FLYING CLOUD AIRPORT

CHAPTER 3

FACILITY REQUIREMENTS

LONG-TERM PLAN
2040

MINNEAPOLIS SAINT PAUL METROPOLITAN AIRPORTS COMMISSION
MAC

SEPTEMBER 2025

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3.0 Facility Requirements

This chapter describes the facility requirements at the Flying Cloud Airport (FCM) needed to meet the current and base forecast demand at FCM through the 2040 planning period. The sections of this chapter address the following topics:

- Critical Aircraft / Airport Reference Code
- Runway Geometric Standards and Gap Standard Analysis
- Taxiway Geometric Standards and Gap Standard Analysis
- NAVAID Critical Areas
- Airfield Capacity
- Pavement Strength Analysis
- Hot Spots, Incidents and Incursions, and Geometric Contributors
- Air Traffic Control Tower Line-of-Sight
- Hangar Requirements
- Fuel Facilities
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3.1 Airport Reference Code / Critical Design Aircraft

The Airport Reference Code (ARC) is an overall designation that relates airport design criteria to the operational and physical characteristics of the largest/most demanding aircraft type(s) that will operate at the airport. The ARC comprises two components related to the critical design aircraft operating at the airport. The FAA defines "critical design aircraft" as the most demanding aircraft with greater than 500 annual operations at a given airport.

The first component of the ARC is related to the Aircraft Approach Category (AAC), represented by a letter A through E. The second component is the Airplane Design Group (ADG), represented by a roman numeral I through IV.

FCM was originally designed to what is currently considered as B-II standards. Within the past 7-10 years, and particularly after the extension of Runway 10R-28L to 5,000 feet, FCM experienced elevated numbers of aircraft operations in the C-II category. Based on recent activity and the aviation activity forecasts highlighted in **Section 2,** the existing and future critical aircraft at FCM is the Bombardier Challenger 300/350 (CL30/CL35), which is a C-II aircraft. **Table 3-1** summarizes the critical design aircraft specifications. As part of the LTP, coordination has occurred with FAA, MAC, MNDOT, and other agencies to acknowledge that the airfield effectively operates as a C-II airport, which will serve as the existing condition for consideration of airfield dimensional standard requirements in this analysis.

The CL30/35 normally only operates on Runway 10R-28L; accordingly, this will be the runway which will have its design standards up-gauged to C-II. The remaining runways and taxiways will retain their current design standards.

Table 3-1: Critical Design Aircraft Specifications - RDC

AIRCRAFT	AAC	ADG	TAIL HEIGHT	WINGSPAN	FY 2021 OPERATIONS	2040 OPERATIONS*
Challenger 300/350	C	II	20 FT	69 FT	961	3,788

*Note: 2040 operations inclusive of all C-II operations

Source: Manufacturer Data; US Department of Transportation, Federal Aviation Administration, MACNOMS, FAA Aircraft Characteristics Database, February 2023

The AAC and ADG of an airport's critical design aircraft, when combined with a runway's approach visibility minimums, determines the Runway Design Code (RDC). The RDC establishes the minimum design standards for a particular runway and parallel taxiway, allowing safe operations for the critical design aircraft under specified weather conditions. The RDC is used for planning and design purposes and does not have any operational application. **Table 3-2** summarizes the existing and future RDCs at FCM.

Table 3-2: Existing and Future RDC

RUNWAY	RDC
10R	C/II/2400
28L	C/II/5000
10L	B/II(S)/5000
28R	B/II(S)/5000
18	B/I(S)/VIS
36	B/I(S)/5000

Source: HNTB Analysis (October 2022)

3.2 Runway Geometric Standards

To maintain a safe airfield environment for aircraft to operate, the FAA has established safety and design standards for runways, taxiways, NAVAIDs, and adjacent land surrounding the runway system, as described in FAA AC 150/5300-13B, *Airport Design* (13B).

Acknowledging that Runway 10R-28L exists with an RDC of C-II, when it was originally designed for B-II aircraft, requires modifications to multiple airfield geometric standards to remain in compliance with FAA design standards given in 13B. Specifically, the following standards of Runway 10R-28L must be reviewed for conformity:

- The Runway Safety Area (RSA) and Runway Object Free Area (ROFA) length beyond the departure end increases from 600 feet to 1,000 feet in both operational directions
- The RSA width increases from 300 feet to 500 feet
- The Departure Runway Protection Zone (RPZ) in both operational directions is enlarged from a length of 1,000 feet and inner/outer widths of 500 and 700 feet, respectively, to a length of length of 1,700 feet and inner/outer widths of 500 and 1,010 feet, respectively.
- The Runway 28L approach RPZ increases from a length of 1,000 feet and inner/outer widths of 500 and 700 feet, respectively, to a length of length of 1,700 feet and inner/outer widths of 500 and 1,010 feet, respectively.

- Runway-to-taxiway separation requirements become 400 feet, which is based on Runway 10R's existing minimums of less than 3/4 mile

As part of the facility requirements analysis, a comprehensive review of the airfield geometry was completed to evaluate airfield geometric standards and requirements in comparison to the existing conditions and determine if dimensional standards gaps exist with respect to the planned RDC for each runway. These gaps are noted in the following sections. Mitigations for any deficiencies are discussed in **Chapter 4**.

3.2.1 Runway Width

Runway width is based on three criteria: the aircraft approach category, the airplane design group, and the lowest visibility minimums to the runway. Runway width standards and the existing runway widths are shown in **Table 3-3**. There are no deficiencies in runway width.

Table 3-3: Existing and Future Runway Width Standards

RUNWAY	RUNWAY DESIGN CODE	STANDARD WIDTH	EXISTING WIDTH
10R-28L	C-II	100 FT	100 FT
10L-28R	B-II Small	75 FT	75 FT
18-36	B-I Small	60 FT	75 FT

Source: FAA Advisory Circular 150/5300-13B, HNTB Analysis (October 2022)

3.2.2 Runway Safety Area (RSA)

The Runway Safety Area (RSA) is defined as a surface surrounding the runway suitable for reducing the risk of damage to aircraft in the event of an undershoot, overshoot, or runway excursion. The FAA requires the RSA to be cleared and graded, drained by grading or storm sewers, capable of accommodating the critical aircraft and fire and rescue vehicles, and free of obstacles not “fixed-by-function”, such as runway or taxiway lights and signage, precision approach path indicators (PAPI), runway end identifier lights (REIL) or approach light systems.

A review of the existing RSA conformity was completed for each runway at FCM. The RSA dimensional standards and any deficiencies are listed in **Table 3-4** and **Table 3-5** and illustrated on **Figure 3.2.** The listing of nonstandard conditions in the table indexed to Figure 3-2 does not note the quantity of objects, but groupings of similar objects in proximity.

Table 3-4: RSA Dimensional Standards

RUNWAY	RUNWAY DESIGN CODE	RSA WIDTH	RSA PRIOR TO THRESHOLD	RSA BEYOND DEPARTURE END
10R-28L	C-II	500 FT	600 FT	1,000 FT
10L-28R	B-II Small	150 FT	300 FT	300 FT
18-36	B-I Small	120 FT	240 FT	240 FT

Source: FAA Advisory Circular 150/5300-13B, HNTB Analysis (October 2022)

Table 3-5: RSA Deficiencies

FIGURE INDEX NUMBER	RSA	DEFICIENCIES	OBJECT[1]	DISPOSITION
1	Runway 28L Departure End (10R Approach)	181 FT	Spring Road, Fence	EMAS
2	Runway 10R Departure End (28L Approach)	232 FT	Flying Cloud Drive	EMAS
3	Runway 28L Approach End (10R Departure)	232 FT	Flying Cloud Drive	EMAS
4	Runway 10R Approach End (28L Departure)	330 FT	VSR	EMAS
5	Runway 28L Approach End (10R Departure)	370 FT	Localizer	EMAS
6	28L Approach	415 FT	VSR	EMAS
7	28L Approach	320 FT	Fence	EMAS
8	Runway 28L (between RWY 18-36 & TW E)	38 FT	Wind Cone	NONE
32	Runway 28L @ Taxiway E	54 FT to 79 FT	Drainage Pipe	NONE

(1) "Utility Boxes" or "PAPI Utility" objects are not included in the inventory even though these objects are within the RSA. It is assumed these objects are at-grade with a suitable cover.

Source: HNTB Analysis (October 2022)

Alternatives to address the RSA deficiencies are presented in **Chapter 4**.

3.2.3 Runway Object Free Area (ROFA)

The ROFA is a two-dimensional rectangular area centered on the surface of the runway. It must be clear of objects, except for objects whose location is fixed-by-function, similar to fixed-by-function objects in the RSA. The ROFA provides wingtip protection in the event of an aircraft excursion from the runway by providing an area clear of above-ground objects protruding above the nearest point of the RSA. The ROFA is centered on the runway, varying in size based on a runway's particular critical design aircraft.

The ROFA dimensional standards and any deficiencies are described in **Table 3-6** and **Table 3-7** and illustrated on **Figure 3.2.** The listing of nonstandard conditions in the table indexed to Figure 3-2 does not note the quantity of objects, but groupings of similar objects in proximity.

Table 3-6: ROFA Dimensional Standards

RUNWAY	RUNWAY DESIGN CODE	ROFA WIDTH	ROFA PRIOR TO THRESHOLD	ROFA BEYOND DEPARTURE END
10R-28L	C-II	800 FT	600 FT	1,000 FT
10L-28R	B-II Small	500 FT	300 FT	300 FT
18-36	B-I Small	250 FT	240 FT	240 FT

Source: FAA Advisory Circular 150/5300-13B, HNTB Analysis (October 2022)

Table 3-7: ROFA Deficiencies

FIGURE INDEX NUMBER	ROFA	DEFICIENCIES	OBJECT [1]	DISPOSITION
1	Runway 10R Approach End (28L Departure)	181 FT	Spring Road, Fence	EMAS
2	Runway 28L Approach End (10R Departure)	232 FT	Flying Cloud Drive	EMAS
4	Runway 10R Approach End (28L Departure)	325 FT	VSR	EMAS
6	Runway 28L Approach End (10R Departure)	406 FT	VSR	EMAS
7	Runway 28L Approach End (10R Departure)	320 FT	Fence	EMAS
8	Runway 28L (Between Runway 18-36 and Taxiway E)	188 FT	Wind Cone	NONE
9	Runway 10R Approach End (28L Departure)	53 FT	Tree	REMOVE
10	Runway 10R Approach End (28L Departure)	13 FT	Power Lines	NONE
11	Runway 10R Approach End (28L Departure)	11 FT	ALS Shelter	NONE
12	Runway 28L Approach End (10R Departure)	370 FT	Localizer Shelter	NONE
13	Runway 28L Approach End (10R Departure)	108 FT	Transfer Station Driveway	NONE

Source: HNTB Analysis (October 2022)

[1] "Utility Boxes" or "PAPI Utility" objects are not included in the inventory even though these objects are within the ROFA. It is assumed these objects are at-grade with a suitable cover.

3.2.4 Runway Protection Zone (RPZ)

The RPZ is a trapezoidal trapezoid surface intended to protect for people and property on the ground. There is both a departure and approach RPZ on each of bi-directional runways, of which the departure RPZ is tied to the end of declared Takeoff Run Available (TORA) and the arrival RPZ being tied to the beginning of Landing Distance Available (LDA).Unlike the RSA and ROFA, the primary functions of which are to enhance the safety of aircraft, the primary goal of the RPZ is the protection of people and property on the ground by clearing the RPZ of aircraft-incompatible objects and activities. Examples of incompatible land use per the FAA memorandum*, Interim Guidance on Land Uses Within a Runway Protection Zone, September 2012*, found in Appendix I of 13B, include roadways, buildings, recreational land use, transportation facilities, fuel storage facilities, hazardous material storage, wastewater treatment facilities, and above-ground utility infrastructure. Airport control of the land uses in each runway's RPZ by ownership or easement is the preferred means of ensuring public safety in these areas.

