uses would enter the limits of the RPZ as the result of:

- An airfield project (e.g., runway extension, runway shift)
- A change in the critical design aircraft that increases the RPZ dimensions
- A new or revised instrument approach procedure that increases the RPZ dimensions
- A local development proposal in the RPZ (either new or reconfigured)

The size of an RPZ for a runway end is a function of the critical design aircraft and the visibility minimums established for that end. Visual runways have smaller RPZs because the landing minimums are higher, resulting in the runway not being used during periods of reduced visibility. Essentially, the greater precision of the approach (and the lower the visibility minimums for landing), the larger the resulting RPZ. **Table 4-6** presents BVY's RPZ design criteria based on the existing and future RDC of each runway. Note that these are consistent with the Airport's current RPZs.

Table 4-6: Runway Protection Zone Dimensions

RPZ Criteria	RWY 16	RWY 34	RWY 9	RWY 27
Visibility Minimums	1-Mile	1-Mile	1-Mile	1-Mile
RDC	B-II	B-II	B-II	B-II
Approach RPZ – Length – Inner Width – Outer Width	 1,000' 500' 700'	 1,000' 500' 700'	 1,000' 500' 700'	 1,000' 500' 700'

Source: Jviation.

BVY's existing RPZs are compliant with FAA standards in terms of recommended land uses to varying degrees. Three of its RPZs currently have public roads within them and two also have residences. The Airport should continue to work to ensure that land uses within its RPZs are completely compatible. It is important to understand that existing RPZ conditions are effectively "grandfathered" and non-compliance with the interim RPZ guidance noted above is effective if/when RPZ conditions change

It is recommended that BVY's RPZs be consistent with FAA design standard recommendations to the degree practicable.

Building Restriction Line (BRL)

A Building Restriction Line (BRL) is the line indicating the limit of where airport buildings can be to limit their proximity to aircraft movement areas. The BRL is an amalgamation of airport design standards including RPZs, OFAs, OFZs, the runway visibility zone, NAVAID critical areas, and various other critical airspace-related areas (typically associated with a 35-foot building height limitation). The BRL at BVY considers all these factors. Note that structures taller than 35 feet within the BRL require additional analysis to ensure compliance with the 14 CFR Part 77 surfaces.

It is recommended that BVY's BRL be consistent with FAA design standards and be clear of obstructions.

Runway Line-of-Sight Requirements

There are two components associated with runway line-of-sight requirements. First, related to an individual runway, two points located five feet above the runway centerline must be mutually visible for the entire runway length. Second, for airports with intersecting runways like BVY, two points located five feet above the intersecting runway centerlines at specified points must also be mutually visible. BVY currently meets all runway line-of-sight standards for both individual runway and intersecting runways.

BVY meets all Line-of-Sight standards; no action is required.

Runway Blast Pads

A runway blast pad is a paved surface adjacent to the ends of runways designed to reduce the erosive effect of jet blast and propeller wash during takeoff operations. BVY currently lacks blast pads on all its runway ends. FAA requires blast pads for runways accommodating ADG IV and higher aircraft and recommends blast pads for runways accommodating ADG III aircraft. Since BVY's ADG is planned to be a Group II throughout the planning period, no action is required.

BVY meets runway blast pad design standards; no action is required.

Runway & Taxiway Shoulders

Shoulders are areas adjacent to the defined edge of paved runways or taxiways that provide a transition between the pavement and the adjacent surface. They are designed to enhance drainage, provide for blast protections, and support aircraft and emergency vehicles that deviate from the full-strength pavement. Like runway blast pads, FAA only requires paved shoulders for runways and taxiways accommodating ADG IV and higher aircraft and recommends paved shoulders for runways and taxiways accommodating ADG III aircraft. Turf, aggregate-turf, soil cement, line or bituminous stabilized soil are recommended adjacent to runways and taxiways accommodating ADG I and ADG II aircraft. BVY has turf runway and taxiway shoulders that meet the design standards recommended above. Since BVY's ADG is planned to be Group II throughout the planning period, no action is required.

BVY meets all runway and taxiway shoulder design standards; no action is required.

Taxiway Design Standards

Similar runway design requirements, all taxiways have FAA-mandated Taxiway Safety Area (TSA) and Taxiway Object Free Area (TOFA) design requirements to help ensure safe operational conditions on an airport. These standards promote the safe movement of aircraft without the threat of aircraft wingspan striking any objects or other aircraft. As shown in **Table 4-5**, BVY's taxiways meet current design standards.

BVY meets all taxiway design standards; no action is required.

4.3.2 Runways

Runway Orientation

The runway configuration is the physical layout of the airfield system, including the number of runways, their orientation, and their locations relative to each other, as well as to the landside facilities. Each runway configuration has a different capacity due to operational limitations and restrictions. For example, runways that converge or intersect have lower capacities than parallel runways since an aircraft on a converging runway must wait to land or takeoff until the aircraft on the second converging runway has either completed its landing or has cleared the path for aircraft arriving or departing from the other runway.

As described in **Chapter 2**, BVY has two runways: Runway 16-34 is positioned with a northwest/southeast orientation, while Runway 9-27 has west/east alignment. Since these runways intersect, only one runway can be used as a time, even with the presence of the ATCT. Nevertheless, the overall capacity of the airfield remains substantially above the demand projected over for the planning period (as detailed in Section 4.2).

Additionally, climatological conditions specific to the location of an airport not only influence the layout of the airfield but also affect the use of the runway system. Surface wind conditions have a direct impact on airport operations in that runways not oriented to take the maximum advantage of prevailing winds will restrict the utility of an airport to varying degrees. When landing and taking off, aircraft can operate properly on a runway if the wind component perpendicular to the direction of travel (defined as a crosswind) is not excessive (generally, this is specific to the operational requirements and capabilities of individual aircraft).

Surface wind conditions (i.e., direction and speed) generally determine the desired alignment and configuration of the runway system. 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. It can be generally stated that the smaller the aircraft, the more susceptible it is to the effects of crosswinds. To determine wind velocity and direction at Beverly Regional Airport, wind data from observations taken at the Airport from 2009 to 2019 was obtained from the National Climatic Data Center and was utilized to construct VFR, IFR and all-weather wind roses.

The allowable crosswind component is dependent upon the types of aircraft that utilize the Airport on a regular basis. As stated earlier, the future RDC for Runway 16-34 will remain a B-II as will that of Runway 9-27. Based on FAA AC 150/5300-13A, the B-II RDC requires that a 13-knot crosswind component be utilized for this analysis. (Note that the potential ultimate RDC for Runway 16-34 is a C-II, which requires a crosswind component of 16-knots.) Crosswind components of 10.5, 13, and 16 knots were used for this analysis to evaluate the allowable crosswind component for various sizes of aircraft.

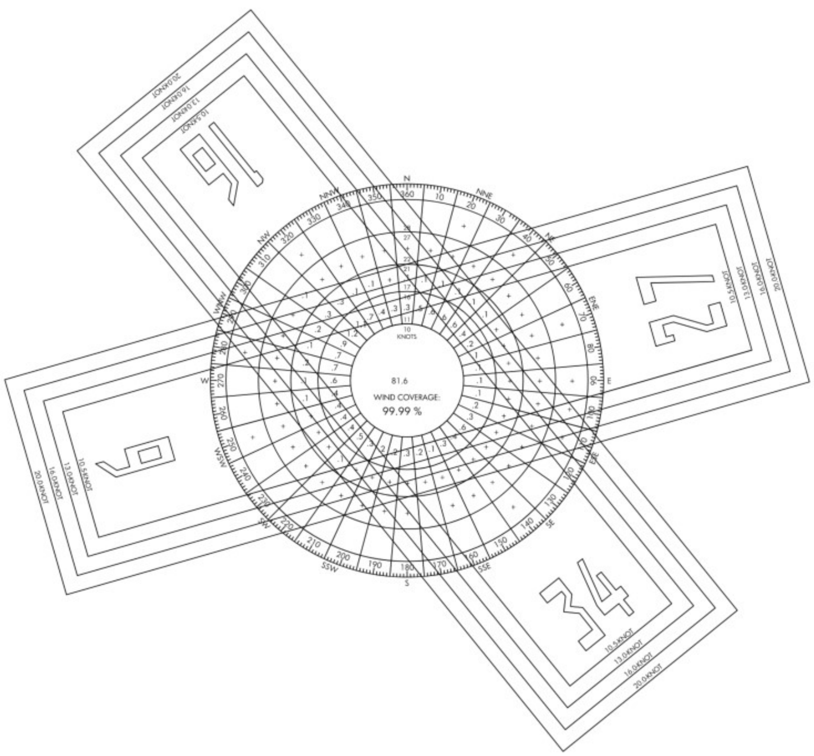
The following illustrations **Figure 4-3** and **Figure 4-4** show the All-Weather and IFR wind rose generated for BVY. According to the FAA, the desirable wind coverage for an airport is 95% during all weather conditions. This means that the runway orientation and configuration should be developed such that the maximum crosswind component is not exceeded by more than 5% of the time annually. (Note that this is a recommendation, not a requirement.) As shown in **Table 4-7**, while BVY's runways, individually, do not meet wind coverage recommendations (10.5 knots), their combined crosswind coverage in all weather conditions is 98.19%, exceeding FAA’s minimum recommended coverage of 95%. Therefore, the wind coverage at BVY by its current runway orientation is considered to be adequate for the planning period.

Table 4-7: BVY Wind Coverage

	10.5 knots	13 knots	16 knots
All Weather			
Runway 16-34	92.79%	96.11%	99.04%
Runway 9-27	91.08%	95.40%	98.72%
Combined	98.19%	99.54%	99.90%
IFR			
Runway 16-34	90.37%	94.48%	99.56%
Runway 9-27	88.33%	93.53%	99.59%
Combined	96.27%	98.88%	99.98%
VFR			
Runway 16-34	93.56%	96.64%	99.89%
Runway 9-27	92.02%	96.05%	99.85%
Combined	98.83%	99.76%	99.99%

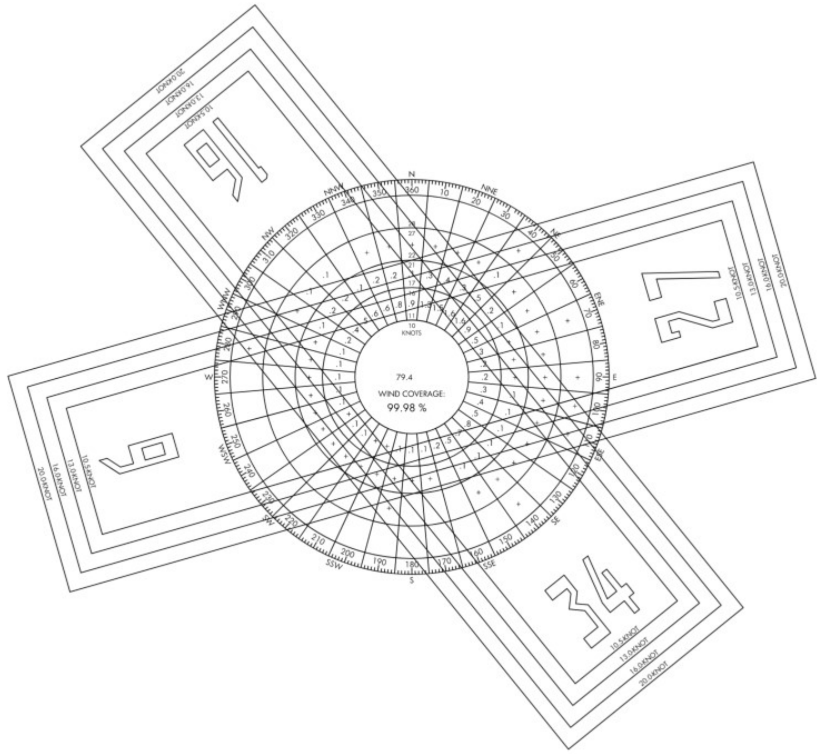
Source: NCDC, Station 725088, FAA AGIS Wind Rose Form, BVY Annual Period of Record: 2010-2019.

Figure 4-3: All Weather Windrose



Source: Jviation.

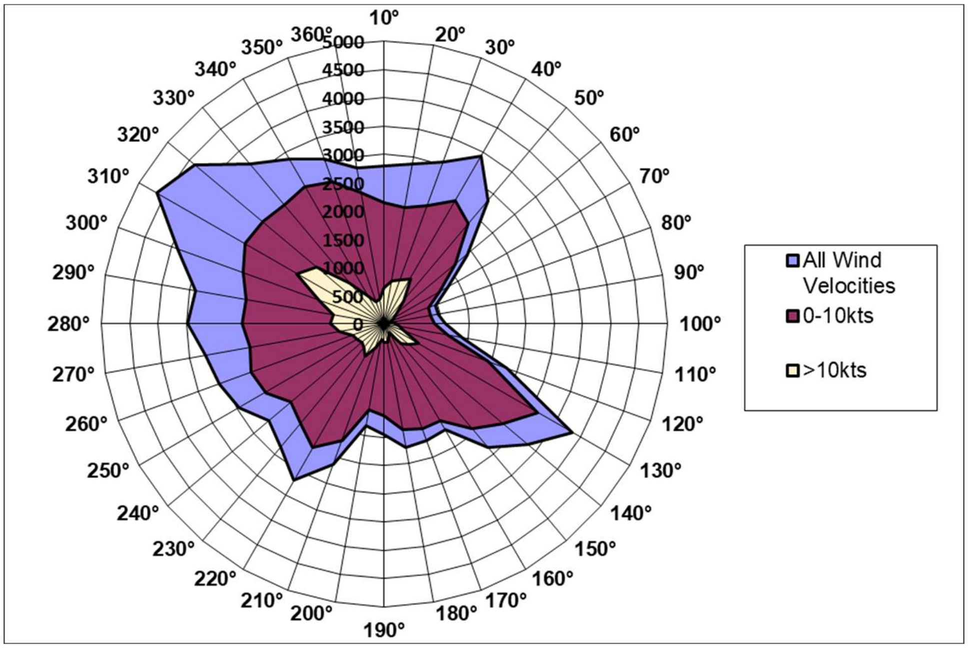
Figure 4-4: IFR Windrose



Source: Jviation.

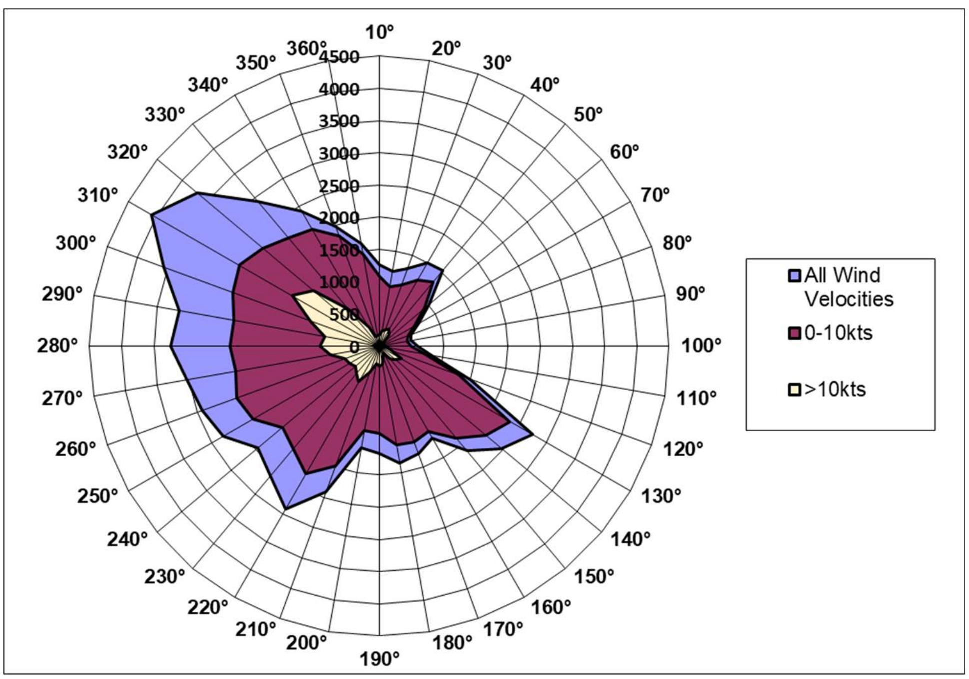
Beyond these windrose percentage calculations, it is often useful to examine annual wind persistency trends near an airport to identify preferred runway utilization (based on wind) and any potential anomalies that should be considered. **Figure 4-5**, **Figure 4-6**, and **Figure 4-7** reflect annualized wind patterns at BVY based on all-weather, VFR, and IFR weather conditions, respectively. Each graph depicts the number of observations recorded at a given wind direction and velocity.

Figure 4-5: All-Weather Wind Persistency



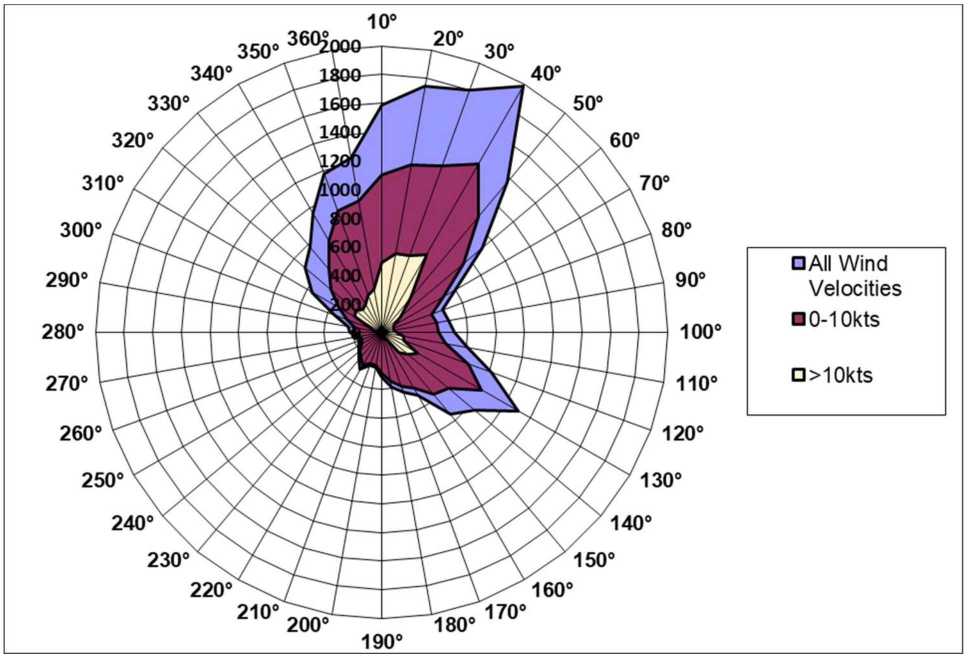
Source: Jviation; FAA GIS wind rose generator; station 725088 2010-2019 annualized data.

Figure 4-6: VFR Wind Persistency



Source: Jviation; FAA GIS wind rose generator; station 725088 2010-2019 annualized data.

Figure 4-7: IFR Wind Persistency



Source: Jviation, FAA GIS wind rose generator; station 725088 2010-2019 annualized data.

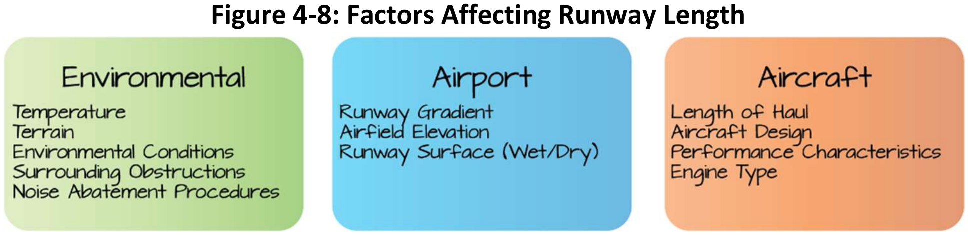
Demonstrated in the wind coverage analysis and reinforced by the persistency tables shown above, area winds typically are oriented northwest/southeast, resulting in greater usage of Runway 16-34. Based on these various analyses, BVY's current runway configuration adequately accommodates the requirements of the area weather patterns.

The existing configuration for BVY's runway layout provides adequate wind coverage per FAA guidance, no orientation alternatives will be considered for the 20-year planning period.

Runway Length

The purpose of this section is to conduct a runway length analysis to determine if the existing runway lengths are adequate to accommodate the aircraft fleet currently operating and projected to operate at BVY, and if not, what those lengths should be. It should be noted that in practical application, specific runway length requirements must be generated for each flight that originates at any airport. At BVY, along with all other airports, these requirements are dependent on a wide range of variables (see **Figure 4-8**), many of which can vary dramatically daily or even hourly.

Figure 4-8: Factors Affecting Runway Length



Source: Jviation.

To normalize those variables for master planning purposes, a runway length analysis was conducted under FAA AC 150/5325-4B, *Runway Length Requirements for Airport Design,* to ensure that the existing and future runway lengths are suitable for the forecasted range of critical design aircraft. The FAA methodology establishes minimum runway length requirements based primarily upon several factors including airport elevation, average temperature, and type aircraft expected to use the runway regularly. As described below, the advisory circular employs a five-step process to establish a recommended length for a given runway:

> Step #1: Identify the critical design airplane or airplane group.
>
> Step #2: Identify the airplanes or family/group that will require the longest runway lengths at maximum certificated takeoff weight (MTOW).
>
> Step #3: Determine the method that will be used for establishing the recommended runway length.
>
> Step #4: Select the recommended runway length through application of the appropriate determination methodology.
>
> Step #5: Apply any necessary adjustment to the obtained runway length.

Runway 16-34 is currently 5,001 feet long and Runway 9-27 is 4,755. The Airport's published altitude is 107 feet Mean Sea Level (MSL) with a mean daily maximum temperature in the hottest month (July) of 80° Fahrenheit. Additionally, as discussed previously, the future design code for both runways is projected to remain as an RDC of B-II, which is representative of a wide variety of mid-sized business aircraft (e.g., Cessna Citation Latitude and Dassault Falcon 900).

The following sections describe the application of each of these steps for determining the FAA-length requirement for both runways at Beverly Regional Airport

Runway 16-34 Length Requirement (FAA Methodology)

Step #1: Identify the critical design airplanes or airplane group.

In **Chapter 3**, the critical design airplane for Runway 16-34 was identified as a Cessna Citation Latitude, an aircraft with an RDC of B-II.

Step #2: Identify the airplanes or family group that will require the longest runway lengths at maximum certificated takeoff weight (MTOW).

The Cessna Citation Latitude has a maximum takeoff weight (MTOW) of 30,800 pounds.

Step #3: Determine the method that will be used for establishing the recommended runway length

Step 3 simply involves identifying the appropriate runway length determination methodology provided in FAA AC 150/5325-4B that should be applied for the design aircraft. Based on Table 1-1 of the AC, the methodology described within Chapter 3 of the AC must be employed for this assessment.

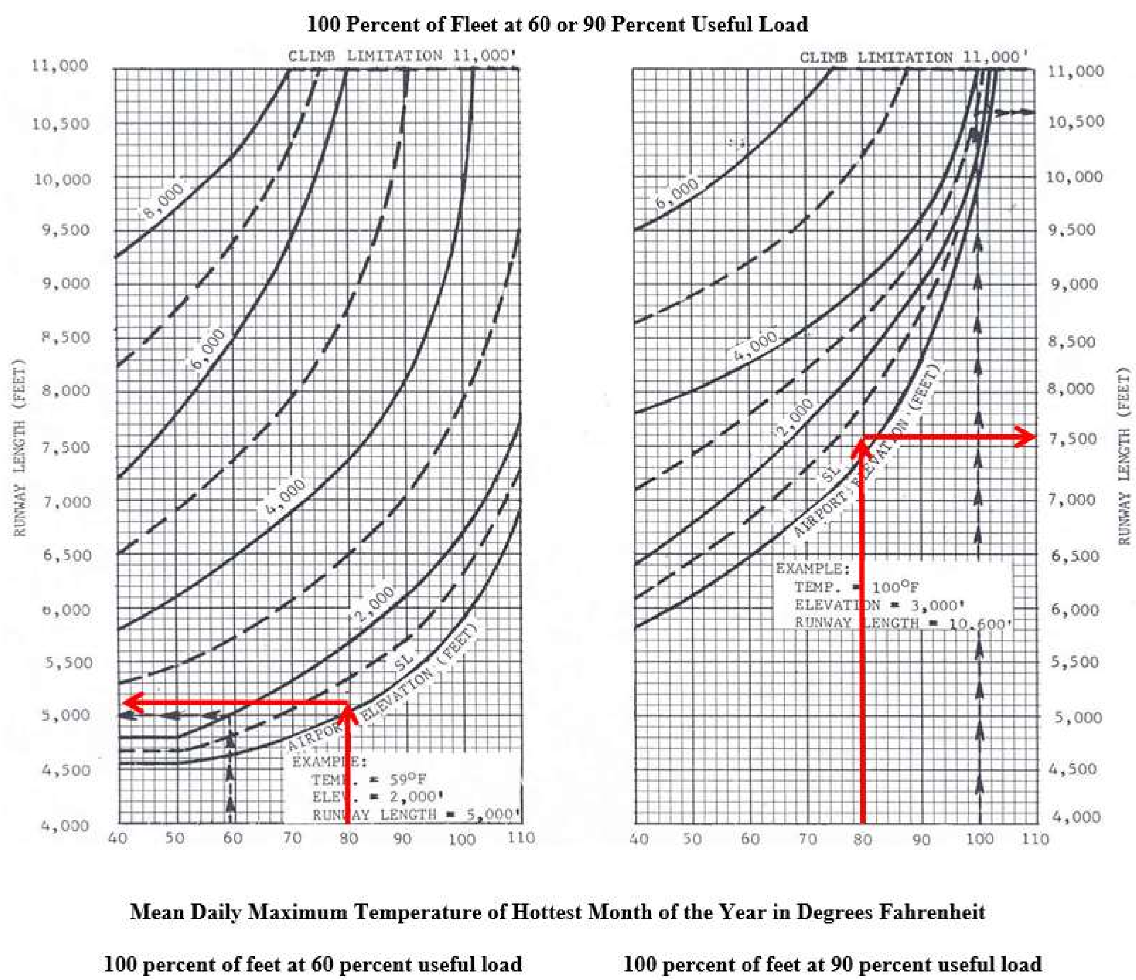
Step #4: Select the recommended runway length through application of the appropriate determination methodology.