Incompatible land uses have been identified within the RPZs for Runway 18-36 and Runway 10R-28L. **Table 3-8** identifies the RPZ dimensional standards and incompatible uses located within the RPZs. The RPZs are illustrated in **Figure 3.2.**

Table 3-8: RPZ Incompatible Land Uses

RUNWAY	RPZ LENGTH	RPZ INNER WIDTH	RPZ OUTER WIDTH	INCOMPATIBLE USE	FAA COORDINATION
Approach RPZ Runway 18	1,000 FT	250 FT	450 FT	Pioneer Trail	N/A
Approach RPZ Runway 36	1,000 FT	250 FT	450 FT	Flying Cloud Drive	N/A
Approach RPZ Runway 28R	1,000 FT	250 FT	450 FT	Flying Cloud Drive	N/A
Approach RPZ Runway 10R	2,500 FT	1,000 FT	1,750 FT	Spring Road, Mitchell Road	
Approach RPZ Runway 28L	1,700 FT	500 FT	1,010 FT	Flying Cloud Drive,	
Departure RPZ Runway 18	1,000 FT	250 FT	450 FT	Flying Cloud Drive	N/A
Departure RPZ Runway 36	1,000 FT	250 FT	450 FT	Pioneer Trail	N/A
Departure RPZ Runway 10L	1,000 FT	250 FT	450 FT	Flying Cloud Drive	N/A
Departure RPZ Runway 10R	1,700 FT	500 FT	1,010 FT	Flying Cloud Drive	
Departure RPZ Runway 28L	1,700 FT	500 FT	1,010 FT	Spring Road, Mitchell Road	

Source: FAA Advisory Circular 150/5300-13B, HNTB Analysis (October 2022)

Although the non-compatible land uses are within the RPZs, no mitigation is proposed as part of the LTP. The non-compatible land uses may remain unless new non-aeronautical developments are proposed within the RPZ, runway minimums change, or there is a change to runway end points.

3.2.5 Runway Obstacle-Free Zone (ROFZ)

The ROFZ is a three-dimensional area centered on a runway that must remain clear of objects except for those needed for air navigation or aircraft ground maneuvering purposes. Safety standards for the ROFZ preclude aircraft or any other object penetrations, except for frangible NAVAIDs that need to be in the OFZ because of their function.

The ROFZ extends 200-ft beyond each end of the runway, and its width is dependent on the weight of aircraft the runway serves (>12,500 or <=12,500 lbs. MTOW) and visibility minimums associated with the runway. At FCM, the Runway 10L-28R and Runway 18-13 ROFZ is 250 feet wide and the Runway 10R-28L ROFZ is 400 feet wide.

There are no known penetrations of the ROFZs at FCM. Objects within the ROFZs, such as runway and taxiway lighting, signs, PAPIs, REILs, and glide slope antenna equipment are assumed to be mounted on frangible couplings, thus determined not to be penetrations to the ROFZ.

3.2.6 Runway Precision Obstacle Free Zone (POFZ)

The POFZ is a three-dimensional area centered on a runway beginning at the runway threshold and extending 200 feet beyond the runway threshold. The elevation of the POFZ is the same elevation as the runway threshold. The POFZ applies to runways with cloud ceiling minimums less than 250 feet or visibility less than ¾ statute mile and is in effect when an aircraft is on final approach within 2 miles of the runway threshold. The only runway end with a POFZ at FCM is Runway 10R. An aircraft fuselage or tail-mounted horizontal stabilizer may not penetrate the POFZ when it is active.

The critical design aircraft at FCM, the Challenger 350, does not penetrate the POFZ when holding on Taxiway B, short of Runway 10R. An intermediate hold position marking exists at the Taxiway B and Taxiway H intersection prior to the runway hold position marking which can be used to hold larger aircraft when the POFZ is active. Therefore, no deficiencies of the POFZ are noted.

3.2.7 Inner-approach OFZ (IA-OFZ)

The IA-OFZ is a volume of airspace centered on the approach area applicable only to runways with an approach lighting system (ALS). The IA-OFA begins 200 feet from the runway threshold at the threshold elevation and rises at a slope of 50:1 to a point 200 feet beyond the last light in the ALS. At FCM, the only runway with an ALS is Runway 10R.

The IA-OFZ passes over the vehicle service road (VSR) and Spring Road, west of Runway 10R. The VSR is approximately 30 feet below the threshold elevation providing ample clearance for any vehicles operating on the VSR not to penetrate the IA-OFZ. Spring Road is approximately 65 feet below the threshold elevation of Runway 10R, providing ample clearance for vehicles operating on Spring Road not to penetrate the IA-OFZ. Therefore, no deficiencies of the IA-OFZ are noted.

3.2.8 Inner-transitional OFZ (IT-OFZ)

The IT-OFZ is a volume of airspace adjacent to the ROFZ and IA-OFZ which only applies to runways with lower than ¾ mile approach visibility minimums. At FCM, the IT-OFZ only applies to Runway 10R. Aircraft tails may not penetrate the IT-OFZ. An intermediate hold position marking exists at the Taxiway B and Taxiway H intersection prior to the runway hold position marking which can be used to protect the IT-OFZ from penetration from large aircraft tails. Therefore, no deficiencies of the IT-OFZ are noted.

3.2.9 Parallel Runway Separation

The centerline-to-centerline spacing of parallel runways affects the operational capabilities of an airport. If sufficient runway-to-runway spacing exists, the FAA can authorize simultaneous, independent operations during visual or instrument weather conditions. For simultaneous, independent landings and departures operating under visual flight rules (VFR), the minimum parallel runway separation is 700 feet, either at towered or non-towered airports or when the tower is not operational. For simultaneous, dependent landings and departures under VFR, the minimum runway spacing is 300 feet. For simultaneous, independent landings and departures operating under instrument flight rules (IFR) the minimum parallel runway spacing is 2,000 feet and may be larger depending on the airport elevation, type of approach (straight-in or offset), departure courses, and location of adjacent thresholds.

At FCM, the existing runway-to-runway separation is 500 feet. This meets the minimum requirements for dependent, VFR operations but not independent VFR or IFR operations. Both parallel runways are often in use at FCM with piston aircraft using both Runway 10R-28L and Runway 10L-28R and larger multi-engine and jet aircraft using Runway 10R-28L. This requires the air traffic control tower (ATCT) to coordinate operations on the parallel runways to maintain sufficient separation between landings and departures and within the traffic pattern to prevent touch-and-go operations from occurring on the two runways at the same time. When aircraft on both runways are light piston twins or smaller, independent VFR operations are permitted, per FAA Order JO7110.65Z, *Air Traffic Control*.

3.2.10 Hold Lines

Hold lines prevent aircraft from entering protected areas of a runway or navigational surface and are also used to control aircraft traffic at taxiway intersections. There are three patterns of hold lines: Pattern A, Pattern B, and Pattern C.

3.2.10.1 Pattern A

Pattern A hold lines are characterized by two solid lines adjacent to two dashed lines. Pattern A hold lines are commonly referred to as runway hold lines and are used to instruct aircraft to stop prior to entering or crossing a runway while taxiing on a taxiway or intersecting runway, or in land and hold short operations (LAHSO), in which they are used to instruct aircraft to stop prior to an intersecting runway or taxiway after landing. Their separation from the runway centerline is dependent on the critical design aircraft's physical and operating characteristics and visibility minimums of the runway. At towered airports, aircraft are required to receive a specific clearance to cross runway hold lines. **Table 3-9** presents the runway hold line separation standards and existing separations at FCM. As noted in the table, there are no deficiencies in the Pattern A hold lines at FCM.

Table 3-9: Pattern A Hold Line Separation

RUNWAY	RUNWAY DESIGN CODE	STANDARD SEPARATION	EXISTING SEPARATION
10R-28L	C-II	250 FT	250 FT
10L-28R	B-II Small	125 FT	125 FT
18-36	C-I Small	125 FT	125 FT

Source: FAA Advisory Circular 150/5300-13B, HNTB Analysis (October 2022)

3.2.10.2 Pattern B

Pattern B hold lines are characterized by two transverse solid markings with short solid lines connecting the two transverse lines, creating a ladder effect. Pattern B hold lines are used to instruct aircraft to stop and hold short before entering a protected area of the ILS or POFZ. Pattern B hold lines are present at the Taxiway B / Taxiway H intersection protecting the Runway 10R glideslope and IT-OFZ. There are no deficiencies in the location of the Pattern B hold lines.

3.2.10.3 Pattern C

Pattern C hold lines are characterized by transverse dashed lines. Pattern C hold lines are commonly referred to as intermediate hold lines are used at taxiway/taxiway intersections or other locations as needed for operational purposes on taxiways to hold aircraft. As noted in **Table 3-10**, there is an existing deficiency of the Pattern C hold line in the Runway 28L hold bay for ADG II aircraft. The standard dimension for an ADG II taxilane centerline to fixed or moveable object is 55 ft, and the existing clearance provided by the hold line is 25 ft. To address this deficiency, the hold bay needs to be expanded to fully accommodate aircraft without a deficiency in hold line separation.

Table 3-10: Pattern C Hold Line Separation

TAXIWAY	LOCATION	DEFICIENCY
Taxiway B	Runway 10R Hold Bay	NONE
Taxiway B	Runway 28L Hold Bay	30 FT

Source: FAA Advisory Circular 150/5300-13B, HNTB Analysis (October 2022)

3.2.10.4 Movement Area Boundary Line

The movement area boundary line is characterized by a single solid line adjacent to a dashed line. The movement area boundary line is used to delineate portions of the airfield that are under control by the ATCT. The movement area boundary lines coincide with the Taxiway Object Free Area (TOFA) limit. Standards and gaps of the movement area boundary line and TOFA are discussed in greater detail in **Section 3.3.4**.

3.2.11 Runway to Taxiway Separation

Runway to parallel taxiway separation is based on the physical and operating characteristics of the critical design aircraft. Standard separations are set to ensure simultaneous runway and taxiway traffic can operate safely with negligible risk of wing clipping. The Approach Reference Code (APRC) and Departure Reference Code (DPRC), as defined in **Chapter 1**, are operational designations for runways, specifically for runway-to-taxiway separations. **Table 3-11** summarizes the existing and future APRC and DPRC of each runway at FCM, as well as the existing and future runway-to-taxiway separations at FCM. Since the APRC is dependent on a runway's lowest visibility minimums, different separation standards can apply depending on the runway configuration in use.

The APRC is dependent on the visibility minimums of the runway and sets separation standards as it relates to operating conditions without restrictions. This means that different separation standards can apply based on the type of aircraft on approach and the weather conditions at the time of the approach. The separation standards and existing separation at FCM are presented in **Table 3-11**. As noted in the table, there are no deficiencies in the runway to taxiway separations.

Table 3-11: Existing and Future Runway-Taxiway Separations and APRC / DPRC

RUNWAY	PARALLEL TAXIWAY	STANDARD SEPARATION	EXISTING SEPARATION	RDC	APRC	DPRC
10R	Taxiway B	400 FT	400 FT	C/II/2400	D/V/2400	D/V
28L	Taxiway B	400 FT	400 FT	C/II/5000	D/V/4000	D/V
10L	Taxiway A	240 FT	250 FT MIN	B/II(S)/5000	B/II/4000	B/II
28R	Taxiway A	240 FT	250 FT MIN	B/II(S)/5000	B/II/4000	B/II
18	Taxiway D	150 FT	315 FT MIN	B/I(S)/VIS	B/II/VIS	B/II
36	Taxiway E	150 FT	255 FT	B/I(S)/5000	B/II/VIS	B/II

Source: HNTB Analysis (October 2022)

3.2.12 Runway Length Requirements

Runway length requirements are dependent on myriad factors, including aircraft type and flap settings, MTOW, runway elevation, runway gradient, and weather conditions (surface condition, air temperature, and wind). Runway length requirements were analyzed according to the guidance contained in FAA Advisory Circular (AC) 150/5325-4B, *Runway Length Requirements for Airport Design*. This AC contains three methodologies for determining runway length requirements based on the weight of aircraft expected to use the runway. The three categories are as follows:

1. Airplanes with a Maximum Certified Takeoff Weight (MTOW) of 12,500 pounds or less,
2. Airplanes within an MTOW greater than 12,500 pounds up to and including 60,000 pounds, and
3. Regional jets and airplanes with an MTOW greater than 60,000 pounds.

FCM routinely experiences operations by aircraft with MTOW greater than 12,500 pounds but based on the aviation activity forecast and critical aircraft determination in **Section 2.5**, is not expected to incur operations by aircraft with an MTOW greater than 60,000 pounds. Therefore, the second methodology was utilized to determine the required runway length at FCM. The AC lists five steps to determine the required runway length regardless of the methodology used. These steps are summarized as follows:

1. Identify the critical design airplanes that will make regular use of the runway. (FAA defines “regular use” as greater than 500 annual operations.)
2. Identify the airplanes that will require the longest runway lengths at MTOW.
3. Identify the weight category of the critical design aircraft as described above to determine the appropriate methodology
4. Determine the required runway length based on the methodology used.
5. Make any required runway length adjustments. Adjustments may be required for runway gradients and wet pavement conditions for landing operations.

Table 3-12 and **Table 3-13** provide the basic runway and airport characteristics affecting runway length at FCM.

Table 3-12: Runway Characteristics

	RUNWAY 10L – 28R	RUNWAY 10R – 28L	RUNWAY 18 - 36
Length (Feet)	3,898	5,000	2,690
Grade Difference Between Runway Ends (Feet)	7	2	6
Runway Effective Gradient	0.17%	0.04%	0.22%

Source: HNTB Analysis (October 2022)

Table 3-13: Airport Meteorological Characteristics

CHARACTERISTIC	VALUE
Elevation (FT)	906
Mean Maximum Temperature Hottest Month (F)	85

Source: HNTB Analysis (October 2022)

A fleet mix of eleven aircraft was developed based on the most demanding aircraft with over 500 annual operations at FCM. The fleet mix is shown in **Table 3-14.**

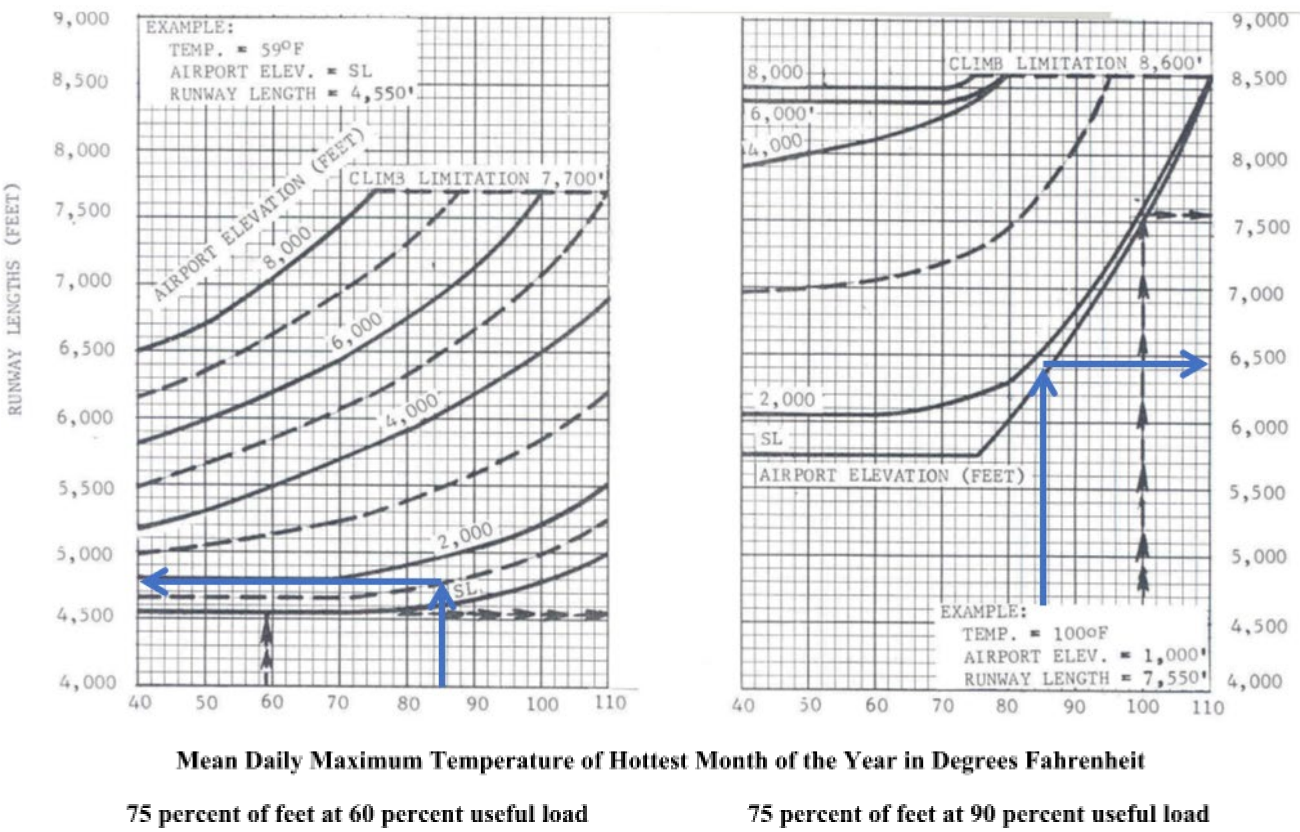
Table 3-14: Fleet Mix

AIRCRAFT	OPERATIONS	MTOW (LBS)
Challenger 350 (CL35)	408	40,600
Challenger 300 (CL30)	553	38,500
Citation Latitude (C68A)	792	30,800
Citation Sovereign (C680)	1,126	30,300
Citation Encore (C560)	560	16,630
Citation Excel (C56X)	1,676	20,200
Embraer Phenom (E55P)	618	17,970
Beechjet (BE40)	1,447	16,300
King Air 300/350 (BE30)	680	15,000
King Air 200 (BE20)	2,696	12,500
King Air 90 (BE9L)	519	10,100
Pilatus (PC12)	1,135	10,450

Source: MACNOMS (July 2021 – June 2022), HNTB Analysis (October 2022)

The fleet mix above was compared to pre-populated fleet mixes in the AC to determine the best representation of critical design aircraft expected at the airport. Following the methodology in the AC, the "percentage of fleet" to be accommodated by the airport's runway length was established. The AC provides two percentages to be accommodated: 75% and 100% of the fleet. 75% of the fleet was selected since the sample of aircraft in the AC best matches the developed fleet mix. Next, the required runway length to accommodate 75% of the fleet mix assuming, zero runway gradient, was determined using the figures in the AC based upon the mean daily maximum temperature of the hottest month and the airport's elevation at 60% and 90% useful load. The results from the AC figures are shown below in **Figure 3.1**.

Figure 3-1: Required Runway Length to Accommodate 75% of Fleet



Source: FAA AC 150/5325-4B Runway Length Requirements for Airport Design, Figure 3-1, HNTB Analysis (October 2022)

The analysis resulted in a base runway length requirement of 4,800-feet to accommodate 75% of the fleet at 60% payload, and 6,450-foot at 90% payload. The required runway lengths were then adjusted for runway gradient and surface condition (wet runway). The results are shown in **Table 3-15**.

Table 3-15: Runway Length Requirement (Feet)

	60% Useful Load	90% Useful Load
Base Requirement	4,800 FT	6,450 FT
Runway Gradient Adjusted (1)	4,820 FT	6,470 FT
Wet Runway Adjusted (2)	5,520 FT	7,418 FT
Runway Length Requirement	5,520 FT	7,418 FT

(1) Base requirement is increased 10 feet for each foot in elevation difference between high and low points of the runway

(2) Base requirement is increased 15% to account for wet conditions during landing

Source: HNTB Analysis (October 2022)

It is important to note that this analysis does not conclude that a longer runway is needed to accommodate the developed fleet mix, i.e., the most demanding aircraft with greater than 500 operations per year at FCM, or that the existing runway length limits the size of aircraft operating at the Airport. In fact, several aircraft listed in the pre-populated fleet mix in the AC requiring greater than 5,000-foot runways operate regularly at FCM with greater than 400 operations within the last year. The FAA AC methodology is a conservative approach that spans a wide range of aircraft types. Prior to each flight, a pilot is responsible to determine the actual payload for the flight based on their aircraft operating characteristics, company procedures, weather conditions at the airport, distance of the flight, and available takeoff and landing runway lengths. It is also important to note that the FCM runway length is statutorily limited to 5,000 feet under Minnesota State Law for a Minor Use Airport such as FCM (Minnesota Statute Section 473.641).

As discussed in **Section 2.5**, the Bombardier Challenger 350 is the critical design aircraft at FCM. Per Bombardier's specifications, the Challenger 350 has a theoretical maximum range of 3,200 nautical miles (nm), and at sea level, standard temperature (59°F), and MTOW conditions, the required takeoff distance is 4,835 feet. From FCM, this 3,200 nm range covers all North America and northern South America. Western Ireland and northwestern United Kingdom are the only transoceanic destinations within range of FCM. As there is no Customs and Border Patrol support at FCM, there are no arriving aircraft from international destinations. MACNOMS data from July 2021 through June 2022 only shows destinations within the continental United States for Challenger 350 departures from FCM. The non-international arrival restriction, historical departure information, and aircraft characteristics all suggest that the existing runway length is adequate for the critical design aircraft. This is supported by historical data showing the Challenger 350 with regular operations at FCM. There are no changes proposed to runway lengths at FCM as part of the LTP.

3.3 Taxiway / Taxilane Geometric Standards

The following subsections describe the requirements related to taxiway and taxilane design standards. The requirements are also compared against existing conditions to identify deficiencies.

3.3.1 Taxiway Design Group

TDG is a principle that groups aircraft based on landing gear dimensions. In contrast to ADG, the Taxiway Design Group (TDG) relates the dimensions of the cockpit to main gear and the width of the main landing gear of aircraft, which are primary design factors for taxiway and taxilane width and fillet standards. Based on this key difference, different areas of the airport may have taxiways or taxilanes with different TDG classifications, and it may be possible that the critical design aircraft for TDG is different from the critical design aircraft for RDC (i.e., the CL30/350). Based on a review of MACNOMS data from July 2021 through June 2022, the critical aircraft for the purpose of TDG is the Beechcraft King Air 200 (BE20), which is a TDG 2A aircraft. The d Since the publication of AC 150/5300-13B in 2022, TDG classifications were expanded from the previous guidance to include TDG 2A and 2B, as opposed to a sole TDG 2 classification. The BE20 is classified as a TDG 2A aircraft. Key information relative to the BE20 is shown in **Table 3-16** below.

Table 3-16: Critical Design Aircraft Specifications - TDG

AIRCRAFT	TDG	COCKPIT TO MAIN GEAR	MAIN GEAR WIDTH	FY 2021 OPERATIONS
King Air 200	2A	15.0 FT	17.2 FT	2,696

Source: Manufacturer Data; US Department of Transportation, Federal Aviation Administration, MACNOMS, FAA Aircraft Characteristics Database, February 2023

3.3.2 Taxiway/Taxilane Width and Shoulder Width

Required taxiway width and shoulder width is dictated by the TDG of the taxiway. The minimum width on straight segments ensures that standard taxiway edge safety margin (TESM) is present for possible aircraft wander. The existing taxiway system at FCM was reviewed for the width of each taxiway and associated shoulder and compared to the standard width. **Table 3-17** shows the results of this review.

Table 3-17: Taxiway / Taxilane Width

DESIGNATOR	TAXIWAY TYPE	EXISTING WIDTH	EXISTING SHOULDER WIDTH	ADG	TDG	STANDARD WIDTH	STANDARD SHOULDER WIDTH	DEFICIENCY (WIDTH / SHOULDER)
A	Full Parallel	40 FT	(1)	II	2A	35 FT	15 FT	None / None
A1	Entrance	40 FT	(1)	II	2A	35 FT	15 FT	None / None
A2	Exit	40 FT	(1)	II	2A	35 FT	15 FT	None / None
A3	Exit	40 FT	(1)	II	2A	35 FT	15 FT	None / None
B	Full Parallel	40 FT	(1)	II	2A	35 FT	15 FT	None / None
B4	Crossover	40 FT	(1)	II	2A	35 FT	15 FT	None / None
C	Exit / Entrance	40 FT	(1)	II	2A	35 FT	15 FT	None / None
D	Full Parallel	40 FT	(1)	II	2A	35 FT	15 FT	None / None
D1	Entrance	40 FT	(1)	II	2A	35 FT	15 FT	None / None

DESIGNATOR	TAXIWAY TYPE	EXISTING WIDTH	EXISTING SHOULDER WIDTH	ADG	TDG	STANDARD WIDTH	STANDARD SHOULDER WIDTH	DEFICIENCY (WIDTH / SHOULDER)
D2	Exit	28 FT	(1)	II	1A	25 FT	10 FT	None / None
E	Full Parallel	40 FT	(1)	II	2A	35 FT	15 FT	None / None
E1	Entrance	40 FT	(1)	II	2A	35 FT	15 FT	None / None
E2	Exit	28 FT	(1)	II	1A	25 FT	10 FT	None / None
F	Exit	40 FT	(1)	II	2A	35 FT	15 FT	None / None
G	Entrance	40 FT	(1)	II	2A	35 FT	15 FT	None / None
H	Entrance	40 FT	(1)	II	2A	35 FT	15 FT	None / None
Alpha	Taxilane	27 FT	(1)	I	1	25 FT	10 FT	None / None
Bravo	Taxilane	20 FT	(1)	I	1	25 FT	10 FT	5 FT / None
Charlie	Taxilane	20 FT	(1)	I	1	25 FT	10 FT	5 FT / None
Delta	Taxilane	20 FT	(1)	I	1	25 FT	10 FT	5 FT / None
Echo	Taxilane	20 FT	(1)	I	1	25 FT	10 FT	5 FT / None
Foxtrot	Taxilane	20 FT	(1)	I	1	25 FT	10 FT	5 FT / None
Golf	Taxilane	20 FT	(1)	I	1	35 FT	10 FT	5 FT / None
Hotel	Taxilane	20 FT	(1)	I	1	25 FT	10 FT	5 FT / None
India	Taxilane	20 FT	(1)	I	1	25 FT	10 FT	5 FT / None
Juliette	Taxilane	20 FT	(1)	I	1	25 FT	10 FT	5 FT / None
Kilo	Taxilane	20 FT	(1)	I	1	25 FT	10 FT	5 FT / None
Lima	Taxilane	20 FT	(1)	I	1	25 FT	10 FT	5 FT / None
Mike	Taxilane	20 FT	(1)	I	1	25 FT	10 FT	5 FT / None
November	Taxilane	20 FT	(1)	I	1	25 FT	10 FT	5 FT / None
Papa	Taxilane	35 FT	(1)	I	2	35 FT	15 FT	None / None
Quebec	Taxilane	94 FT	(1)	II	2	35 FT	15 FT	None / None
Romeo	Taxilane	25 FT	(1)	I	1	25 FT	10 FT	None / None
Sierra	Taxilane	25 FT	(1)	I	1	25 FT	10 FT	None / None
Iowa	Taxilane	32 FT	(1)	II	2A	25 FT	10 FT	None / None
Kansas	Taxilane	32 FT	(1)	II	2A	25 FT	10 FT	None / None
Kentucky	Taxilane	32 FT	(1)	II	2A	25 FT	10 FT	None / None
Louisiana	Taxilane	32 FT	(1)	II	2A	25 FT	10 FT	None / None
Michigan	Taxilane	32 FT	(1)	II	2A	25 FT	10 FT	None / None
Minnesota	Taxilane	30 FT	(1)	II	2A	25 FT	10 FT	None / None
Spring	Taxilane	40 FT	(1)	II	2A	35 FT	15 FT	None / None

(1) Stabilized shoulders are required for taxiways serving critical design aircraft of ADG I, ADG II, and ADG III. The stabilized shoulder is required to be turf or stabilized soil. Existing taxiway and taxilane shoulders at FCM are comprised of turf.