Step 4 is the actual runway length assessment, which is conducted through applying a series of runway or airport dependent factors to FAA runway length curves. For BVY Runway 16-34, the key dependent factors include the following:

- Airport Elevation: 107.3 feet (Mean Seal Level - MSL)
- Mean Daily Maximum Temperature (hottest month): 80°F (July)
- Critical design airplanes: Family grouping of large airplanes with a MTOW of over 12,500 pounds but less than 60,000 pounds (100 percent of the fleet category has been utilized)

These dependent variables are then used as input into the FAA runway length curves for large airplanes weighing less than or equal to 60,000 pounds (see **Figure 4-9**).

Figure 4-9: FAA Runway Length Curve – Airplanes within a MTOW of more than 12,500 Pounds up to and including 60,000 Pounds (100 Percent Fleet)



Source: FAA AC150/5325-4B, Figure 3-2; Jviation.

Applying those variables to the FAA curves results in the following recommended runway lengths at two useful loads:

Large airplanes weighing less than or equal to 60,000 pounds:

- *100% of these Large Airplanes at 60% Useful Load* *5,100 feet*
- *100% of these Large Airplanes at 90% Useful Load* *7,600 feet*

It should be recognized that the AC provides some flexibility in applying runway length curves in terms of percentage of fleet (either 75 percent of the fleet or 100 percent of the fleet). Through application of the FAA's AC in terms of the aircraft listed within the percent categories, the 100 percent category was identified as being appropriate for the primary runway BVY. Note that the AC also defines a 100 percent category airport as being one that is "primarily intended to serve communities located on the fringe of a metropolitan area or a relatively large population remote from a metropolitan area." This definition is consistent with the character of Beverly Regional Airport.

Step #5: Apply any necessary adjustment to the obtained runway length.

The fifth and final step of the FAA runway length determination process provides for adjustments to the obtained runway length based upon local circumstances, Of the multiple variables that could impact an ultimate runway length requirement, only the runway gradient is applicable to BVY. This variable considers the difference in runway end elevations and request that an additional 10 feet of runway length be added for each foot of elevation change. Runway 16-34 has an elevation change of 25.1 feet, meaning that 251 feet should be added to the totals projected in Step 4. Thus, the final FAA runway length determination is as follows:

Large airplanes weighing less than or equal to 60,000 pounds:

- *100% of these Large Airplanes at 60% Useful Load* *5,351 feet*
- *100% of these Large Airplanes at 90% Useful Load* *7,851 feet*

Considering that Runway 16-34 is currently 5,001 feet in length, it is evident that based on this methodology, the existing runway length is inadequate to meet the existing and future needs at either 60 or 90 percent useful loads. Therefore, based on the FAA runway length requirement methodology, an extension of 2,850 feet of Runway 16-34 would be warranted to achieve an ultimate runway length of 7,851.

Runway 9-27 Length Requirement (FAA Methodology)

Step #1: Identify the critical design airplanes or airplane group.

In **Chapter 3**, the critical design airplane for Runway 9-27 was identified as a Dassault Falcon 900, an aircraft with an RDC of B-II.

Step #2: Identify the airplanes or family group that will require the longest runway lengths at maximum certificated takeoff weight (MTOW).

The Dassault Falcon 900 has a maximum takeoff weight (MTOW) of 46,500 pounds.

Step #3: Determine the method that will be used for establishing the recommended runway length

Based on Table 1-1 of the AC, the methodology described within Chapter 3 of the AC must be employed for this assessment.

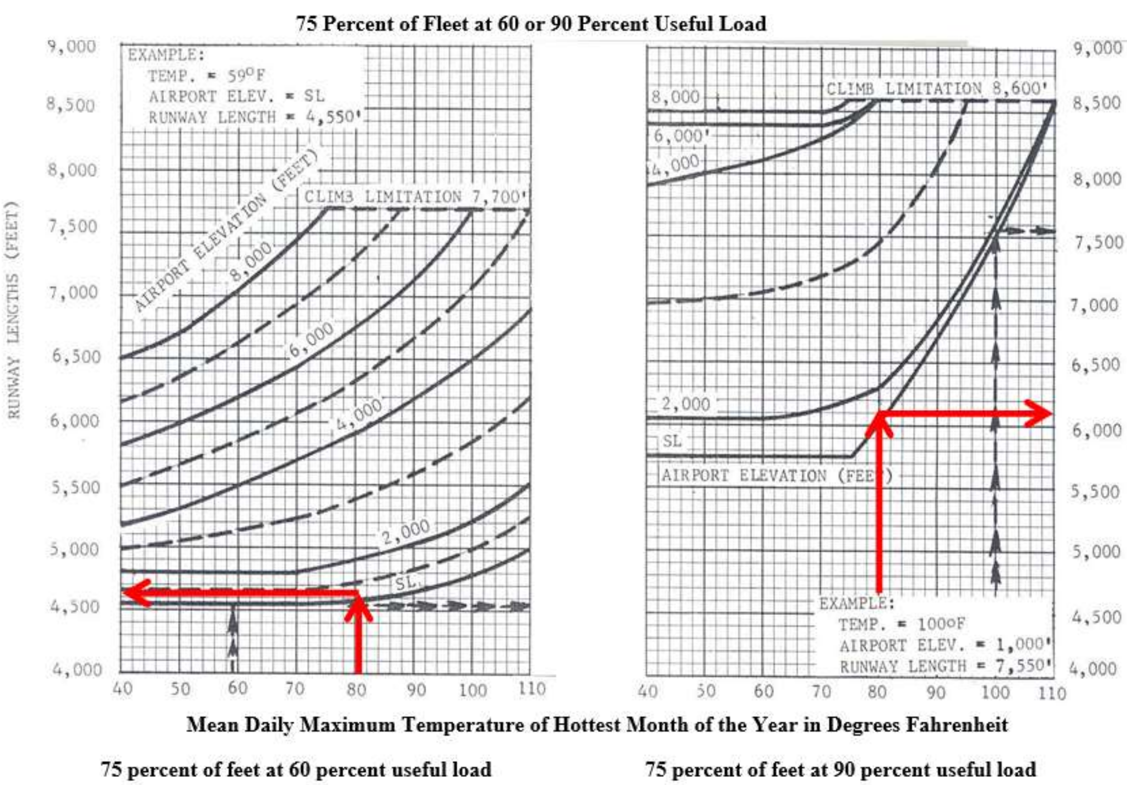
Step #4: Select the recommended runway length through application of the appropriate determination methodology.

For BVY Runway 9-27, the key dependent factors include the following:

- Airport Elevation: 107.3 feet (Mean Seal Level - MSL)
- Mean Daily Maximum Temperature (hottest month): 80°F (July)
- Critical design airplanes: Critical design airplanes: Family grouping of large airplanes with a MTOW of over 12,500 pounds but less than 60,000 pounds (75 percent of the fleet category has been utilized)

These dependent variables have been applied to the FAA runway length curves for large airplanes weighing less than or equal to 60,000 pounds within the 75 percent fleet category (see **Figure 4-10**). Note that through application of the FAA's AC in terms of the aircraft listed within the percent categories, the 75 percent category was identified as being appropriate for the Airport's crosswind runway.

Figure 4-10: FAA Runway Length Curve – Airplanes within a MTOW of more than 12,500 Pounds up to and including 60,000 Pounds (75 Percent Fleet)



Source: FAA AC150/5325-4B, Figure 3-1; Jviation.

Applying those variables to the FAA curves results in the following recommended runway lengths at two useful loads:

Large airplanes weighing less than or equal to 60,000 pounds:

- *75% of these Large Airplanes at 60% Useful Load* *4,650 feet*
- *75% of these Large Airplanes at 90% Useful Load* *6,100 feet*

Step #5: Apply any necessary adjustment to the obtained runway length.

The final step provides for adjustments to the obtained runway length based upon local circumstances. Runway 9-27's current runway gradient has an elevation change of 19.7 feet, meaning that 197 feet should be added to the totals projected in Step 4. Thus, the final FAA runway length determination is as follows:

Large airplanes weighing less than or equal to 60,000 pounds:

- *75% of these Large Airplanes at 60% Useful Load* *4,847 feet*
- *75% of these Large Airplanes at 90% Useful Load* *6,297 feet*

As Runway 9-27 is currently 4,755 feet in length, it does not meet the recommended runway length for existing and future needs at either 60 or 90 percent useful load. Therefore, based on the FAA runway length requirement methodology, an extension of 1,542 feet of Runway 16-34 would be warranted to achieve an ultimate runway length of 6,297 feet.

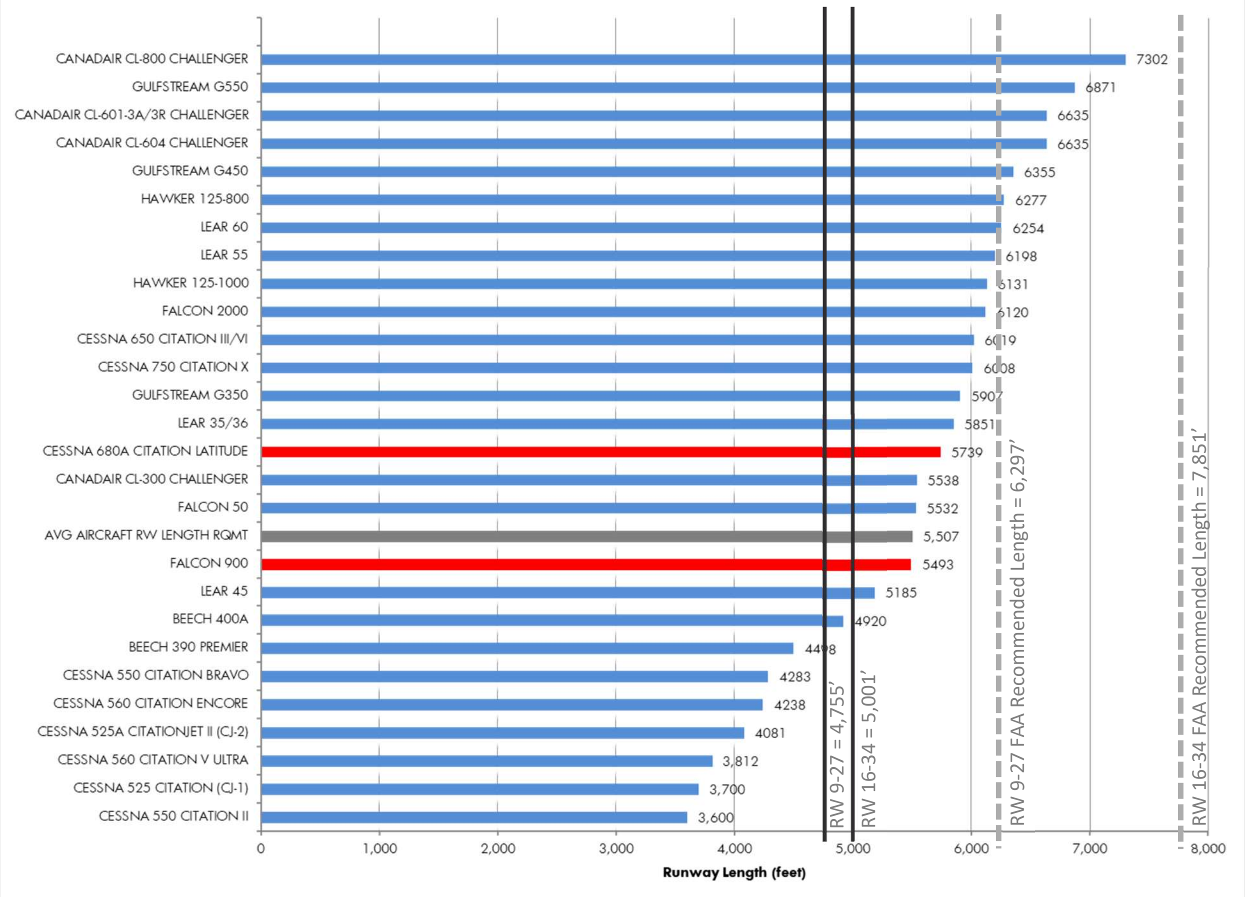
Runway Length Recommendations

The previous sections defined the FAA-recommended length for each runway at BVY. However, it must be acknowledged that these lengths are the lengths that the FAA would be able to consider for each of BVY's runways; they are not in fact the minimum length requirements for these runways. BVY's current runways are capable of adequately serving all small aircraft types and can frequently accommodate the needs of much larger aircraft to varying degrees. As stated previously, a runway length requirement for a particular flight is a factor of local weather conditions, aircraft type and engines, aircraft payload, location of destination, aircraft insurance requirements, etc. Given the wide range of variables present in each individual flight, the determination of a runway length recommendation for all flights projected to be accommodated by a given runway effectively is a preponderance of those factors associated with the most common operations for the critical design aircraft as well as other aircraft that regularly operate on that runway.

Presented below in **Figure 4-11** is a graphical representation of the runway length requirements for various aircraft types that commonly operate at BVY (note that the critical design aircraft for Runway 16-34 and for Runway 9-27 are highlighted in red). These runway length requirements are based on generalized assumptions and reflect the most common operations. These representative runway length requirements are measured against BVY's current runway lengths as well as the FAA-recommended runway lengths defined above. Several important observations can be made regarding this graphic, including the following:

- The length of Runway 16-34 is currently 738’ short of meeting the requirements of its critical design aircraft (Cessna Citation Latitude).
- The FAA-recommended length for Runway 16-34 exceeds the runway length requirements for its critical design aircraft (Cessna Citation Latitude) by 2,112 feet. (In fact, the FAA recommendations exceed the need for all aircraft types defined in the chart, including those with an RDC of C-II.)
- The length of Runway 9-27 is also 738’ short of meeting the requirements of its critical design aircraft (Dassault Falcon 900).
- The FAA-recommended length for Runway 9-27 exceeds the runway length requirements for its critical design aircraft (Dassault Falcon 900) by 804 feet. The FAA recommendations also exceed the need for nearly all other aircraft types defined in the chart.