Source: FAA Advisory Circular 150/5300-13B, HNTB Analysis (October 2022)

As stated above, the critical design aircraft from a TDG perspective is a TDG 2A aircraft. The pavement width required for TDG 2A is 35 feet. Except for Taxiway E2 and Taxiway D2, all taxiways at FCM are 40 feet wide (a MAC standard) which exceeds the minimum required taxiway width by five feet. Taxiway E2 and Taxiway D2 are both 28 feet wide. While these two taxiways do not meet the FAA or MAC standard for width, their connection to Runway 18-36, which has an RDC of B-I (small aircraft only), limits the occurrence of TDG 2A aircraft operating on these taxiways to occasional situations of high crosswinds when these larger aircraft may be unable to use Runway 10R-28L. Future pavement rehabilitation of these taxiways should include provision for increasing taxiway width to standard width (MAC or FAA).

The LTP does not propose mitigation for the substandard taxilane widths. The substandard taxilanes provide access to existing hangars where aircraft are taxiing at slow speeds.

3.3.3 Taxiway Edge Safety Margin (TESM)

The TESM is the distance between the outer edge of the landing gear of an aircraft cockpit over centerline and the edge of the taxiway pavement. Its purpose is to protect from possible aircraft wander while taxiing, ensuring an aircraft's gear remains on the taxiway-strength pavement. The TDG of a given taxiway sets the dimensional standards for the TESM. Taxiway fillets and straight segments should be designed such that all aircraft types using it do not exceed the TESM. Taxiway fillets are utilized at taxiway-taxiway and taxiway-runway intersections to ensure adequate TESM is maintained throughout the turn while minimizing the need for excess pavement. The fillet is made up of multiple straight line, tapering tangents with a small circular radius at the center of the turn. None of the taxiway intersections at FCM are constructed with taxiway fillets that meet current standards as prescribed in FAA AC 150/5300-13B. Instead, they are constructed with a single, circular corner fillet. Future taxiway reconstructions should incorporate standard TDG 2A taxiway fillets as required by FAA AC 150/5300-13B (or current version).

3.3.4 Taxiway / Taxilane Object Free Area

The TOFA and the Taxilane Object Free Area (TLOFA) are areas symmetrical about the taxiway centerline and are wider than the taxiway safety area. Their purpose is to provide vertical and horizontal wingtip clearance for taxiing aircraft. FAA criteria for the TOFA/TLOFA require that there be an area on both sides of the taxiway free of objects, except those objects needed for navigational purposes. Standard TOFA/TLOFA widths are determined by the wingspan plus the minimum taxiway/taxilane wingtip clearance of the largest aircraft belonging to the ADG for which the taxiway/taxilane has been designed.

FAA criteria for ADG II TOFA/TLOFAs require the total width to be 124/110 feet, centered on the taxiway /taxilane centerline. All taxiways at FCM are designed to ADG II width standards. The taxilanes south of Taxiway B are designed to ADG II standards. The taxilanes between hangars north of Runway 10L-28R are reduced to ADG I, which results in a TLOFA standard width of 79 feet. Hangar development in this area is based on legacy standards. Reconstruction to existing standards would be burdensome to private aircraft hangar owners and would remove a substantial number of hangars. The MAC is committed to maintaining the current layout, likely requiring self-funding of pavement maintenance in these hangar areas.

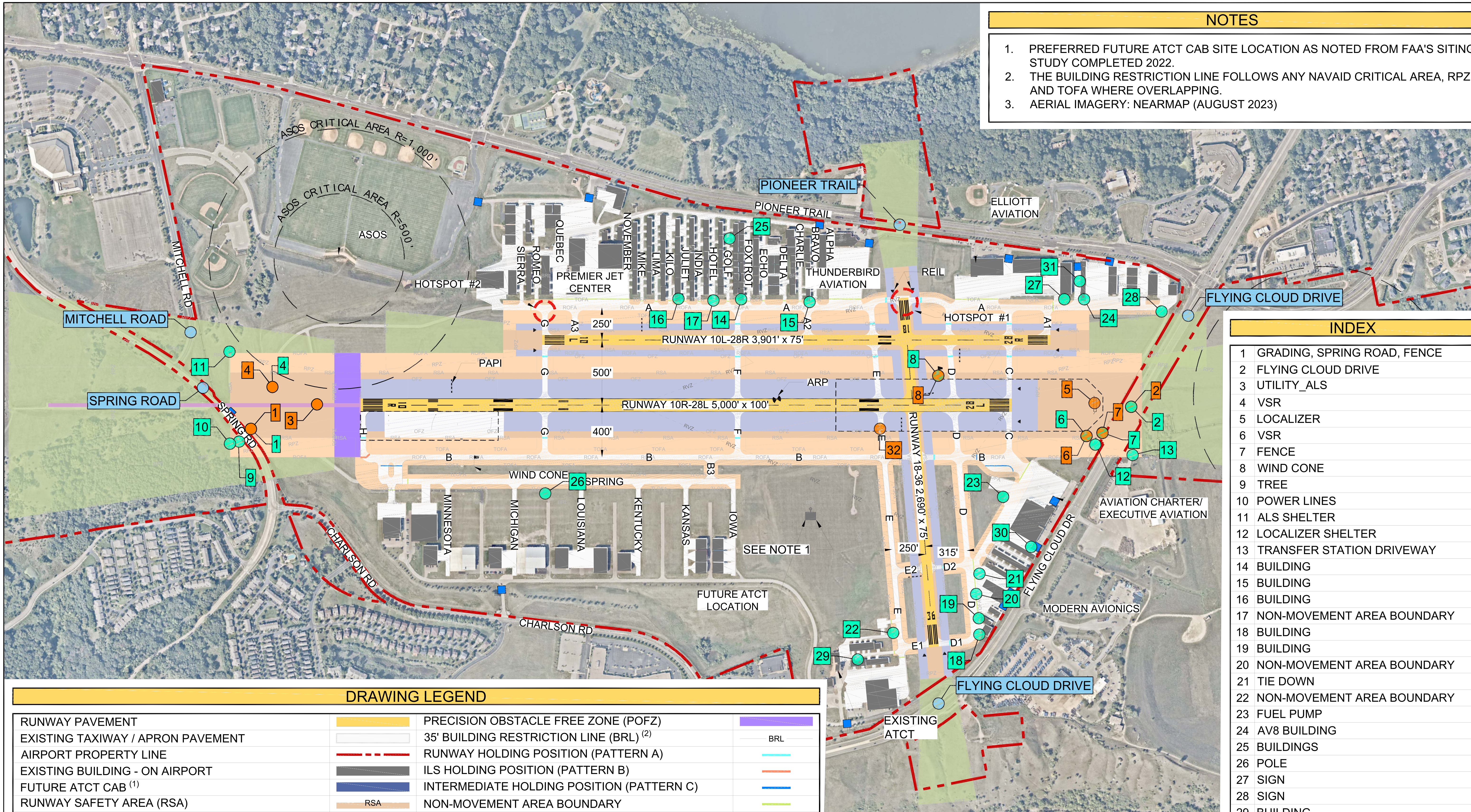
An examination of the taxiway and taxilane geometry and TOFA/TLOFAs identified various objects within the TOFA and TLOFAs. **Table 3-18** lists the objects and locations, which are depicted on **Figure 3.2**.

Table 3-18: TOFA / TLOFA Deficiencies

FIGURE INDEX NUMBER	TAXIWAY	TAXIWAY SEGMENT	STANDARD (Half-Width)	DEFICIENCY	DESCRIPTION[1]	DISPOSITION
14	Taxiway A	Taxiway F	62 FT	10 FT	Building 46A	Remove
15	Taxiway A	Taxiway A2	62 FT	12 FT	Building 38A	Remove
16	Taxiway A	Taxiway F and A3	62 FT	12 FT	Buildings 52A, 54A, 56A	Remove
17	Taxiway A	Taxilane B through Taxilane M	62 FT	10 FT – 14 FT	Non-movement area boundary (12)	Repaint boundary
18	Taxiway D	Taxiway D1 and D2	62 FT	7 FT	Building 15	Relocate TW D
19	Taxiway D	Taxiway D1 and D2	62 FT	5 FT	Building 13	Relocate TW D
20	Taxiway D	Taxiway D1 and D2	62 FT	20 FT	Non-movement area boundary	Relocate TW D
21	Taxiway D	Taxiway D1 and D2)	62 FT	15 FT – 20 FT	Tie down (2)	Relocate TW D
22	Taxiway E	Taxiway E1 and E2	62 FT	6 FT – 10 FT	Non-movement area boundary (3)	Repaint boundary
23	Executive Aviation Ramp			3 FT [2]	Fuel pump	Relocate pump
24	Taxiway A Extension	East of TW A1	62 FT	5 FT	Av8 Flight School Building	None
25	Taxilanes A through N, Taxilane R & S	North of TW A	39.5 FT	Varies[3]	Hangars	None
26	Taxilane Spring	Taxilane Michigan & Taxilane Louisiana	55 FT	2 FT	Pole	Relocate pole
27	Taxiway A Extension	Taxiway A1 and Apron	62 FT	10 FT	Sign	Remove
28	Taxiway A Extension (Apron)		62 FT	25 FT	Sign	Remove
29	Unnamed Taxilane	West of Taxiway E1		2 FT	Building	None
30	Unnamed Taxilane	South of Executive		9 FT	Fence	Relocate
31	Unnamed Taxilane	East end Inflight Ramp		3 FT	Building	None

[1] Refer to Flying Cloud Airport Layout Plan for building numbers
[2] Dimension approximate based on aerial imagery
[3] Deficiency varies in each taxilane due to the varying location of each aircraft hangar

Source: HNTB Analysis (October 2022)



NOTES

1. PREFERRED FUTURE ATCT CAB SITE LOCATION AS NOTED FROM FAA'S SITING STUDY COMPLETED 2022.
2. THE BUILDING RESTRICTION LINE FOLLOWS ANY NAVAID CRITICAL AREA, RPZ AND TOFA WHERE OVERLAPPING.
3. AERIAL IMAGERY: NEARMAP (AUGUST 2023)

INDEX

1	GRADING, SPRING ROAD, FENCE
2	FLYING CLOUD DRIVE
3	UTILITY_ALS
4	VSR
5	LOCALIZER
6	VSR
7	FENCE
8	WIND CONE
9	TREE
10	POWER LINES
11	ALS SHELTER
12	LOCALIZER SHELTER
13	TRANSFER STATION DRIVEWAY
14	BUILDING
15	BUILDING
16	BUILDING
17	NON-MOVEMENT AREA BOUNDARY
18	BUILDING
19	BUILDING
20	NON-MOVEMENT AREA BOUNDARY
21	TIE DOWN
22	NON-MOVEMENT AREA BOUNDARY
23	FUEL PUMP
24	AV8 BUILDING
25	BUILDINGS
26	POLE
27	SIGN
28	SIGN
29	BUILDING
30	FENCE
31	BUILDING
32	DRAINAGE PIPE

DRAWING LEGEND

RUNWAY PAVEMENT		PRECISION OBSTACLE FREE ZONE (POFZ)	
EXISTING TAXIWAY / APRON PAVEMENT		35' BUILDING RESTRICTION LINE (BRL) [2]	BRL
AIRPORT PROPERTY LINE		RUNWAY HOLDING POSITION (PATTERN A)	
EXISTING BUILDING - ON AIRPORT		ILS HOLDING POSITION (PATTERN B)	
FUTURE ATCT CAB [1]		INTERMEDIATE HOLDING POSITION (PATTERN C)	
RUNWAY SAFETY AREA (RSA)	RSA	NON-MOVEMENT AREA BOUNDARY	
RUNWAY OBSTACLE FREE ZONE (OFZ)	OFZ	APPROACH LIGHTING SYSTEM (MALSR)	
RUNWAY OBJECT FREE AREA (ROFA)	ROFA	NAVAID CRITICAL AREA	
RUNWAY PROTECTION ZONE (RPZ)	RPZ	HOT SPOT	
TAXIWAY OBJECT FREE AREA (TOFA)	TOFA	AIRSIDE GATE	

DEFICIENT OBJECTS WITHIN RSA	XX
DEFICIENT OBJECTS WITHIN OBJECT FREE AREA	XX
INCOMPATIBLE LAND USES WITHIN RPZ	XX

FCM

MAC — METROPOLITAN AIRPORTS COMMISSION — MINNEAPOLIS SAINT PAUL

FLYING CLOUD AIRPORT
2040 LONG-TERM PLAN (LTP) UPDATE

0 700' 1,400'

HNTB

FINAL DOCUMENT

FIGURE 3-2 SEPTEMBER 2025

AIRFIELD GAP STANDARD SUMMARY

3.3.5 Taxiway Safety Area

The taxiway safety area, which also applies to taxilanes, is an area symmetrical to the taxiway or taxilane centerline. Its purpose is to support the safe passage of aircraft and emergency vehicles and equipment. Standard taxiway safety area widths are given by the wingspan of the largest aircraft belonging to the ADG for which the taxiway has been designed. The TSA must be kept clear of all objects, except for objects required to be within the surface due to their function. The taxiway safety area also must be adequately grades to remove hazardous surface variations and prevent the accumulation of surface water. **Table 3-19** presents the TSA dimensional standards for taxiways and taxilanes at FCM. No deficiencies to the safety areas were identified during analysis of the existing taxiways and taxilanes.

Table 3-19: Taxiway / Taxilane Safety Area Standards

ADG	STANDARD WIDTH
I	49 FT
II	79 FT

Source: FAA Advisory Circular 150/5300-13B, HNTB Analysis (October 2022)

3.4 NAVAIDs / Approach Procedures

3.4.1 NAVAIDS

Proper siting and protection of the areas that surround navigational aids (NAVAIDs) ensures their proper operation. Protection of NAVAIDs is accomplished by establishing a critical area surrounding the NAVAID in which structures, trees, parked aircraft, and equipment should be avoided. NAVAIDs reviewed at FCM include the Runway 10R glide slope antenna, Runway 10R localizer antenna, Very High Frequency Omni-Directional Range (VOR), and the automated surface observation system (ASOS).

The Runway 10R glideslope and localizer antennae were determined to be properly sited. The hold position marking on Taxiway H is within the glide slope critical area, meaning that an aircraft could potentially be stopped within the glideslope critical area. An intermediate hold line at the Taxiway B and Taxiway H intersection provides mitigation for this condition. There are no obstructions within the localizer critical area.

The VOR critical area is comprised of a 1,000-foot circle centered on the VOR facility. There are individual and groups of trees and a fence line within the critical area. However, there are no known issues with the VOR siting and this VOR is on the FAA's list for decommissioning in the near future.

The Federal Standard for Siting Meteorological Sensors at Airports provides siting criteria applicable to the ASOS system at FCM. The Standard provides two options for siting at airports with precision instrument runways without runway visual range (RVR) instrumentation, such as FCM:

- Option 1: General criteria requires that the cloud height, visibility, and wind sensors are located adjacent to the primary instrument runway between 1,000 feet and 3,000 feet down the runway from the threshold and located between 750 feet and 1,000 feet from the runway centerline.
- Option 2: General criteria requires that the cloud height and visibility sensors are located behind the glideslope shelter and wind sensors located on the glideslope antenna or separate tower.

The ASOS system at FCM does not meet the criteria for either option, as it is located prior to the Runway 10R threshold and 1,120 feet from the extended runway centerline. The Standard does allow for exceptions to the siting criteria provided the resultant observations from the site are representative of conditions at the touchdown zone of the primary instrument runway and applicable sensor exposure criteria are met. To date, there have been no known issues with the accuracy of weather data reported by the current ASOS location.

The ASOS critical area consists of two concentric circles surrounding the ASOS, one at 500-feet radius and one at 1,000-feet radius. All obstructions must be at least 15 feet lower than the height of the wind sensor within the 500-foot radius and be at least 10 feet lower than the wind sensor from 500 to 1,000 feet. There are individual and groups of trees within the outer 1,000-foot radius critical area whose height is unknown.

There have been no pilot complaints about the accuracy of reporting from the ASOS, and the FAA regularly checks and inspects the system, therefore its current location is presumed to be adequate for equipment siting purposes. However, locations were evaluated for relocation of the ASOS to meet the siting standards and are presented in **Section 4.**

3.4.2 Approach Procedures

Table 3-20 contains an inventory of the various instrument approach procedures that currently are published for FCM, organized by runway end and type of approach, as well as visibility and decision altitude minimums. The minimums are shown for AAC C, commensurate with the critical design aircraft. Within each approach, the lowest published straight-in minimums are listed. For example, if Localizer Performance with Vertical Guidance (LPV) minimums are available, LNAV/VNAV minimums are not shown.

Table 3-20: Instrument Approach Procedure Inventory

RUNWAY	APPROACH TYPE	DECISION ALTITUDE OR MINIMUM DESCENT ALTITUDE (AGL)	VISIBILITY MINIMUMS (CATEGORY C)
10R	ILS	200 FT	½ MILE
10R	LOC	494 FT	¾ MILE
10R	RNAV (GPS)	200 FT	½ MILE
10R	VOR	554 FT	1 MILE
10R	COPTER ILS	200 FT	¼ MILE
10R	COPTER LOC	494 FT	¼ MILE
10L	RNAV (GPS)	281 FT	1 MILE
28L	RNAV (GPS)	250 FT	1 MILE
28R	RNAV (GPS)	250 FT	1 MILE
36	RNAV (GPS)	355 FT	1 MILE
36	VOR/DME	375 FT	1 MILE

Source: FAA (Charting Cycle 02 NOV 2023 – 30 NOV 2023)

Based on a review of the existing approach procedures and minimums, FCM currently has the capability to accommodate the critical aircraft during instrument meteorological conditions (IMC) as low as 200 ft above ground level and ½ mile visibility, which is the lowest minimums permitted for ILS Category 1 (CAT I) operations. Any lower minimums would require an upgrade of the approach to CAT II, which would require additional lighting and meteorological sensing equipment. Given the role of FCM as a general aviation reliever, additional instrument approach capabilities beyond the lowest minimums currently available are not recommended.

3.5 Airfield Capacity

Airfield capacity refers to the level of aircraft activity, as defined by hourly or annual aircraft operations that can be accommodated by the existing airfield system with an acceptable level of delay.

3.5.1 Annual Service Volume (ASV)

The FAA specified metric used for estimating annual airfield capacity is the Annual Service Volume (ASV). The ASV utilizes peak hourly capacities of the airfield and ratios of annual to monthly demand and daily to hourly demand to derive a reasonable estimate of the annual capacity of the airfield. There are currently two primary methodologies used to estimate hourly airfield capacity for the ASV calculation.

FAA Advisory Circular (AC) 150/5060-5: *Airport Capacity and Delay*. (AC 150/5060-5) is the official method used to estimate ASV by identifying the appropriate geographical layout of the airfield from a defined set of representative airfield layouts within the AC and incorporating factors such as weather, aircraft operating at the airport, percentage of touch-and-go operations, and the location and quantity of runway exit taxiways. Various operating conditions, peaking factors, and the amount of time in each operating condition are then determined to calculate a weighted ASV representing the airport capacity

An alternative method for calculating ASV is based upon guidance contained within Airports Cooperative Research Program (ACRP) Report 79. This methodology employs a spreadsheet model that uses the same inputs as the FAA method, but also can account for runway occupancy time and arrival/departure buffers. However, as applied to FCM, this methodology has limitations with respect to the FCM runway configurations not well represented within the model, as well as not accounting for runway length.

The ASV analysis contained within this section is based upon the FAA AC 150/5060-5 methodology. An assessment of ASV based upon the ACRP methodology was also conducted and reviewed with MAC as part of the LTP. Based on coordination with FAA throughout the LTP process, the FAA methodology was utilized to assess the forecast future aircraft operations against the calculated ASV. A description of the inputs for the ASV calculation utilizing AC 150/5060-5 is described within the following subsections.

3.5.1.1 Weather

The split between Visual Meteorological Conditions (VMC) and Instrument Meteorological Conditions (IMC) impacts capacity due to spacing requirements between aircraft in the various weather conditions. Due to the close runway spacing at FCM, simultaneous independent operations on the two parallel runways are only allowed in VFR conditions when aircraft on both runways are light piston twin engine aircraft or smaller, per FAA Order JO7110.65Z, *Air Traffic Control*. Reported weather conditions were analyzed for dates from January 2017 through December 2021. For the purposes of this analysis, Marginal Visual Meteorological Conditions (MVMC), where the ceiling is between 1,000 and 3,000 feet and visibility between 3 to 5 miles, was considered VMC conditions. Reported weather conditions were reviewed for the period from January 2012 through December 2021. **Table 3-19** summarizes this analysis.

Table 3-21: Historical Reported Weather Conditions

OBSERVATION	NUMBER OF OBSERVATIONS	PERCENT
VFR	48,974	85%
IFR	8,965	15%
TOTAL	57,939	

Source: HNTB Analysis (October 2022)

3.5.1.2 Fleet Mix

For use in capacity calculations, aircraft are split into four categories according to maximum certified takeoff weight. These categories are defined as follows:

- A: Single engine aircraft weighing 12,500 pounds or less (e.g., Cessna 172)
- B: Twin engine aircraft weighing 12,500 pounds or less (e.g., Beechcraft King Air)
- C: Large aircraft weighing greater than 12,500 pounds but less than 300,000 pounds (e.g., Challenger 350, Boeing 737)
- D: Heavy jet aircraft weighing greater than 300,000 pounds (e.g. Boeing 747)

It should be noted that these four categories of aircraft are not the same A through D categories as those used for Aircraft Approach Category.

The fleet mix index is calculated as the sum of the percentage of large aircraft operations (Category C) and three times the percentage of heavy jet aircraft (3 x Category D).

MACNOMS operational data was reviewed for three different periods spanning 2021 and 2022. Three different time periods were chosen to capture the effects of the COVID recovery, recent trends, and changing economic conditions. The three time periods analyzed were:

- January 2021 through December 2021
- July 2021 through June 2022
- January 2022 through September 2022 (end of data available at time of analysis)

The most recent data available was used in the fleet mix calculation since it is assumed that current trends will be sustained. Aircraft with over 100 operations in the period were categorized according to their weight. Helicopters and "unknown" aircraft were not categorized. **Table 3-22** summarizes the analysis of aircraft categories.

Table 3-22: Fleet Mix

CATEGORY	PERCENT OF OPERATIONS
A	75.8%
B	7.7%
C	13.6%
D	0%
Helicopters	2.0%
"Unknown"	0.9%

Source: HNTB Analysis (October 2022)

Based on this analysis, the fleet mix used in calculations was 14% (13.6% (C) + 3(D)).

3.5.1.3 Touch and Go Factor

Given the high volume of flight training at FCM, the number of touch-and-go operations needs to be considered. A touch-and-go operation is when a pilot lands and takes off without coming to a complete stop. Like fleet mix, three time periods between January 2021 and June 2022 were analyzed, and the most recent data was used to determine the touch-and-go factor (T) calculated as a percentage of total operations. A flight was considered as a "touch and go" if its recorded duration was less than 10 minutes, which is reflective of an aircraft staying in the traffic pattern completing many practice landings and takeoffs. MACNOMS data for July through September 2022 did not contain ending time of flights to calculate the duration of flight, therefore the period used to calculate (T) was October 2021 through June 2022. **Table 3-23** summarizes the analysis.

Table 3-23: Touch-and-Go Factor

COUNT	DURATION	PERCENT OF OPERATIONS
24,235	< 10 minutes	38%
39,970	> 10 minutes	62%

Source: HNTB Analysis (October 2022)

The Advisory Circular tables provide various ranges of (T) to use in capacity calculations. Based on 38% of the recorded flights being categorized as touch-and-go, the touch-and-go factor (T) used for capacity calculations was the range 31% to 60% of total operations at the airport.