Figure 4-11: Recommended Runway Lengths



Source: Jviation; Aircraft Operating Manuals.

Based on this graphic, it is reasonable to conclude that both runways at BVY have a need for longer runway length; however, that additional runway length may not need to be at a length recommend by the FAA. Therefore, based on the runway length analysis presented above and to the degree practicable, it is recommended that extensions be explored for each of BVY’s runways to, at a minimum, meet the runway length requirements for their respective critical design aircraft.

The existing length for Runway 16-34 is insufficient to accommodate the runway length requirements for its critical design aircraft; to the degree practicable, options should be explored to increase the operational capabilities of this runway to a minimum runway departure length of 5,739 feet (Cessna Citation Latitude runway length requirement) and a maximum length of 7,851 feet (FAA recommendation).

The existing length for Runway 9-27 is insufficient to accommodate the runway length requirements for its critical design aircraft; to the degree practicable, options should be explored to increase the operational capabilities of this runway to a minimum runway departure length of 5,493 feet (Dassault Falcon 900 runway length requirement) and a maximum length of 6,297 feet (FAA recommendation).

Runway Width

The required width of a runway is defined in FAA AC 150/5300-13A, *Airport Design*, and is a function of the RDC and the instrument approaches available for that runway. The minimum width for a B-II runway that is equipped with nonprecision instrument approaches is 75 feet. Since both Runway 16-34 and Runway 9-27 fit that criteria and are currently 100 feet wide, they both exceed the minimum runway width as defined by the FAA by 25 feet. (Note that FAA airport design requirements are considered to be the minimum standards, meaning that they can be exceeded, although the FAA may not support funding for such an exceedance.) For BVY, at the time of its next reconstruction, Runway 9-27 should be narrowed to the 75-foot standard since there is not sufficient justification to fund a wider than required crosswind runway. However, at the time of its next reconstruction, consideration should be given to maintaining the 100-foot width on Runway 16-34 for the following reasons:

- As the primary runway for the Airport, Runway 16-34 tends to be the runway that experiences the majority of the larger business class jet operations, many of which require a 100-foot runway width to operate. Given its role as an FAA Reliever Airport for Logan International Airport, it is critical that BVY maintain its ability to accommodate these types of jet operations to the maximum extent possible.
- As suggested previously, there is a strong potential that Runway 16-34's RDC will eventually migrate from a B-II to a C-II, which has a 100-foot minimum runway width. Thus, it would be prudent to maintain the existing width to protect for that potential eventuality.
- Narrowing Runway 16-34 to 75 feet per the B-II minimum airport design standards would require additional engineering and construction costs (e.g., reduction of runway box section size, relocation of runway lighting, potential drainage issues, etc.). If the runway's RDC were to eventually change to a C-II, the runway would then need to return to a 100-foot width and these additional costs would again have to be incurred to return it to its current condition.

The existing 100-foot width of Runway 9-27 should be narrowed to 75 feet in conformance with FAA airport design criteria.

Strong consideration should be given to maintaining the existing 100-foot width of Runway 16-34, instead of narrowing it to 75 feet in conformance with FAA airport

design criteria. This consideration will be detailed in Chapter 5, Alternatives Analysis & Development Concepts.

Runway Lighting

Both runways at BVY have medium intensity runway lights (MIRLs) installed, so no additional lighting is required. However, given recent improvements in light-emitting diode (LED) technology, the Airport should also consider transitioning its lighting systems to LEDs at appropriate opportunities (i.e., as runways are constructed and/or reconstructed). These energy-efficient fixtures will improve lighting effectiveness, require less maintenance, conserve energy, and reduce Airport operating costs.

The Airport should transition its runway lighting to LEDs as able.

4.3.3 Taxiways

A taxiway system should be designed to facilitate safe and efficient aircraft movement to and from the runways and the aprons that serve pilot/passenger amenities, hangars, and other general aviation facilities. It is generally recommended that an airport’s primary runway be served by a full-length parallel taxiway to allow aircraft to enter or exit the runway environment as expeditiously as possible. At Beverly Regional Airport, the current taxiway system was constructed over many years and is largely based on the original military airfield configuration that is no longer suitable. This has resulted in the current taxiway system being generally inefficient, potentially confusing, and not consistent with current taxiway design practices. Of greatest note is the lack of full-length parallel taxiways that result in aircraft having to make additional runway crossings when accessing each runway from different areas of the airfield. This also results in aircraft being forced to remain in the runway environment for longer periods before takeoff and after landing.

Taxiway Width

The taxiways at Beverly Regional Airport currently range from 35 feet wide to 50 feet. Based on the FAA design requirements as described in FAA AC 150/5300-13A, BVY has a TDG of 2 (based on the Dassault Falcon 900) which results in a minimum taxiway width requirement of 35 feet. Thus, the Airport's current taxiway widths meet the minimum requirements for width throughout the planning period.

The ultimate design aircraft (late model Challenger 300) has a 1B TDG designation, which requires a 25-foot taxiway width. Although this aircraft has a lower TDG designation than the Dassault Falcon 900, the Challenger 300 has a higher RDC designation of C-II, which influences other airport design standards. It is expected that the Dassault Falcon 900 and other similar aircraft with a TDG of 2 will continue to operate regularly at BVY and that the Airport should continue to hold a TDG of 2.

Existing taxiway widths meet the FAA's minimum width requirements throughout the planning period. Taxiway widths that exceed the TDG 2 minimum requirements should be considered for a potential reduction. No action is required.

Taxiway Lighting

Taxiways at Beverly Regional Airport all have medium intensity taxiway edge lights (MITLs), so no additional taxiway lighting is required. However, given recent improvements in LED lighting technology, the Airport should consider transitioning its lighting system to LEDs at appropriate opportunities (i.e., as taxiways are constructed and/or reconstructed). These energy-efficient fixtures will improve lighting effectiveness, require less maintenance, conserve energy, and reduce Airport operating costs.

The Airport should transition its taxiway lighting to LEDs as able.

Taxiway System Capacity and Design

As discussed above, the taxiway system at Beverly Regional Airport is largely based on the former military airfield configuration and antiquated design parameters; the current configuration generally does not reflect current FAA design guidelines. For BVY, the core deficiency of the taxiway system is its lack of full-length parallel taxiways to its runways (see **Figure 2-11**). Taxiway B and Taxiway E serve as partial parallels for Runway 16-34, while Taxiway D and Taxiway H serve as partial parallel taxiways for Runway 9-27. Taxiway A runs east/west and crosses Runway 16-34 at an acute angle near mid-field, providing direct connectivity between the eastern and western ramp areas. Additionally, there are three taxiways (Taxiway C, Taxiway F, and Taxiway G) that connect the Airport's two runways and their associated support facilities.

Note that the FAA has a variety of taxiway design requirements identified in FAA AC 150/5300-13A that are intended to enhance the overall safety of taxiway operations and minimize opportunities for runway incursions. Many of these requirements are relatively new (circa 2012) and were not in effect when most of BVY's pavements were constructed. These newer design principles for taxiway system layouts are identified in **Table 4-8**.

Table 4-8: FAA Taxiway Design Principles

Design Principle	Summarized Definition
Steering Angle	Design taxiways such that the nose gear steering angles is < 50 degrees
Fillet Design	Traditional fillet design standards have been replaced New fillet design more effectively reflects aircraft wheel tracks.
Standardize Intersection Angles	90-degree turns are standard 30, 45, 60, 90, 120, 135, and 150-degree preferred intersection standard angles
Concepts to Minimize Runway Incursions	
Increase Pilot Situational Awareness	Utilize the "three-node concept" Pilot should have three or fewer choices at an intersection (left, right, straight)
Avoid Wide Expanses of Pavement	Wide pavement requires placing signs far from a pilot's eye
Limit Runway Crossings	Reduces the opportunity for human error
Avoid "High Energy" Intersections	Located in the middle third of the runways Limit the runway crossings to the outer thirds of the runway
Increase Visibility	Provide right angle intersections for best pilot visibility Acute angle runway exits should not be used as runway entrance or crossing

Avoid “Dual Purpose” Pavements	Runways used as taxiways and taxiways used as runways can lead to confusion
Indirect Access	Eliminate taxiways leading directly from an apron to a runway
Hot Spots	Limit the number of taxiways intersecting in one spot

Source: Jviation, FAA AC 150/5300-13A, *Airport Design.*

Based on a review of these current taxiway design principles, on a review of the 2018 *BVY Airport Layout Plan Update to Address Non-Standard Geometry Issues* study, and on conversation with representatives of the BVY ATCT, following is a listing of concerns regarding the existing taxiway system (see **Table 4-9**).

Table 4-9: BVY Problematic Geometries and Other Issues

Location	Problematic FAA Geometry Issue
TW A at RW 16-34	TW direct access to RW 16-34 from east ramp TW not at right angle to RW 16-34 TW crossing within middle third of RW 16-34
TW B at RW 16	TW not at right angle to RW 16 end
TW B at RW 9-27	TW not at right angle to RW 9-27
TW F at RW 16-34	TW not at right angle to RW 16-34
TW F at RW 9-27	TW not at right angle to RW 9-27
TW G at RW 16-34	TW direct access to RW 16-34 from east ramp
Location	**Problematic FAA ATCT Operational Issue**
FAA Hot Spot 1 TW A at RW 16-34	Aircraft leaving the east ramp heading west on TW A can enter RW 16-34 without authorization, resulting in a runway incursion.
FAA Hot Spot 2 TW E at TW H	Aircraft taxiing south on TW E can miss the turn onto TW H and enter RW 9-27 without authorization, resulting in a runway incursion.
TW A at RW 16-34	TW A is the primary east/west crossing point of RW 16-34. Beyond FAA geometry issues, crossing is currently having to be used by aircraft fuel trucks.

Source: *2018 BVY Airport Layout Plan Update to Address Non-Standard Geometry Issues*; FAA; Jviation.

In addition to these issues, it should also be recognized that many of BVY’s taxiways have nonstandard alignments and/or exceed minimum FAA design standards related to runway centerline to taxiway centerline separation requirements. While it is permissible for these minimum separation requirements to be exceeded, those may also result in the unintended consequence of reducing the overall amount of airside areas that could potentially be available for future development. In addition to cost, this should also be considered when weighing the prospect of keeping existing runways in their current location.

The existing taxiway system layout is inefficient and, in many ways, incompatible with current FAA design guidelines. The development of an updated taxiway system design is recommended to increase overall airport safety and operational efficiency. Consideration must also be given to the potential ultimate development of BVY.

4.3.4 Airfield Pavement

Runway & Taxiway Pavement Strength

Airfields are constructed to provide adequate pavement strength for aircraft loads, as well as resisting the abrasive action of traffic and deterioration from adverse weather conditions and other influences. They are designed not only to withstand loads of the heaviest aircraft expected to use the airport, but they must also be able to withstand the repetitive loadings of the entire range of aircraft expected to use the pavement over many years. Proper pavement strength design represents the most economical solution for long-term aviation needs.

There are several factors that must be considered when determining appropriate pavement strength for airfield structures. These factors include, but are not limited to, aircraft loads, frequency and concentration of operations, and the condition of subgrade soils. Runway pavement strength at airports is typically expressed by common aircraft landing gear configurations. Example aircraft for each type of gear configuration is as follows:

- Single-wheel: each landing gear unit has a single tire; these types of aircraft include light aircraft and some business jet aircraft.
- Dual-wheel: each landing gear unit has two tires, example aircraft are the Cessna Citation Latitude, Dassault Falcon 90, and Gulfstream G650.
- Dual-tandem: the main landing gear unit has four tires arranged in the shape of a square; example aircraft are the Boeing 757/767.

The aircraft gear type and configuration dictate how aircraft weight is distributed to the pavement and determines pavement response to loading. It should be noted that aircraft operating on a runway generally can exceed the defined pavement strength, but such operations will ultimately degrade the pavement prematurely and create wear issues that require more aggressive pavement maintenance. The published pavement strengths of the runways at BVY are presented in **Table 4-10.**

Table 4-10: Runway Pavement Strength

Runways	Published Pavement Strength	Surface Type & Condition	Pavement Condition Index (PCI)*
Runway 16-34 – Single Wheel Gear (S) – Dual Wheel Gear (D) – Duel Tandem Gear (DTW)	 30,000 lbs. 55,000 lbs. 103,000 lbs.	Asphalt Good	PCI = 96-100
Runway 9-27 – Single Wheel Gear (S) – Dual Wheel Gear (D) – Duel Tandem Gear (DTW)	 30,000 lbs. 114,000 lbs. 180,000 lbs.	Asphalt Good	PCI = 41-55 (RW 16 to RW 9-27) PCI = 71-85 (RW 34 to RW 9-27)

Source: Jviation; FAA 5010 Data; FAA Airport Facility Directory.
* PCI based on MassDOT Aeronautics, Airport Pavement Management System (Field inspection 11/2016).

The dual-wheel configuration is appropriate for application on both runways given the type of aircraft using the airport. Both runways' current strength is sufficient to accommodate the critical design aircraft (Cessna Citation Latitude and Dassault Falcon 900) as well as larger aircraft such as the Bombardier Challenger CL300. (Note that heavier aircraft can operate on a runway with a lower weight rating if it isn't a regular or normally occurring operation since it could prematurely decrease the useful life of the pavement.) However, given the general trend of increasing maximum takeoff weights (MTOW) of business jet aircraft in addition to the fact that BVY accommodates occasional use of larger corporate aircraft (e.g., a Gulfstream G650 has a MTOW of 99,600 lbs. and the Global Express has an MTOW of 99,500 lbs.)

that exceed BVY's published pavement strengths, consideration should be given to increasing the strength of Runway 16-34.