3.5.1.4 Exit Taxiways

The location and number of exit taxiways directly affects the runway occupancy time of landing aircraft. The higher the runway occupancy time, the lower the capacity of the airfield since it will take aircraft longer to clear the runway. The exit factor (E) is determined by applying the calculated fleet mix index and counting the number of exit taxiways meeting spacing criteria provided by the Advisory Circular tables. In determining (E), a balanced 50% arrival rate and 50% departure rate was assumed. Resulting exit factors used in the capacity calculations for various operating conditions (described in **Section 3.5.1.7**) were 0.9 and 0.93.

3.5.1.5 Hourly Capacity

Hourly capacity is calculated as the product of the base hourly capacity read from charts in the AC, the touch-and-go factor, and exit factor. Different charts are used to determine hourly capacity in both VFR and IFR conditions. Hourly capacities are used when weighting runway capacity based on the amount of time in each operating condition (discussed further in **Section 3.5.1.7**).

RUNWAY CONFIGURATION	HOURLY CAPACITY – VFR (OPERATIONS)	HOURLY CAPACITY – IFR (OPERATIONS)
SINGLE RUNWAY	87	59
DUAL RUNWAY	158	60

3.5.1.6 Peaking Factors

The ratio of annual demand to average peak month daily demand (D) and ratio of average peak month daily demand to average peak hour demand (H) are determined and applied in capacity calculations to ensure sufficient capacity is provided for most days of the year. (D) and (H) were calculated using MACNOMS data for calendar years 2017 through 2021. The results for calendar year 2021 were used to validate calculations using date from October 2021 through September 2022. **Table 3-24** summarizes the historic (D) and (H) calculations and factors used in the capacity calculations.

Table 3-24: Peaking Factors

PERIOD	AVERAGE DAILY OPERATIONS (AUGUST)	ANNUAL OPERATIONS	D FACTOR	PEAK HOUR OPERATIONS	H FACTOR
CY 2017	328	89,347	272.6	28.43	11.53
CY 2018	340	91,060	268.2	28.62	11.87
CY 2019	373	96,238	257.8	31.70	11.78
CY 2020	431	119,710	277.7	36.85	11.70
CY 2021	582	133,217	228.8	52.75	11.04
Average Value for Analysis	--	--	237.0	--	11.67

Source: HNTB Analysis (October 2022)

3.5.1.7 Operating Conditions

Two operating conditions were analyzed using the AC method: a single runway with intersecting runway and dual runways with an intersecting runway.

The single runway with intersecting runway model was analyzed to simulate a condition with a north-south wind exceeding the 10.5 knot crosswind component. In this weather condition, it is assumed that smaller aircraft would operate on Runway 18-36 and large aircraft (turboprop or jet) would operate on Runway 10R-28L.

The dual intersecting condition represents a condition with an east-west wind with crosswind component less than 10.5 knots. In this weather condition, small aircraft would operate primarily on Runway 10L-28R and larger aircraft would operate on Runway 10R-28L. A weighted average is calculated based on the amount of time that each runway configuration is in use in VFR and IFR conditions.

3.5.1.8 Weighted Annual Service Volume – Parallel East-West Runways with Intersecting Crosswind Runway

ASV is calculated as the product of the weighted hourly capacity of the runways (C_w), and peaking factors (D) and (H).

$$ASV = C_w \; x \; D \; x \; H$$

(C_w) is determined by identifying the different runway conditions in use, calculating the VFR and IFR hourly capacities of the various runway conditions considered, determining the percent of time each runway configuration is in use, the percent of maximum capacity that each represents, a weighting factor (W) determined from Table 3-1 in the AC, and the percentage of time each operating condition occurs. Table 3-25 presents the factors for calculating (C_w).

$$C_w = \frac{(C_1 x P_1 x W_1) + (C_n x P_n x W_n)}{(P_1 x W_1) + (P_n x W_n)}$$

Table 3-25: (C_w) Calculation

OPERATING CONDITION	HOURLY CAPACITY, C	PERCENT OF TIME OCCURRING, P	PERCENT OF MAXIMUM CAPACITY	WEIGHTING FACTOR, W
Dual Runways (VFR)	206	79%	100%	1
Dual Runways (IFR)	74	14%	36%	4
Single Intersecting (VFR)	104	6%	50%	25
Single Intersecting (IFR)	72	1%	35%	4

Source: HNTB Analysis (December 2022)

The resulting weighted capacity (C_w) is 126.22.

Applying the peaking factors from **Section 3.5.1.6** results in a weighted ASV of 349,000. FAA Order 5100-38D, *Airport Improvement Program Handbook, Change 1*, February 2019 states that 60% of the annual capacity of an airport's primary and secondary runways is the threshold for considering when to plan a new runway. For the parallel east-west runways with crosswind runway scenario this equates to 209,400 annual operations.

3.5.1.9 Weighted Annual Service Volume – Single East-West Runway with Intersecting Crosswind Runway

A second ASV calculation was completed to simulate a condition with a single east-west runway with crosswind runway. The calculation utilized all the same inputs as the parallel east-west runway with intersecting crosswind runway condition.

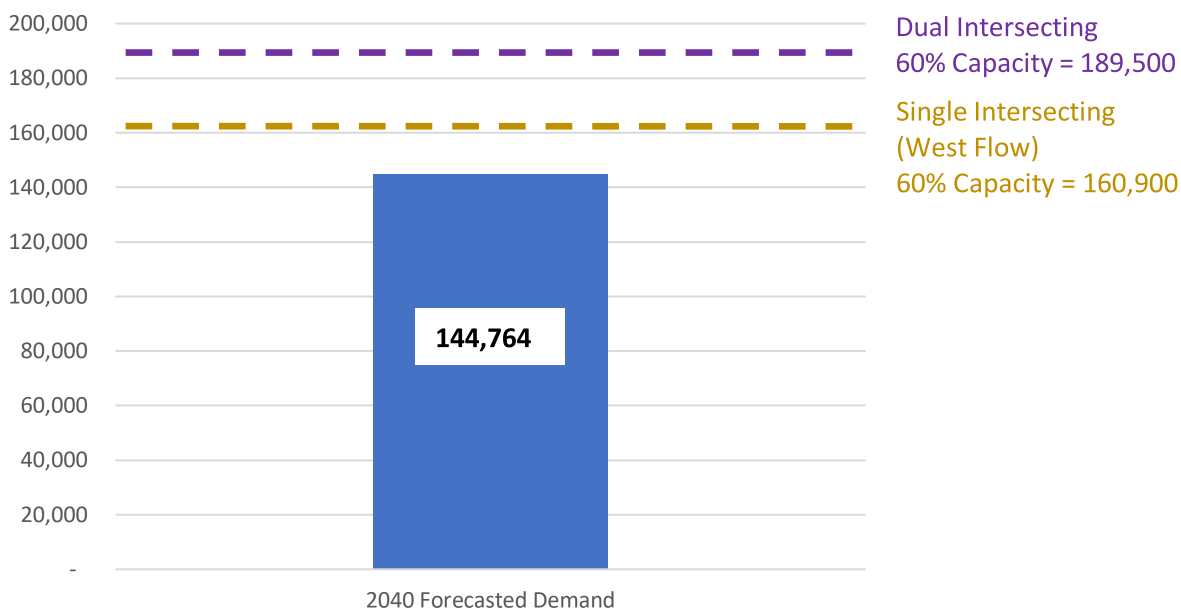
The calculated weighted ASV for this condition is 237,000. The 60% threshold for when to consider planning a new runway in this scenario is 142,200 annual operations.

3.5.2 Capacity Conclusion

The LTP does not propose any modifications to the number of runways at FCM. Runway 18-36 is required to accommodate small aircraft in crosswind conditions and the parallel runways allow air traffic control to separate small piston aircraft from turboprop and jet aircraft operations.

As presented in **Chapter 2**, the 2024 forecast annual demand at FCM is 144,764. This demand is slightly above 60% of the capacity of a single east-west runway with intersecting crosswind runway as shown in **Figure 3.3**.

Figure 3-3: Capacity Summary



3.6 Pavement Strength Analysis

The Metropolitan Airports Commission Ordinance 97, effective January 31, 2003, restricts operations at FCM to aircraft with a Certified Maximum Gross Takeoff Weight (MTOW) of 60,000 lbs. or less. The FAA defines MTOW as the maximum certified weight for an airplane at takeoff, i.e., the start of the takeoff run. In 2002, MAC conducted a geotechnical review to determine the appropriate weight limitation for FCM. Using available geotechnical data and applying reasonable engineering judgment, this review determined that existing pavement throughout the airfield is adequate to support 60,000 lbs. In 2005, the primary runway at FCM, Runway 10R-28L, which is subjected to the heaviest aircraft loads, was reconstructed to meet the maximum 60,000 lb. design strength. As noted in **Section 2.5,** the critical design aircraft at Flying Cloud is the Challenger 350. The MTOW of the Challenger 350 is 40,600 lb., therefore the existing pavement structure is suitable for the critical aircraft.

3.7 Hot Spots and Geometric Contributing Factors to Incursions

The following sections describe the existing hot spots on the airfield as well as the incident history from 2019 through 2021. Specific characteristics in the airfield geometry which may contribute to the risk of surface incidents and/or runway incursions are identified.

3.7.1 FAA Hot Spots

A hot spot is typically identified as a complex or confusing taxiway-runway or taxiway-taxiway intersection, which has an increased risk for, or history of, runway incursions and incidents which can be due to airport layout or geometry, traffic flow, or airport marking signage and lighting, which requires heightened attention by pilots and drivers. These hot spots are identified and defined by a Runway Safety Action Team (RSAT) by analyzing the airport's history of runway incursions and incidents. The FAA publishes the hot spots in the Airport Facility Directory (AFD) and on Airport Diagrams.

As of December 2023, there are two official FAA Hot Spots at FCM. Two former hot spots were previously mitigated by removing direct access between apron areas and Runway 10L-28R. This change was supported based on input from the FCM RSAT. **Figure 3.2** shows the current Hot Spots at FCM. **Table 3-26** describes the locations and descriptions of the three hot spots at Flying Cloud.

Table 3-26: FAA Hot Spot Description

HOT SPOT	LOCATION	DESCRIPTION
HS 1	Taxiway A / Runway 18 intersection	Runway 18 approach area proximity to adjacent ramps along Taxiway A
HS 2	Taxiway A / G intersection	Short taxi distance from ramp to runway hold line

Source: FAA, October 2022

3.7.2 FAA National Inventory of Runway Incursion Mitigation Locations

The FAA also maintains national inventory of Runway Incursion Mitigation (RIM) locations. Designation as a RIM location indicates a location on an airport where three or more peak annual RIs occurred in a given calendar year or where cumulative incursion counts averaged one or more RIs per year of data analyzed, and that the FAA is currently working with an airport on mitigation strategies for these locations. There are two locations at FCM identified as RIM locations on the FAA's national inventory. These locations are summarized in **Table 3-27.**

Table 3-27: FAA RIM Locations at FCM

LOCATION	IDENTIFIER	ASSOCIATED HOTSPOT	YEAR ADDED	CUMULATIVE RI	PEAK CY RI
Approach ends of Runway 28L and 28R	FCM-25	N/A	2015	24	4
Taxiway G at approach end of Runway 10 (north of runway)	FCM-HS3	Hotspot 3	2022	11	4

Source: FAA

3.7.3 FAA Arrival Alert Notices

Beginning with the May 19, 2022 charting cycle, the FAA began producing new graphically oriented safety notices, known as Arrival Alert Notices (AAN) that visually depict an approach at specific airports to help mitigate potential wrong surface events or a case of a pilot inadvertently lining their aircraft up for landing on the wrong runway. The AANs not only provide a graphic depicting the approach at a particular airport, but also a description of the potential risk for misalignment. FCM was one of the initial airports to have an AAN published, and the current AAN is depicted on **Figure 3.4.**

3.7.4 Runway Incursions and Surface Incident History

AC 150/5300-13B consolidates a variety of recent research findings related to airfield safety and is supplemented by other FAA documentation. Several airfield safety enhancement bulletins had been published in past FAA orders and engineering briefs, many of which remain relevant as does documentation associated with the FAA's national runway incursion program office. The research correlates existing design geometries with incursion history as well as the future potential for an incursion to take place. In all this research, the FAA has determined that there are specific characteristics in airfield geometry that can contribute to the greater potential for both surface incidents and runway incursions. Surface Incidents and Runway Incursions are defined by the FAA as follows:

Surface Incident (SI) – Any event where unauthorized or unapproved movement occurs within the airport movement area, or an occurrence in the movement area associated with the operation of an aircraft that affects or could affect the safety of flight. A surface incident can occur anywhere on the airports surface including the runway.

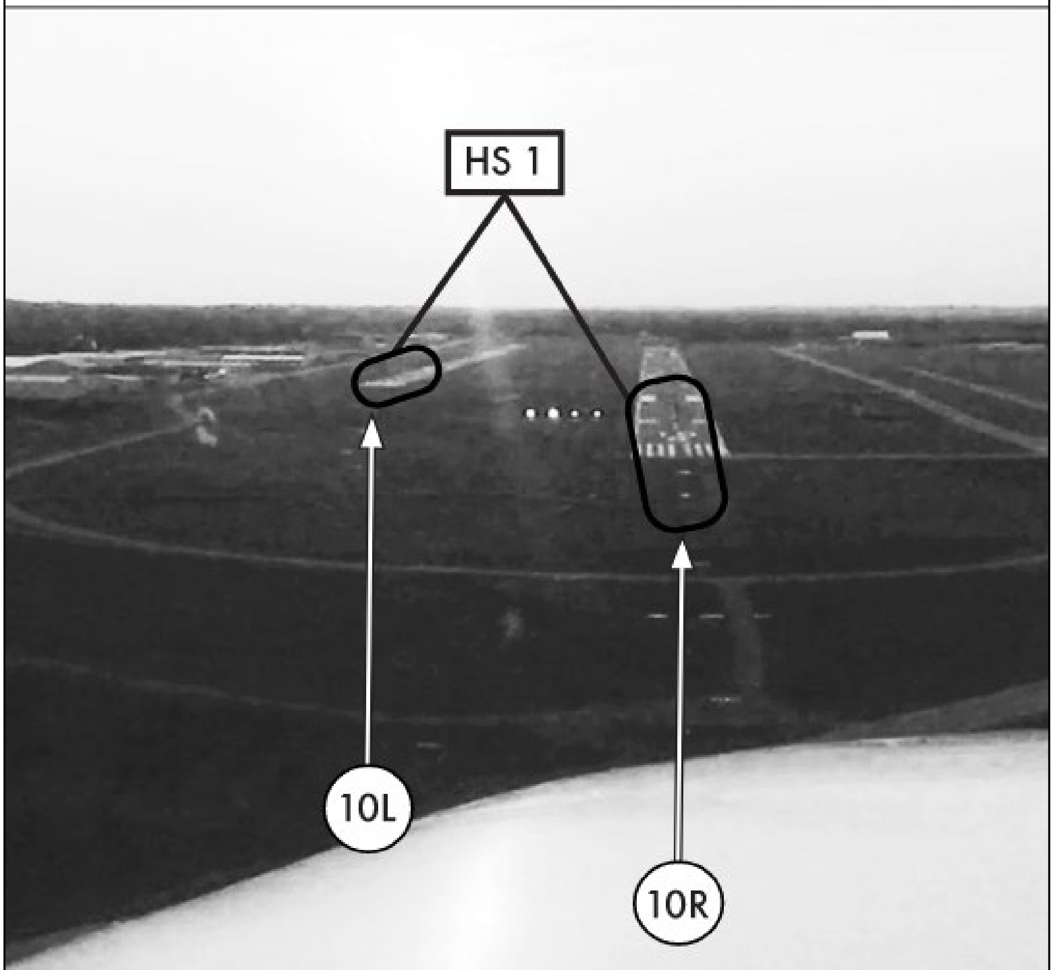
Runway Incursion (RI) – Any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle, or person on the protected area of a surface designated for the landing and takeoff of aircraft.

Shown in **Table 3-28**, the FAA has adopted four categories of runway incursions, with category "A" being the most severe.

Figure 3-4*:* FCM FAA Arrival Alert Notice

FLYING CLOUD (FCM) ARRIVAL ALERT

Landing East
Rwy 10L and Rwy 10R



Off-set Parallels.
Pilots be aware that Rwy 10L is 1,400 feet farther down the approach than Rwy 10R.

Not for Navigational Purposes
For Situational Awareness Only
For Inquiries: 9-awa-RunwaySafety@faa.gov
Effective 19 MAY 2022 to 16 MAY 2024

Table 3-28: FAA Runway Incursion Severity Categories

SEVERITY CLASSIFICATION	DESCRIPTION
A	A serious incident in which a collision was narrowly avoided
B	An incident in which separation decreases and there is a significant potential for collision, which may result in a time critical corrective/evasive response to avoid a collision
C	An incident characterized by ample time and/or distance to avoid a collision
D	An incident that meets the definition of a runway incursion such as incorrect presence of a single vehicle/person/aircraft on the protected area of a surface designated for the landing and takeoff of aircraft but with no immediate safety consequences

Source: FAA

Sources of runway incursions include the following:

1.) Operational Incidents (OI) - Action of an Air Traffic Controller that results in: Less than required minimum separation between 2 or more aircraft, or between an aircraft and obstacles, (vehicles, equipment, personnel on runways) or clearing an aircraft to take off or land on a closed runway
2.) Pilot Deviations (PD) - Action of a pilot that violates any Federal Aviation Regulation. For example: a pilot crosses a runway without a clearance while enroute to an airport gate
3.) Vehicle/Pedestrian Deviations (V/PD) - Pedestrians or vehicles entering any portion of the airport movement areas (runways/taxiways) without authorization from air traffic control

Runway incursions and surface incidents at FCM were captured for the years 2019 through September 2023 are summarized in **Table 3-29** and **Table 3-30** by incursion severity or incident type, respectively.

Table 3-29: Incursion/Incident Summaries

YEAR	AIRSPACE CONFLICT	A	B	C	D	SI	TOTAL
2019	1	0	0	8	11	0	**20**
2020	1	0	0	1	7	1	**10**
2021	2	0	1	4	15	0	**22**
2022	0	0	0	0	11	0	**11**
2023*	0	0	0	1	2	0	**3**
Total	**4**	**0**	**1**	**14**	**46**	**1**	**66**

Source: FAA Runway Incursion Database (HNTB Analysis October 2023)

Notes: SI – Surface Incident

Runway Excursions not included

*Data for 2023 current through September, 2023

Table 3-30: Incident Types

YEAR	OI	PD	V/PD	TOTAL
2019	1	15	4	**20**
2020	0	9	1	**10**
2021	2	18	2	**22**
2022	1	8	2	**11**
2023*	1	2	0	**3**
Total	**5**	**52**	**9**	**66**

Source: FAA Runway Incursion Database (HNTB Analysis October 2022)

Note: Runway Excursions not included

*Data for 2023 current through September, 2023

Incidents from 2019 through September 2023 are depicted in **Figure 3.5**. The airfield alternatives discussed in **Chapter 4** aim to address potential solutions to the geometric contributing factors of these incidents and incursions.

3.7.5 Geometric Contributing Factors

FAA AC 150/5300-13B, *Airport Design*, consolidates recent research findings related to airfield safety. The research correlates existing design geometries with incursion history, as well as the future potential for an incursion to take place. The FAA determined there are specific characteristics in airfield geometry that can contribute to the potential for both surface incidents and runway incursions.

The geometric contributing factors, and locations at FCM, are summarized as follows and are illustrated in **Figure 3.6**:

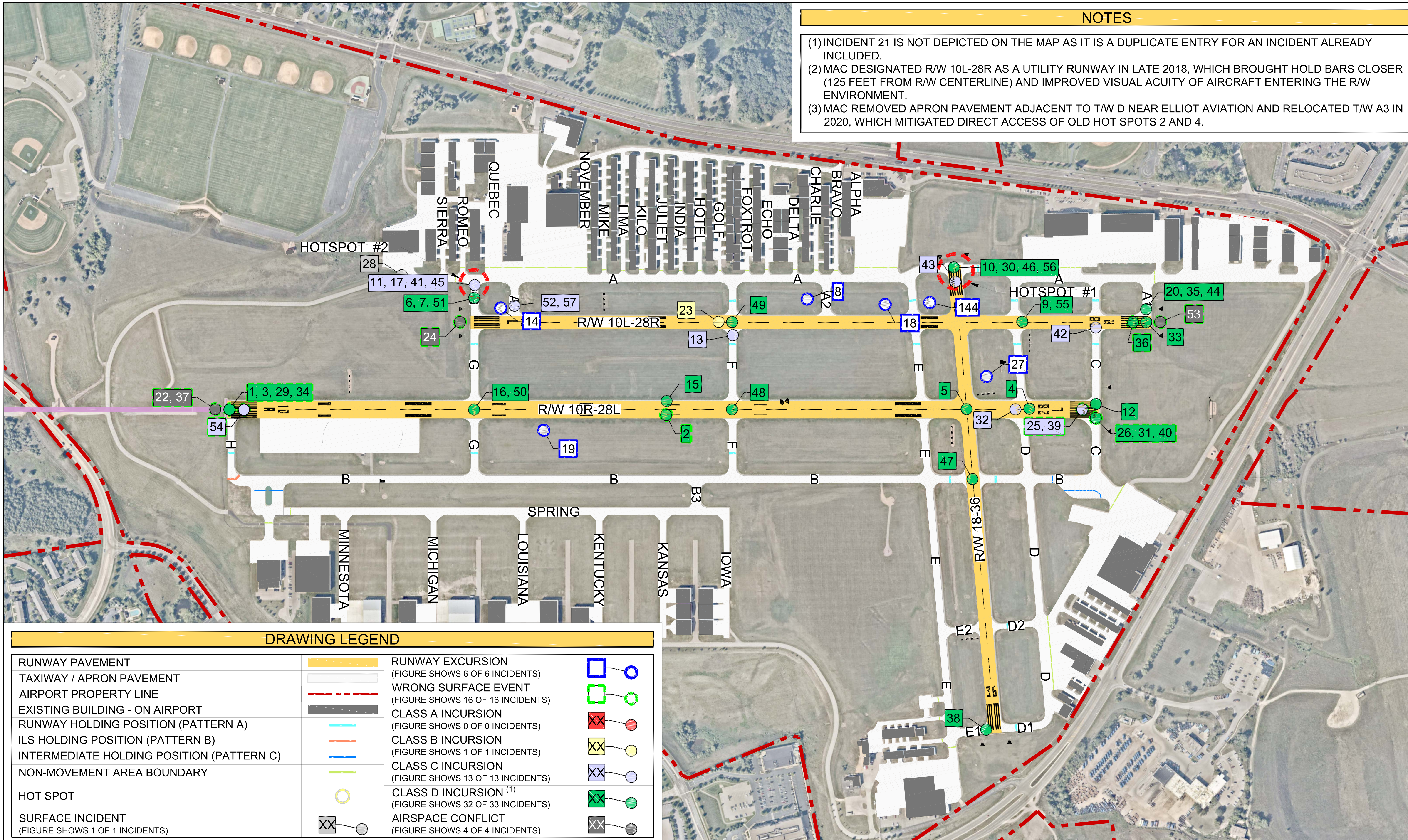
- **High-Energy Runway Crossings** – The middle third of the runway has been known as the portion where aircraft are operating at a higher rate of speed. For this reason, it is recommended practice that runway crossings be limited in the middle third of the runway. At FCM, there are four high energy crossings at the following locations:
    - Runway 10R-28L at Taxiway F
    - Runway 10L-28R at Taxiway E and Taxiway F
    - Runway 18-36 at Taxiway B

The incidents at these locations are similar to other incursions throughout the airfield and are not isolated to these high-energy crossings. The LTP evaluated alternatives to remove the high-energy crossing on Runway 10R-28L, which serves the largest aircraft at FCM. However, removal of taxiway crossings needs to be carefully considered against the operating capacity of the airport. The alternatives that were evaluated are presented in **Chapter 4**.

- **Direct Access** – Pilots could mistakenly enter a runway directly from an apron area without a situational awareness turn. There are no instances of direct access at FCM.
- **Wide Expanse of Pavement – Wide expanses of pavement can result in a loss of situation** awareness and may result in visual cues (signs, markings, lights) being placed outside or far from a pilot's field of vision. There were no locations identified as a wide expanse of pavement during the airfield review conducted as part of the LTP.

NOTES

(1) INCIDENT 21 IS NOT DEPICTED ON THE MAP AS IT IS A DUPLICATE ENTRY FOR AN INCIDENT ALREADY INCLUDED.
(2) MAC DESIGNATED R/W 10L-28R AS A UTILITY RUNWAY IN LATE 2018, WHICH BROUGHT HOLD BARS CLOSER (125 FEET FROM R/W CENTERLINE) AND IMPROVED VISUAL ACUITY OF AIRCRAFT ENTERING THE R/W ENVIRONMENT.
(3) MAC REMOVED APRON PAVEMENT ADJACENT TO T/W D NEAR ELLIOT AVIATION AND RELOCATED T/W A3 IN 2020, WHICH MITIGATED DIRECT ACCESS OF OLD HOT SPOTS 2 AND 4.