Taxiway pavement strength is also expressed in terms of aircraft weights associated with common aircraft landing gear configurations. BVY's taxiway system is a mix of different aged asphalt taxiways. Based on the findings of the *Massachusetts Pavement Management Plan* (see **Figure 2-3),** some have been rehabilitated in recent years while other taxiway constructions date back to the 1980s and 1990s. At the time of their next rehabilitation, the pavement strength of each taxiway should be reevaluated to ensure that it is consistent with runway pavement strengths and meets the needs of the existing and projected fleet mix.

The existing pavement strength of Runway 16-34 and Runway 9-27 is sufficient to accommodate the existing and future critical design aircraft; however, it is recommended that a potential increase in the pavement strength of Runway 16-34 be considered at the time of its next reconstruction to account for the trend of increasing aircraft weights. It is also recommended that taxiway pavement strengths be assessed on an individual basis at the time of their next rehabilitation to ensure consistency with runway pavement strengths.

Runway & Taxiway Surface Condition

FAA AC 150/5380-6b, *Guidelines and Procedures for Maintenance of Airport Pavements*, recommends that detailed pavement inspections be conducted regularly to monitor conditions and establish an appropriate Pavement Condition Index (PCI) for each section. The MassDOT Airport Pavement Management System Update identifies routine maintenance, such as joint and crack sealing, should be performed on a scheduled basis to extend the pavement life. Rehabilitation of airfield pavements should be identified in appropriate timeframes within the 20-year planning period.

BVY should continue to maintain its pavements by consistently updating and executing its Capital Improvement Plan (CIP).

4.3.5 Airfield Visual Aids

Airfield visual aids provide a variety of functions on an airport, including assisting pilots in locating the airport, providing aircraft guidance to and alignment with a specific runway end, offering visual cues on surface weather conditions, and providing direction for aircraft and vehicles operating on the ground, among other services. Generally, visual aids can be broken down into airfield markings, airfield signage, and airfield lighting.

Airfield Markings

As discussed in **Chapter 2**, BVY has a nonprecision VOR (VHF omnidirectional range) and localizer-only approach for Runway 16 and GPS nonprecision approaches with 1-mile visibility minimums to all runways. Per FAA AC 150/5340-1L, *Standards for Airport Markings*, BVY requires nonprecision approach markings that include the runway centerline, runway designator, threshold markings and aiming point markings. Since both Runway 16-34 and Runway 9-27 currently have these markings and a reduction of visibility minimums is not being proposed, BVY is in compliance with runway marking standards.

All taxiways are marked with yellow centerline striping and runway hold positions are appropriately marked with an enhanced yellow centerline to meet the new airport marking standards, as required.

BVY's airfield markings are currently in compliance with FAA design standards; they should be maintained as appropriate; no further action is required.

Airfield Signage

Airfield signage provides essential guidance information that is used to identify locations on an airport. BVY is currently equipped with standard FAA required signage including instruction, location, direction, destination, and information signs, and meets the standards given in FAA AC 150/5340-18F, *Standards for Airport Sign Systems.*

BVY's existing airfield signage meets FAA standards and is in good condition; no action is required.

Airfield Lighting

Airfield lighting provides enhanced situational awareness to those operating on or around an airport, particularly during times of reduced visibility (i.e., nighttime, inclement weather, etc.). For example, to land during periods of limited visibility, pilots must be able to see the runway or associated lighting at a certain distance from and height above the runway. If the runway environment cannot be identified at the minimum visibility point on the approach, FAA regulations prohibit landing.

Table 4-11 shows the current airfield lighting available at BVY. In addition to this lighting equipment, the Airport is also equipped with a rotating beacon and two lighted windsocks. It is recommended that BVY continue to maintain its current lighting infrastructure, improve its efficiency by installing LEDs, as well as installing a PAPI for Runway 34.

Table 4-11: Airfield Lighting

Facility	Type of Approach	Edge/End Lighting	Runway Approach Lighting	Visual Glide Slope Indicator (VGSI)	Lighting Owner
Runway 16	Nonprecision	MIRL	(non-standard MALS)	PAPI	BVY (all)
Runway 34	Nonprecision	MIRL, REIL			BVY (all)
Runway 9	Nonprecision	MIRL		PAPI	BVY (all)
Runway 27	Nonprecision	MIRL		PAPI	BVY (all)
Taxiways A, B, C, E, F, G and H	-	MITL	-	-	BVY (all)

Source: Jviation.

Notes: MIRL: Medium Intensity Runway Lighting; REIL: Runway End Identifier Lights; MALS: Medium Intensity Approach Lighting System Lights; PAPI: Precision Approach Path Indicator; MITL: Medium Intensity Taxiway Lighting

BVY's existing airfield lighting meets FAA standards and is in good condition; no action is required. It is recommended that BVY ultimately transition all existing lighting to LEDs. It is also recommended that PAPIs be installed for Runway 34.

4.3.6 Navigational Aids (NAVAIDs)

Navigational aids (NAVAIDs) consist of equipment to aid pilots in locating an airport (particularly for at times when Air Traffic Control assistance is not available), provide horizontal guidance information for a nonprecision approach, and provide horizontal and vertical guidance information for a precision instrument approach. Approach minimums for such procedures are based upon several factors, including aircraft characteristics, obstacles, navigation equipment, approach lighting, and weather reporting equipment. A summary of the existing visual and navigational aids and their conditions are shown in **Table 4-12**.

Table 4-12: NAVAIDS and Visual Aid Condition

NAVAIDs and Visual Aids	Condition
Area Navigation (RNAV)/Global Positioning System (GPS) – Runways 16, 34, 9, and 27	Good*
Localizer (LOC) – Runway 16	Good*
Medium Intensity Runway Lights (MIRL) – Runway 16-34 and Runway 9-27	Good
Non-Standard Medium Intensity Approach Lighting System (MALS) – Runway 16	Good
Precision Approach Path Indicators (PAPI) – Runway 16, Runway 9, and Runway 27	Good
Runway End Identifier Lights (REIL) – Runway 34	Good
Runway Markings – Runway 16-34, Runway 9-27	Painted Bi-Annually
Medium Intensity Taxiway Lights (MITLs) – All Taxiways	Good
Airport Rotating Beacon	Good
Runway & Taxiway Guidance Signs	Good
Automated Surface Observation System (ASOS) & Automatic Terminal Information Service (ATIS) Frequency 119.2	Good

Source: Airport Management; FAA 5010.
*Owned, installed and maintained by the FAA

As discussed in **Chapter 2, Inventory**, BVY has six published instrument approach procedures that are designed to provide pilots with varying degrees of navigational guidance at the Airport during inclement weather (i.e., when operating under instrument flight rules [IFR]). These procedures and their respective minimums are shown in **Table 4-13**, and are comprised of four GPS nonprecision approaches, one localizer approach, and one VOR approach.

Table 4-13: Instrument Procedure Minima

Instrument Approaches	Lowest Minimums (decision height and visibility)	Visual Aids
Runway 16 LOC	473 ft AGL; 1 sm	MIRL; MALS; PAPI
Runway 16 VOR	613 ft AGL; 1 sm	MIRL; MALS; PAPI
Runway 16 RNAV(GPS) with LPV	250 ft AGL; 1 sm	MIRL; MALS; PAPI
Runway 34 RNAV(GPS) with LPV	280 ft AGL; 1 sm	MIRL, REIL
Runway 9 RNAV(GPS) with LP	394 ft AGL; 1 sm	MIRL; PAPI
Runway 27 RNAV(GPS) with LPV	353 ft AGL; 1 sm	MIRL; PAPI

Source: Jviation; FAA 5010; FAA Instrument Approach Charts.
Notes: Medium Intensity Runway Lighting; REIL: Runway End Identifier Lights; MALS: Medium Intensity Approach Lighting System; PAPI: Precision Approach Path Indicator

Based on conversation with key airport stakeholders, it has been recognized that there would be benefits for pilots operating at BVY to have visibility minimums lower than 1-mile. However, through conversations with the Airport, the FAA, and MassDOT, it has been recognized that meeting the standards associated with the increased FAA airport design safety standards (e.g., RPZs, RSAs, ROFAs, etc.) that would result from the lowered minimums would likely be impracticable to achieve. Therefore, no changes to the Airport's current instrument approaches are recommended.

BVY's existing NAVAIDs are adequate to meet the needs of the Airport throughout the planning period; no action is required.

4.3.7 Obstructions and Airspace Requirements.

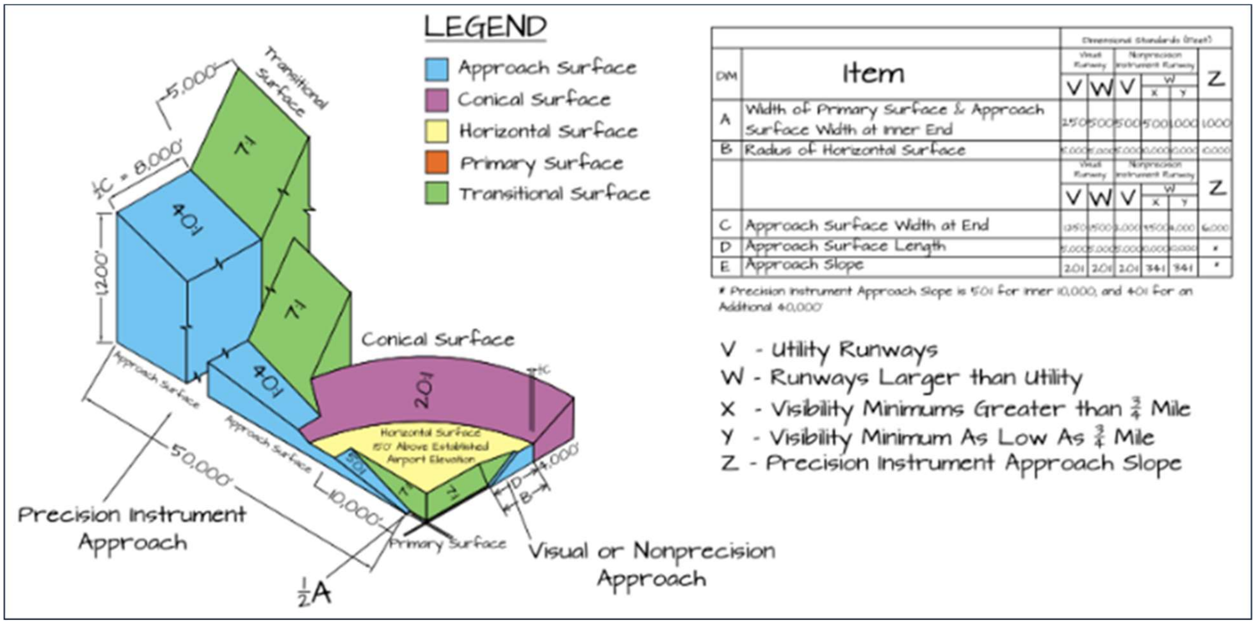
In addition to the primary airport infrastructure on the ground, the FAA also requires airports to consider airspace infrastructure that surrounds the airport. Specifically, through various federal regulatory resources such as Title 14, Code of Federal Regulations (CFR) Part 77, *Safe, Efficient Use, and Preservation of the Navigable Airspace*, FAA AC 150/5300-13A, *Airport Design*, and FAA Order 8260.3B, *U.S. Standard for Terminal Instrument procedures (TERPS),* the FAA defines and establishes the standards for determining obstructions that affect airspace near an airport. These standards apply to the use of navigable airspace by aircraft and to existing or planned air navigation facilities (airports). This is enforced primarily through the implementation of imaginary airspace surfaces that are sized based on the criteria they are designed to protect. Specifically, imaginary airspace surfaces are geometric shapes the size and dimensions of which are based on the category of each runway for existing and planned airport operations, the types of instrument approaches, and their enabling regulatory document. A penetration to these surfaces is an "obstruction," which can be an existing or proposed manmade object, an object of natural growth, or terrain. Note, that the FAA grant assurances signed by BVY require that the imaginary surfaces be cleared of all obstructions to the extent practicable.

Any changes to the airfield must be reviewed by the FAA to ensure the appropriate obstacle clearance necessary to maintain safe airport operations. Prior to any airport development, the airport or the development sponsor must request the FAA to conduct an airspace evaluation to determine the potential impact that a project may have on airport safety, regardless of scale. Part of the airspace evaluation involves the determination of the impact of the proposed development on an airport's imaginary airspace surfaces. For the purposes of the Master Plan, there are three primary regulatory documents (and their associated airspace surfaces) to be considered:

- 14 CFR Part 77 defines five imaginary surfaces as shown in **Figure 4-12**, including the Primary, Approach, Horizontal, Conical, and Transitional surfaces. Any object which penetrates these surfaces is considered to be an obstruction and may affect navigable airspace. Unless these obstructions undergo an additional aeronautical study to conclude they are not a hazard, obstructions are presumed to be a hazard to air navigation.[1] Hazards to air navigation may include terrain, trees, permanent or temporary construction equipment, or permanent or temporary manmade structures (such as power lines) penetrating one of the 14 CFR Part 77 imaginary surfaces.
- FAA AC 150/5300-13A (Engineering Brief No. 99A - July 2020 update) defines approach airspace surfaces that are separate from 14 CFR Part 77 and are designed to protect the use of the runway in both visual and instrument meteorological conditions near the airport. These approach surfaces are defined by each runway's current approach type (i.e., visual, nonprecision instrument, etc.), and typically are trapezoidal in shape, extending away from the runway along the centerline and at a specific slope. To establish the location of a runway threshold, the associated approach surface must be clear of all obstructions. If it is not clear, either the obstructions must be removed, or the runway threshold must be relocated until its associated approach surface is clear.
- TERPS generally defines a wide variety of airspace surfaces that are designed to establish and maintain safe operating conditions around an airport for aircraft that are utilizing a defined instrument approach. Obstructions to a TERPS surface can result in operational impacts to the instrument approach that could include a raising of minimums, making the approach unavailable in certain conditions, or decommissioning the instrument approach altogether.

[1] Title 14, Code of Federal Regulations Part 77, *Safe, Efficient Use, and Preservation of the Navigable Airspace*

Figure 4-12: CFR Part 77 Imaginary Surfaces



Source: FAA 14 CFR Part 77, *Safe, Efficient Use, and Preservation of the Navigable Airspace.*

An obstructions analysis has been conducted as part of this Airport Master Plan and will be reflected in the Airport Layout Plan. In order to help ensure safe operations on and around the Airport, and in conformance with its grant assurances, it is recommended that BVY continue to be diligent in preventing and removing obstructions from its critical airspace surfaces.

4.3.8 Airspace Class and Air Traffic Control

The airspace that surrounds an airport is classified per the activity level of the facility and the presence of an air traffic control tower. BVY is currently in Class D airspace, which is an airspace that surrounds an airport with an operating air traffic control tower. BVY's airspace lies underneath Boston Logan International Airport's (BOS) Class B airspace. Aircraft can still operate into and out of BVY without contacting BOS as long as they remain under the 3000-foot elevation Class B floor.

BVY's current airspace classification is consistent with existing and future activity levels; no action is required.

4.4 Landside Facility Requirements

This section describes the landside facility requirements needed to accommodate BVY's general aviation activity throughout the planning period. Areas of focus include the administration, aircraft hangars, aprons and tiedown areas, automobile parking, access, as well as the various associated support facilities

4.4.1 Administration Building

The Beverly Regional Airport Administration Building is a 4,500-square-foot facility that accommodates a variety of functions for the Airport. Located in the east side development area of the Airport (see **Figure 2-4**) and identified as Building #50, the building accommodates the airport administrative offices, a large conference room, bathrooms, a pilot lounge, and flight planning area. This facility was built in 2016 and is in excellent condition. Based on discussions with airport management as well as an analysis utilizing standard building programming criteria, the administration building has been deemed to be adequate in size to meet existing and future demand throughout the planning period. It should also be noted that the BVY's sole fixed base operator (FBO) has a fully functional terminal area located in the west side development area in Building #10 (see **Figure 2-5**). The only recommendation is for the Airport and the FBO to continue to maintain their facilities appropriately to meet the needs of their users.

BVY's terminal/administration buildings is adequate to meet existing and future activity levels; no action is required other than regular maintenance.

4.4.2 Aircraft Hangar Requirements

The utilization of hangar space at airports varies as a function of local climate, security, and owner preferences. The trend in general aviation aircraft (single or multi-engine) is toward newer, more sophisticated, and consequently, more expensive aircraft. Therefore, most aircraft owners reasonably prefer a secure, enclosed hangar space versus locating their aircraft outside on a tiedown. This is particularly true in states like Massachusetts, where harsh, cold-weather climates can degrade or damage aircraft stored outside. This trend has led to a national and regional increase in demand for hangars and a reduction in demand for apron tiedown space.

Based aircraft are routinely stored at airports in a variety of hangar styles that are usually determined by aircraft size, the type of aircraft owner (business or leisure), and the region of the country. Following are the hangar styles currently in use at BVY (see **Table 2-9** for additional details):

- T-hangars: T-hangars are a series of interconnected aircraft hangars (forming a single large structure) with footprints in the shape of a "T" that can store one single- or multi-aircraft in each individual unit. At BVY, there are 3 T-hangar buildings (encompassing approximately 32,400 square feet in area) that have a total of 22 individual hangar units. According to Airport administration, there is currently a waiting list for T-hangars that is largely comprised of BVY aircraft owners currently located on tiedowns.
- Box Hangars: This hangar type generally includes individual, unattached, clear-span hangar units that are typically designed to accommodate one or more smaller aircraft. These can be connected to form a single larger building or they can be standalone units. There are currently 11 structures classified as box hangars (having 12 individual hangar units) on the Airport encompassing a total of approximately 62,300 square feet.
- Corporate Hangars: This classification typically includes larger, clear-span hangars used for storing aircraft and/or housing a variety of businesses (including FBOs) that are located at an airport. These often have attached offices and may be used by only one tenant. These hangars can house just one or more corporate aircraft (i.e. turboprops and jets), depending on the

owner's needs. BVY currently has four such hangars ranging in size from 12,400 square feet to 19,000 square feet and having a total area of approximately 59,900 square feet.

The demand for aircraft storage hangars is largely dependent upon the number and type of aircraft expected to be based at the airport in the future. For planning purposes, it is necessary to estimate hangar requirements based upon forecasted operational activity. Note that larger, higher-value based aircraft are more likely to be stored in a hangar; thus, it is assumed that all of the based multi-engine aircraft fleet will require hangar space. Similarly, it is assumed that all multi-engine itinerant aircraft would also require hangar space for overnight storage. Based on these assumptions, the hangar space requirements by aircraft type is presented below in **Table 4-14**.

Per the analysis below, BVY requires a mixture of additional T-hangars and corporate itinerant hangars throughout the planning period. It is important to note, however, that hangar development is subject to the specific requirements of the users, meaning that even if an airport has capacity in its hangar inventory, it may not meet the needs of a given user. This is especially true for large box hangar and corporate tenants and it is for this reason that BVY should continue to preserve its hangar development concepts to maintain the potential for future customized development.

Feedback from the key stakeholders (e.g., Airport administration, based aircraft tenants, tenant businesses, etc.) through a user survey and conversations supports the need for additional hangars at BVY. Both based and transient operators advised that there is an existing shortage of hangar space at the Airport, with some survey respondents indicating that they are currently based at Laurence G. Hanscom Field (BED) and Lawrence Municipal Airport (LWM) although they would prefer to base at BVY if appropriate hangar space were available.

It is recommended that BVY plan for future T-hangar and corporate hangar development to accommodate immediate needs. Additionally, it is recommended that the Airport preserve areas for potential long-term hangar development that may exceed the planning period and should pursue such development if/when demand warrants it through active discussions and negotiations with prospective tenants or developers.

Table 4-14: Aircraft Hangar Requirements

	2019	2024	2029	2034	2039
Total Based Aircraft					
– Single Engine	82	84	85	87	89
– Multi-Engine	9	10	10	11	11
– Jet/Turbine	5	7	10	13	16
– Helicopter	4	5	7	8	9
– Other (military / ultralight)	0	0	0	0	0
Total	**100**	**106**	**112**	**119**	**125**
Based Aircraft Demand for Hangars					
– Single Engine	58	63	68	75	81
– Multi-Engine	9	10	10	11	11
– Jet/Turbine	5	7	10	13	16
– Helicopter	4	5	7	8	9
– Other (military / ultralight)	0	0	0	0	0
Total	**76**	**85**	**95**	**107**	**117**
T-Hangars Demand					
– Single Engine / Other (1,400 sf)	40,600	44,800	47,600	53,200	57,400
– Total T-Hangar Demand (aircraft)	29	32	34	38	41
– Total T-Hangar Demand (SF)	40,600	44,800	47,600	53,200	57,400
– Total Existing T-Hangar / Small Box (SF)	32,400	32,400	32,400	32,400	32,400
Surplus/(Deficiency) (SF)	(8,200)	(12,400)	(15,200)	(20,800)	(25,000)
Box / Corporate Hangars Demand					
– Single Engine / Other (1,400 sf)	40,600	43,400	47,600	51,800	56,000
– Multi-Engine (100%) (1,600 sf)	14,400	16,000	16,000	17,600	17,600
– Jet /Turbine (100%) (6,400 sf)	32,000	44,800	64,000	83,200	102,400
– Helicopter (100%) (2,000 sf)	8,000	10,000	14,000	16,000	18,000
– Total Demand (aircraft)	47	53	61	69	76
– Total Demand Aircraft (SF)	95,000	114,200	141,600	168,600	194,000
– Existing Hangars (SF)	85,700	85,700	85,700	85,700	85,700
Surplus/(Deficiency) (SF)	(9,300)	(28,500)	(55,900)	(82,900)	(108,300)
Itinerant Aircraft Demand					
– Total Demand (aircraft)	4	6	8	10	12
– Total Demand (SF) (2,850 sf avg)	11,400	17,100	22,800	28,500	34,200
– Existing Hangars (SF)	0	0	0	0	0
Surplus/(Deficiency) (SF)	(11,400)	(17,100)	(22,800)	(28,500)	(34,200)
Total Hangar Demand (SF)	**147,000**	**176,100**	**212,000**	**250,300**	**285,600**
Total Existing Hangars (SF)	**118,100**	**118,100**	**118,100**	**118,100**	**118,100**
SURPLUS/(DEFICIENCY) (SF)	**(28,900)**	**(58,000)**	**(93,900)**	**(132,200)**	**(167,500)**

Source: Jviation.

4.4.3 Aircraft Parking Aprons

Aprons are considered premium airport space and should be strategically utilized to maximize their operational efficiency and benefit for the airport. Apron layout design should account for the location of FBOs and other aviation-related access facilities in addition to providing parking for based and transient airplanes, and access to the pilot/passenger support facilities, aircraft fueling, and surface transportation. Apron spatial requirements for BVY were based on criteria provided in FAA AC 150/5300-13A, *Airport Design*. There are existing aprons in three locations on the west side with the FBO managing the largest two aprons measuring approximately 250,000 square feet including taxilanes, as well as an associated 33,000 square-foot apron located across from Taxiway B. The third apron is located southwest of the FBO and measures approximately 40,000 square feet. The apron located on the east side of the Airport is approximately 350,000 square feet including all aircraft movement areas (e.g., taxilanes, tiedowns, other aircraft parking areas, etc.). The aircraft apron parking requirements for based and transient aircraft are presented in **Table 4-15**.

Table 4-15: Apron Parking Requirements

	2019	2024	2029	2034	2039
Based Aircraft					
Projected Apron Demand (SF)	189,000	193,500	198,000	198,000	198,000
Current Apron Availability (SF)	425,000	425,000	425,000	425,000	425,000
Surplus/(Deficiency) (SF)	236,000	231,500	227,000	227,000	227,000
Transient Aircraft					
Projected Apron Demand (SF)	187,200	234,000	280,800	327,600	374,400
Current Apron Availability (SF)	208,000	208,000	208,000	208,000	208,000
Surplus/(Deficiency) (SF)	20,800	(26,000)	(72,800)	(119,600)	(166,400)
Total Apron Demand (SF)	**422,400**	**474,800**	**527,200**	**574,000**	**620,800**
Total Existing Apron (SF)	**633,000**	**633,000**	**633,000**	**633,000**	**633,000**
SURPLUS/(DEFICIENCY) (SF)	**210,600**	**158,200**	**105,800**	**59,000**	**12,200**

Source: Jviation.

As shown above, BVY currently has a surplus of apron space for both based and transient aircraft. For based aircraft, this is consistent with the general industry trend towards based aircraft migrating from apron tiedowns into hangars for enhanced security and protection from inclement weather. For transient aircraft, the results reflect an increasing number of larger aircraft activity at BVY over the planning period. However, it should also be acknowledged that these gross apron areas do not account for the efficiency of the layout which could result in larger than normal movement area requirements. At BVY, apron areas have largely been developed over time based on the local site constraints and on immediate needs rather than a planned manner. This has resulted in apron layouts that are less efficient than may otherwise be anticipated. Therefore, while the reasonable conclusion to be drawn from the table above is that BVY has sufficient apron space throughout the planning period, consideration must be given to each apron area as to its actual functional capabilities.

BVY currently has enough apron area to meet its current and forecasted demand for based and transient aircraft. However, it is recommended that the transient apron layout be reassessed to ensure that it is configured appropriately for efficient use over the long term.

4.4.4 Landside Access and Parking Requirements

Regional Transportation Network

BVY is located less than ½ mile from State Route 128 to the south, Route 62 to the west, Route 35 to the west and north, and Route 97 to the east and north, affording it excellent accessibility to the regional roadway network.

BVY's existing regional roadway network is adequate to meet the Airport's access needs throughout the planning period; no action is required.

On-Airport Circulation Roadways

The east side of the Airport is directly accessed via LP Henderson Road off Cabot Street (Route 97), while the west side of the Airport must be accessed via Bill Mahoney Way off Old Burley Street, a largely residential area. Operators and users identified that there is a lack of wayfinding signage that will direct people to the west side of Airport. Additionally, some challenges may be realized over time in accessing the west side of the Airport via Old Burley Street; however, these are not anticipated to occur within the planning period.

BVY's existing surrounding roadways should be monitored for any potential capacity constraints. Additionally, airport signage should also be reviewed and improved as required to ensure that tenants and users can easily navigate to airport businesses and facilities.

Auto Parking

BVY currently has two primary paved auto parking lots, totaling approximately 206 public parking spots. The largest contiguous parking lot abuts the BVY administration building, which itself can accommodate 84 vehicles in paved, marked spots. The FBO parking lot on the west side of the airport has 122 marked spaces. For planning purposes, forecasted passenger enplanements have been utilized to determine auto parking space requirements for passengers, rental cars, and airport employee parking.

Table 4-16: Auto Parking Demand

	2019	2024	2029	2034	2039
Based Aircraft	100	106	112	119	125
Existing Parking Spaces for Based Aircraft Owners/Tenants*	206	206	206	206	206
Surplus/(Deficiency)	**106**	**100**	**94**	**87**	**81**

Source: Jviation.

Based on this analysis, aviation-related auto parking at BVY is currently considered to be adequate for meeting existing and future demand levels within the planning period.

BVY's existing auto parking areas are adequate to meet demand levels throughout the planning period. Other than regular maintenance, no additional action is required.

4.5 Airport Support Facilities

4.5.1 Airport Security

Airport security is essential to the safe operation of any airport. BVY should maintain a level of security that is commensurate with federal requirements and the industry's current best practices for a general aviation reliever airport. Regarding federal requirements, since BVY does not have an air carrier or a commercial operator with a security program, the Airport does not fall under 49 CFR 1544 or 1546, meaning that it is not under the direct regulatory authority of the Transportation Security Administration (TSA). However, the TSA has previously released guidance designed to establish non-regulatory best practices for general aviation airport security. This guidance from TSA, combined with direction from other aviation-related organizations (i.e., state aeronautics agencies, AOPA, NBAA, AAAE, ACRP, etc.), loosely comprise the general aviation industry's best management practices for security. (It should be noted that General Aviation Subgroup of the TSA Aviation Security Advisory Committee (ASAC) is currently in the process of providing updated recommendations to the TSA guidance.) In general, appropriate security measures should include the following:

- Controlling movement on the Airport: including the movement of persons, aircraft and ground vehicles on airport property by installing airport user signs, aircraft guidance signs, airfield lights and markers, and pavement markings, as appropriate.
- Preventing theft and illegal operation of aircraft: including airport lighting and promotion of aircraft owner anti-theft measures.
- Preventing unauthorized access including unauthorized access of persons and ground vehicles into unauthorized areas on airport property, typically through the use of security fencing and gates. This entails, among other things, preventing unauthorized access into the Airport/Air Operations Area (AOA), moving between areas within the AOA, and separating/segregating persons and ground vehicles from aircraft, fueling facilities and other areas of concern within the AOA.

Additionally, the Transportation Security Administration's (TSA) Security Guidelines for General Aviation Airports publication states that an appropriate security boundary design is a function not only of its effectiveness in preventing unauthorized access, but also of the cost of equipment, installation, and maintenance. A scoring system developed by TSA and included in the document rates BVY in the "high" security category, which suggests security recommendations that include security fencing, closed-circuit television (CCTV), intrusion detection system, access controls, lighting system, personnel ID systems, vehicle ID systems, challenge procedures, law enforcement support, the establishment of a security committee, transient pilot sign-in/out procedures, signs, documented security procedures, all aircraft secured, positive passenger/cargo/baggage ID, community watch program, and a contact list.

Based on these considerations, the following recommendations are made for BVY to deter unauthorized access to restricted airport areas and improve safety.

- Access control system: Access controls as well as personnel and vehicle identification systems should be maintained and/or established. (Note that a service/perimeter road should be constructed to help maintain/inspect the fence and enhance security.)
- Enhanced surveillance: Selected areas of the Airport should be monitored by video or camera surveillance. Cameras or systems with improved capabilities are recommended in sensitive areas and can be connected to airport administration/operations as well as local law enforcement.
- Security Checks: Regular airport staff patrols along the Airport perimeter are recommended to conduct maintenance operations and security inspections.

BVY has recently implemented a full access control system that includes ID badges controlling vehicle and pedestrian gates as well as closed circuit television (CCTV). It is recommended that BVY continue to pursue airport security enhancements as available to help ensure the safety and security of operations on the Airport.

4.5.2 Airport Perimeter Road

An airport perimeter road is an important asset for any active airport since it enables ground vehicles to transit the airport without having to navigate on the airfield pavements utilized by aircraft. This enhances safety (by avoiding potential conflicts between aircraft and ground vehicles), improves security (perimeter roads are often co-located with fencing which improves fence inspections and security checks), and enhances efficiency for ground activities. Beverly Municipal Airport does not currently have an airport perimeter road and because of that, it has experienced conflicts between ground vehicles and aircraft, it does not have easy access to its security fenceline, and it experiences operational inefficiencies. Most notably and identified by the BVY ATCT, aircraft fuel trucks currently have to utilize airfield pavements (including crossing Runway 16-34) in order transit from one side of the airport to the other. This is not a desirable condition.

It is recommended that BVY explore options for establishing a complete airport perimeter road.

4.5.3 Fuel Storage Requirements

As a major revenue source for the maintenance and operation of the Airport, aviation fuel sales have a significant financial impact on the Airport in addition to benefiting its users. BVY has two (2) 10,000-gallon above ground Jet-A fuel storage tanks located on the west side of the Airport near the FBO. BVY has one (1) 8,000-gallon Avgas (100LL) underground storage tank located on the east ramp area near the Beverly Administration Building. The Avgas tank also has self-serve fueling capability. Additionally, the Airport has mobile fueling trucks including two (2) 1,000-gallon Avgas trucks and two (2) 3,000-gallon Jet-A fuel trucks. All storage tanks and fuel trucks are maintained and operated by the FBO.

As with similar airports, fuel storage requirements are typically based upon maintaining a two-week supply of Avgas during an average month and a three-day supply of Jet-A. The availability for more frequent deliveries can reduce the fuel storage capacity requirement. Storage beyond a four-week period is not recommended as it could degrade the quality of fuel. Because an increasing percentage of future aircraft utilizing the Airport will require Jet-A fuel, future fuel storage requirements may consider increasing Jet-A fuel capacity.

Table 4-17: Fuel Tank Storage Requirements

	2019	2024	2029	2034	2039
Average day peak month departures	136	144	152	161	170
Avgas					
– Storage Requirement (gal)	6,126	6,475	6,844	7,234	7,647
– Existing Storage Capacity (gal)	8,000	8,000	8,000	8,000	8,000
Surplus/(Deficiency)	**1,874**	**1,525**	**1,156**	**766**	**353**
Jet-A					
– Storage Requirement (gal)	16,336	17,267	18,251	19,292	20,391
– Existing Storage Capacity (gal)	20,000	20,000	20,000	20,000	20,000
Surplus/(Deficiency)	**3,664**	**2,733**	**1,749**	**708**	**(391)**

Source: Jviation.

BVY's fuel tanks provide adequate capacity to accommodate both existing and projected demand. It is recommended that the Airport appropriately maintain its existing fuel tanks and prepare for a potential expansion of its Jet-A capacity over the long term.

4.5.4 Deicing Facilities

All BVY deicing fluids are stored securely by the FBO. According to Airport Administration, the FBO uses fewer than 20 gallons of deicing fluid annually. At this level, the Airport is not required to control the deicing fluid discharge through a glycol recovery and containment system. However, BVY should continue to monitor its deicing activities to ensure compliance with US EPA standards. Based on the demand forecast over the 20-year planning period, glycol containment or collection is not required for BVY.

BVY's current deicing operations comply with US EPA requirements; no action is required.

4.5.5 Snow Removal Equipment (SRE)/Airfield Maintenance Facilities

BVY has one 5,000-square foot building located south of L.P. Henderson Road that serves as the Airport's vehicle maintenance and storage building. There is also a 2,500-square foot paved area that abuts the building to the southeast that is also used for equipment storage. This facility is currently at capacity which has required the Airport to store equipment outside on the paved area; unfortunately, exposure to the elements does accelerate equipment degradation.

FAA AC 150/5220-18A, *Buildings for Storage and Maintenance of Airport Snow and Ice Control Equipment and Materials*, requires that SRE storage space be allocated to accommodate storage areas, support areas, and special equipment areas. To minimize the deterioration of equipment that must be stored outside, the Airport wants to consider an expansion of the existing facility on top of the existing paved area to protect equipment from the elements.

It is recommended that the existing building be expanded, and/or a new building be constructed to accommodate existing and future SRE/airfield maintenance vehicles and equipment within the 20-year planning period.

4.5.6 Airport Equipment

Aircraft Rescue and Firefighting (ARFF) Equipment

BVY does not have a Part 139 certification and therefore is not required to have a dedicated ARFF response and/or station. Most general aviation airport's emergency response is provided by landside community fire stations. When additional capacity is needed, this typically occurs through mutual aid agreements with adjacent fire departments.

BVY's existing fire response is provided by vehicles from the North Beverly Fire Station located at the Dodge Street and Cabot Street intersection in Beverly, MA. Additional fire department response to BVY is supported by a mutual governmental agreement with the Town of Danvers and Town of Wenham Fire Departments. The Danvers fire station is located at 2 Locust Street in Danvers, MA and the Wenham fire station is located at 140 Main Street in Wenham, MA.

No action is required regarding ARFF equipment during this planning period.

Snow Removal Equipment and Maintenance Equipment

BVY's current SRE and airfield maintenance equipment (listed previously in **Chapter 2**) is currently adequate to meet the requirements of FAA AC 150/5200-30C, *Airport Winter Safety and Operations*. However, it should be noted that FAA Order 5100.38D, *Airport Improvement Program Handbook (AIP)*, specifies that the useful life for equipment to be 10 years. In considering the eligibility for replacing equipment, it must be designed and justified based on both FAA AC 150/5200-30, and AC 150/5220-20, *Airport Snow and Ice Control Equipment*.[2]

The 1983 Vohl snowblower, 1995 Ford F-350 with 9' plow, 1997 Caterpillar loader, the two Sterling dump trucks with 11' wing-plows, the two John Deere tractors and the 2008 Dodge Charger are recommended to be replaced within the 20-year planning period. These have been prioritized according to age and replacement schedules.

Ground Support Equipment (GSE)

Ground support equipment at BVY is provided by the Airport's FBO. GSE can include aircraft tugs, deicers, ground power units, lavatory carts, potable water carts, baggage carts, belt loaders, air stairs, and other service vehicles. The FBO is responsible for the storage of its GSE within its facilities. Note that the amount of GSE required at an airport is generally determined by the demand of individual operators. GSE at the Airport is projected to be adequate to meet the demand of existing and future operations. Existing parking for GSE is also adequate for existing operations. The FBO will need to continue to maintain or replace its equipment as required.

GSE equipment storage is adequate for current and future demand during the 20-year planning period.

4.5.7 Utilities

The utility lines serving the Airport are a combination of overhead and buried underground and provide service to the administration building, hangar area, airfield facilities, lighting, and navigation aids. Utilities at BVY include water, sanitary sewer, phone, electric, stormwater, and natural gas. The current utilities at the Airport are adequate for the existing structure as well as for potential taxiway lighting system installment. For future hangar and/or landside development, the water lines should be analyzed for capacity and/or limitations to the current system. Additionally, the Airport should consider establishing and maintaining a complete utility infrastructure master plan for the entire airport to ensure situational awareness.

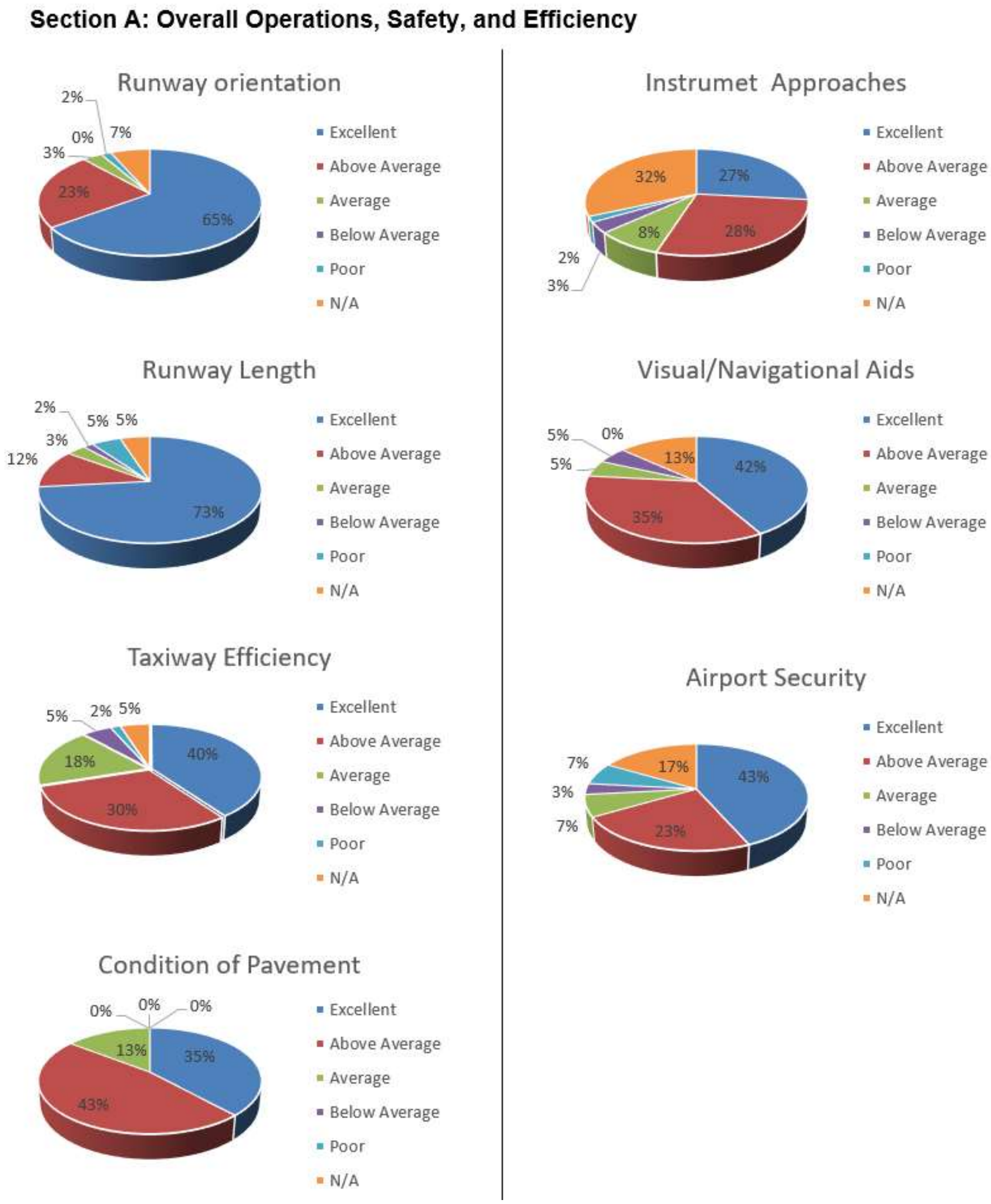
It is recommended that BVY maintain the utility infrastructure to meet current demand within the 20-year planning period. As future landside and hangar development occurs, utility locations and capacity would have to be analyzed for limitations to the current infrastructure. In association with this planning, the Airport should consider establishing and maintaining a utility infrastructure plan to ensure that it has access to and knowledge of current conditions.

[2] For airports that are not 14 CFR part 139 certified airports, per FAA policy, only one snow removal carrier vehicle is eligible unless the ADO concurs that the airport is large enough, busy enough, and/or has significant snowfall to warrant an additional vehicle.

4.6 Airport User Survey

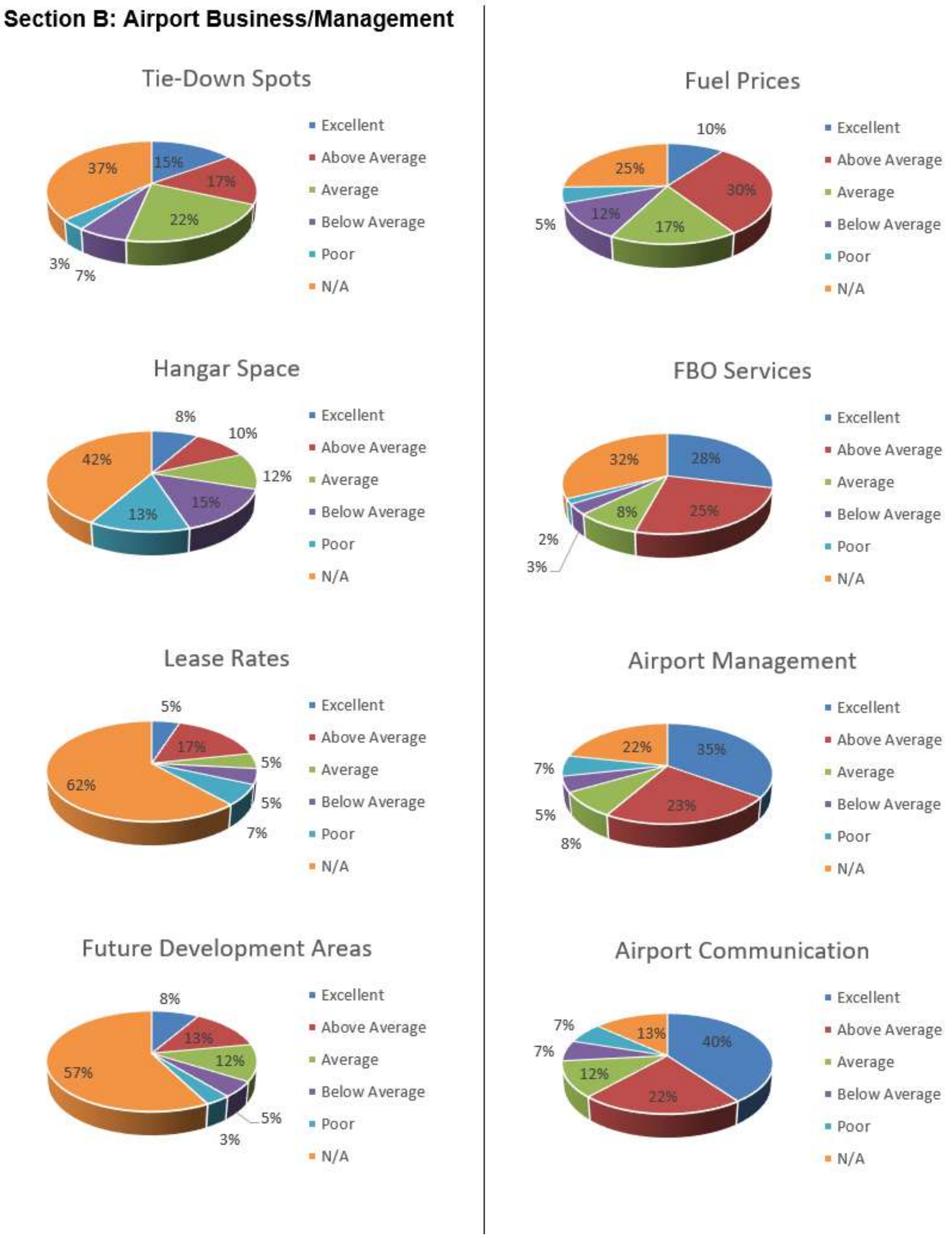
BVY users were surveyed in 2019 about the condition of airport facilities, operations, safety and services (see **Figure 4-13** and **Figure 4-14**). In general, the Airport received positive responses (average to excellent) and other comments generally supported the recommendations included in this chapter.

Figure 4-13: BVY User Survey Response Summary 1



Source: Jviation.

Figure 4-14: BVY User Survey Response Summary 2



Source: Jviation.

4.7 Previous Master Plan Deficiencies & Recommendations

The last Beverly Municipal Airport Master Plan was last completed over 20 years ago in 1998 and much of that plan has been acted upon in that interim time. In addition to meeting long-term operational demands and complying with FAA design standards, the 1998 Airport Master Plan Update had several focus issues that were addressed:

- Regaining runway safety areas (RSAs)
- Regaining runway object-free areas (ROFAs)
- Reducing/eliminating runway displacements
- Maintaining a runway with a 5,000-foot length
- Determining runway classifications
- Identifying likely environmental mitigation efforts
- Providing site planning for general-aviation terminal areas
- Obtaining conformance with airport design standards
- Identifying a likely capital-improvement plan for the next 20 years

Specific facility requirements generated for the Airport in the 1998 Master Plan are summarized **Table 4-18**.

Table 4-18: 1998 BVY Master Plan Facility-Improvement Recommendations

	Short Term (2003)	Intermediate Term (2008)	Long Term (2018)
Airport Reference Code	B-II	B-II	B-II
Runway Dimensions	– Maintain 5,000’ X 100’ for one runway; – Maintain at least 4,000’ X 100’ feet for secondary runway		
Taxiways	Parallel taxiway access to all runway ends, if possible		
Hangar Demand	45 aircraft	47 aircraft	52 aircraft
Apron Requirements	29,250 square feet	55,710 square feet	120,850 square feet
Automobile-parking Requirements	8 spaces Lighting parking areas	18 spaces	spaces
FAA Standards -RSA and ROFA -RPZ -Part 77 Surfaces -Threshold Siting -Surfaces Line-of-Sight	– Meet RSA and ROFA standards to extent possible – Maintain control over RPZs to extent practical – Clear off-airport Part 77 surfaces to extent practical – Clear threshold siting surface/displaced threshold to extent practical – Clear line-of-sight for tower		
Pavement Rehabilitation	Runway 9-27 (short term), Runway 16-34 (intermediate term), existing aprons (intermediate term), Taxiway F (intermediate term), other taxiways (long term)		
NAVAIDs	– GPS approach to Runway 9; PAPIs for Runways 9, 27, and 34 – Investigate upgrade of MALS at Runway 16 end		
Airport Security and Fencing	Completely enclose airport operating area		
Airport Lighting, Pavement Markings, and Signage	– Light all taxiways – Upgrade marking and signage as necessary – Mark Runway 9 as nonprecision		
Snow-removal and Maintenance Equipment	– Upgrade as necessary (two snowplow trucks) – Purchase/replace other equipment (tractors, brush hogs, mowers, pavement sweeper, paint-stripers) – Coordinate with City of Beverly		
Non-aeronautical Uses	Provide land for nonaeronautical uses		

Source: 1998 Beverly Regional Airport Master Plan.

4.8 Regional Airport System Role

In 2010, MassDOT Aeronautics Division published the Massachusetts Statewide Airport System Plan (MSASP). The MSASP evaluated and measured the performance of the Massachusetts system of publicly-owned airports and assigned each airport to one of four functional categories: Commercial Service/Scheduled Charter; Corporate/Business; Community/Business, and Essential/Business. The Plan currently has BVY classified as a Corporate/Business airport. The MSASP evaluated the Airport's current facilities against the Plan's objectives and identified facilities and services that required improvement. **Table 4-19** provides a summary of that evaluation.

Table 4-19: MSASP 2010 Identified Benchmarks for BVY

MassDOT Benchmark	MassDOT Standard	BVY Meets Standard?
Airside Facilities		
Primary Runway Length	5,000' or greater	Yes
Primary Runway Width	To Meet ARC Criteria	Yes
Taxiway	Full Parallel	**No**
Approach	Non-Precision/LPV	Yes
Lighting	MIRL and Reflectors (MITL is desirable)	Yes
Visual Aids	Rotating Beacon; Wind Indicator	Yes
NAVAIDS	REILS; VGSI (PAPI/VASI); ALS as needed	Yes
Weather	ASOS or AWOS	Yes
Landside Facilities		
Hangar Spaces – Based Aircraft	50% of Based Fleet	Yes
Hangar Spaces – Transient Aircraft	25% of Overnight Aircraft	**No**
Apron Spaces	50% of Based Fleet + 50% of Transient	Yes
Terminal/Administration Buildings	Terminal/Administration Buildings	Yes
Auto Parking Spaces	Airport Reports Sufficient Parking	Yes
Services		
Fixed Base Operator (FBO)	Full Service or Limited Service	Yes
Fuel	Avgas (100LL); Jet A as needed	Yes
Terminal/Pilot	Phone; Restrooms; Flight Planning/Lounge	Yes
Ground Transportation Services	On-Site Courtesy Car	Yes
Security	Current GA Security Plan	Yes
Others	Snow Removal and De-Icing is desirable	Yes

Source: 2010 MSASP; Jviation.

It was determined that BVY does not meet some airport-specific objectives identified in the 2010 MSASP. Specifically, BVY does not have a full parallel taxiway to either of its runways, nor does it have adequate hangar space to accommodate the number of overnight aircraft anticipated. Both of these benchmark deficiencies have been discussed earlier in this chapter and will be addressed further in the next chapter.

4.9 Summary

A summary of the facility improvements that currently need to be addressed during the 20-year planning period is provided below in **Table 4-20**. Certain improvements will be examined further in **Chapter 5, Alternatives Analysis & Development Concepts,** in an effort to create and evaluate options to accommodate these facility requirements.

Table 4-20: Facility Requirements Summary

Facility	Identified Requirement
Airfield Facility Requirements	
Airfield Demand Capacity	– No action required
Airport Design Standards	– No action required
Runways	– Explore options for extending both runways
Taxiways	– Update fillet standards per FAA AC 150/5300-13A – Eliminate direct access from apron to runway via Taxiways A and G per FAA AC 150/5300-13A – Resolve potential operational conflicts on Taxiway E at Taxiway H. – Install full-length parallel taxiways for both runways, if practicable. – Improve taxiway layout efficiency
Airfield Pavement	– Investigate and confirm existing pavement strength of Runway 16-34 and Runway 9-27; identify potential need for increasing pavement strength. – Confirm taxiway pavement strengths are consistent with runways
Airfield Visual Aids	– Upgrade Airport lighting to LEDs as able
Navigation Aids (NAVAIDs)	– Add PAPI to Runway 34
Obstruction Removal	– Recommendations to be incorporated into the ALP set
Landside Facility Requirements	
Terminal/Administration Buildings	– No action required
Aircraft Hangar Requirements	– Preserve and prepare for T-hangar development – Preserve and prepare for medium and large corporate hangar development
Aircraft Parking Aprons	– Preserve and prepare for additional apron space as growth occurs
Landside Access and Parking Requirements	– Improve way-finding signage from major streets
Airport Support Facility Requirements	
Airport Security	– Maintain vigilance; no immediate action required
Airport Perimeter Road	– Construct airport perimeter road
Fuel Storage Requirements	– No intermediate action required; possible long-term Jet-A expansion
Deicing Facilities	– No action required
SRE/Airfield Maintenance Facilities	– Expand SRE/Airfield maintenance building capacity
Airport Equipment	– Replace SRE and maintenance vehicles as they reach their useful life, as reflected on CIP.
Utilities	– No intermediate action required; potential long-term expansion may be required with hangar development – Establish and maintain a utility infrastructure master plan

Source: Jviation.