DRAWING LEGEND

RUNWAY PAVEMENT		RUNWAY EXCURSION (FIGURE SHOWS 6 OF 6 INCIDENTS)	
TAXIWAY / APRON PAVEMENT		WRONG SURFACE EVENT (FIGURE SHOWS 16 OF 16 INCIDENTS)	
AIRPORT PROPERTY LINE		CLASS A INCURSION (FIGURE SHOWS 0 OF 0 INCIDENTS)	XX
EXISTING BUILDING - ON AIRPORT		CLASS B INCURSION (FIGURE SHOWS 1 OF 1 INCIDENTS)	XX
RUNWAY HOLDING POSITION (PATTERN A)		CLASS C INCURSION (FIGURE SHOWS 13 OF 13 INCIDENTS)	XX
ILS HOLDING POSITION (PATTERN B)		CLASS D INCURSION [1] (FIGURE SHOWS 32 OF 33 INCIDENTS)	XX
INTERMEDIATE HOLDING POSITION (PATTERN C)		AIRSPACE CONFLICT (FIGURE SHOWS 4 OF 4 INCIDENTS)	XX
NON-MOVEMENT AREA BOUNDARY			
HOT SPOT			
SURFACE INCIDENT (FIGURE SHOWS 1 OF 1 INCIDENTS)	XX		

0 500' 1,000'

FCM

FLYING CLOUD AIRPORT
2040 LONG-TERM PLAN (LTP) UPDATE

FINAL DOCUMENT

FIGURE 3-5

SEPTEMBER 2025

INCURSION/INCIDENT SEVERITY MAP
JANUARY 2019 - DECEMBER 2023

- **Acute-Angled Crossing** – Current FAA guidance on the design of runway/taxiway intersections is to design for a true 90-degree right angle intersection, as right angles provide the best visibility left and right for a pilot at an intersection.. There are five acute-angled crossings identified at FCM:
    - Runway 18-36 at Taxiway B
    - Runway 10R-28L at Taxiway E
    - Runway 10L-28R at Taxiway E
    - Runway 10R-28L at Taxiway D
    - Runway 10L-28R at Taxiway D

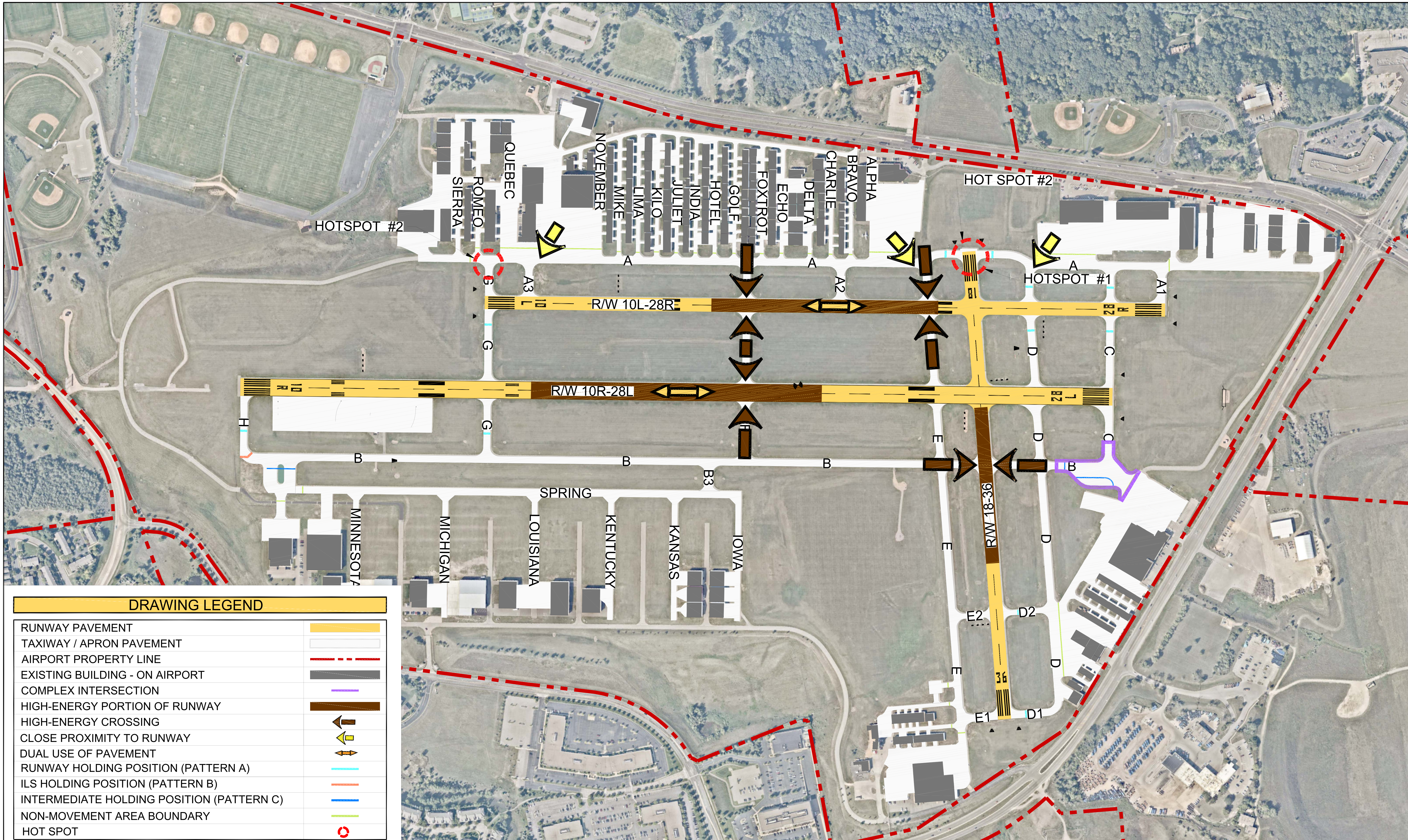
The angle of these crossings measures 85 degrees The current guidance in AC 150/5300-13B provides for the adjustment of the intersection angle to be within 15 degrees from a 90-degree angle when at the runway hold line when it is not practicable to achieve a 90-degree angle. Based on this guidance, the LTP does not propose taxiway geometric changes to address the acute-angled crossings.

From an incident history standpoint, there were no incidents at the Taxiway E crossing, one incident at the Taxiway B crossing due to an aircraft crossing the runway without authorization, and four incidents at the Taxiway D crossing. Three of the incidents were pilot deviations where pilots entered or crossed the runways without authorization and one incident was an operational incident where an aircraft was cleared for takeoff while a second aircraft was simultaneously cleared to taxi across Runway 10L-28R. The pilot deviation incidents are similar in nature to other pilot deviations one the airfield within the study period and are not necessarily attributed to the geometry at these crossings.

- **Acute-Angle Entrance** – Pilots approaching a runway at an acute angle have a reduced field of vision in one direction making it difficult to detect aircraft operating on the runway. An acute-angle entrance also increases pavement width at the intersection which can result in a loss of situational awareness resulting from visual cues being placed outside the pilot's field of vision. There is one location at FCM with an acute-angle entrance on Taxiway A at Runway 18-36, which is 85 degrees instead of 90 degrees.

Taxiway A at the Runway 18-36 intersection is identified as Hot Spot 2 due to the proximity of the aprons to the runway. Based on the current FAA guidance discussed above relative to deviation within 15 degrees from a 90-degree intersection, the LTP does not propose revisions to the taxiway geometry at this location. The pavement at the intersection does not widen, and there are enhanced taxiway centerlines, pattern A hold bars, runway hold position markings, and mandatory runway hold signs at the intersection, all of which serve to increase pilot situational awareness.

- **Complex Intersection** – Complex intersections may preclude the standard placement of signs, markings and lighting which can increase the probability of pilot error. Taxiway intersections should be designed to the "three-path concept" where a pilot has no more than three choices at an intersection – left, right, forward. There are no complex intersections at FCM.
- **Dual Use of Pavement** – Runways should be used solely as runways and taxiways should be used solely as taxiways, without mixing uses or dual purposes (i.e., a runway being used as a taxiway). At FCM, aircraft engine maintenance runups are sometimes conducted on Runway 10R-28L. The LTP evaluated locations for installation of a Ground Runup Enclosure (GRE) for engine maintenance runups so that they no longer occur on the runway. The alternatives evaluated are described in **Chapter 4.**



FCM

MAC — METROPOLITAN AIRPORTS COMMISSION — MINNEAPOLIS SAINT PAUL

FLYING CLOUD AIRPORT
2040 LONG-TERM PLAN (LTP) UPDATE

0 500' 1,000'

HNTB

FIGURE 3-6 SEPTEMBER 2025

GEOMETRIC CONTRIBUTORS

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3.8 Air Traffic Control Tower Line of Sight

ATCT personnel require an unobstructed view from the cab of the ATCT to all locations on the movement area, including runways, taxiways, and the non-movement area boundary lines. The ATCT cab should be located to provide a view to all points of the movement area and should preclude parked aircraft, buildings, and equipment from obstructing the controller's view. The existing ATCT at FCM is located on the south side of the airfield west of the approach end of Runway 36. From this location, it has been documented that the angle of incidence for controllers viewing aircraft on approach to the parallel runways, combined with the close spacing of the runways, results in controllers being unable to determine which runway aircraft are lined up on resulting in an increase of wrong surface landings. The close runway spacing, staggered thresholds, and inability of controllers to determine which runway aircraft are lined up on prior to short final has resulted in the FAA designating the approach ends of the parallel runways as Hot Spot 1. In March of 2022, MAC and the FAA completed a siting analysis for a proposed relocation of the ATCT. The siting study included a Safety Risk Management Panel (SRMP) and use of the FAA's virtual tower siting technology. The study resulted in a preferred location for a future ATCT which improves the controller viewing angle for aircraft on approach to the parallel runways, provides unobstructed views of the movement area, and allows for further development of on-airport land. The preferred location of the future ATCT is shown in **Figure 3.2**.

3.9 Hangar Requirements

Aircraft hangars provide aircraft storage and maintenance space protected from the environment. The existing hangars at FCM are a mix of single occupancy hangars, such as T-hangars, and conventional storage hangars capable of accommodating multiple aircraft types and sizes. Similarly, hangar ownership is a mix of individual and corporation ownership.

A general planning assumption for FCM is that 100% of the based aircraft fleet is hangar-based. This assumption is supported by a lack of tie down positions located at the airport and the desire to store an aircraft in a hangar during the winter months. As outlined in the Forecast, based aircraft at FCM is expected to grow within the forecast horizon from 333 to 354. In addition to the based fleet, FCM requires hangar space to accommodate itinerant aircraft. When evaluating existing and future hangar demand, the number of multiengine and jet aircraft was increased 25% to account for itinerant demand.

The existing hangar capacity was developed through feedback received from MAC Staff on the number of aircraft parked in certain hangars and an evaluation of each existing hangar and a general assumption of the number and type of aircraft parked in each hangar based on its location on the airfield. Once all existing hangars were occupied in this method, a count of the type of aircraft (single engine, multiengine, jet) was completed and then compared to the published based aircraft numbers. **Table 3-31** compares the LTP parked aircraft hangar count with published based aircraft data:

Table 3-31: Existing Hangar Demand

	SINGLE ENGINE	MULTI-ENGINE	JET	HELICOPTER
Hangar Inventory	258	48	38	6
Published Based Aircraft	263	34	30	6
Itinerant Increase	0	25%	25%	0
Existing Demand	263	43	38	6

Source: HNTB Analysis (Planning), FAA National Based Aircraft Inventory Program, June 30, 2021 (Published)

The hangar inventory was compared to the existing demand (published based aircraft + itinerant demand) to determine the existing surplus/deficit of hangars. The future demand surplus / deficit was determined by comparing the existing demand against the forecast demand from **Chapter 2**, which was increased similarly to the existing demand to account for itinerant multi-engine and jet needs, inclusive of a high level of demand for itinerant aircraft to be stored in a hangar during winter months. Other factors influencing hangar demand include current based aircraft owners desiring their own hangar, and pent up demand from non-FCM operators that currently cannot base at FCM due to ATCT line of sight challenges. The existing, midterm, and long-term demands and surplus/deficit are summarized in **Table 3-32.**

Table 3-32: Future Hangar Demand

	EXISTING				MIDTERM (2030)				LONG TERM (2040)			
	Single	Multi	Jet	Heli	Single	Multi	Jet	Heli	Single	Multi	Jet	Heli
Existing	258	48	38	6	258	48	38	6	258	48	38	6
Required	263	53	38	6	253	41	64	6	243	39	89	6
Surplus / (Deficit)	**(5)**	**5**	**0**	**0**	**5**	**7**	**(26)**	**0**	**15**	**9**	**(51)**	**0**

Source: HNTB Analysis and Flying Cloud LTP Forecast

The aviation forecast presented in **Chapter 2** predicts a decrease in the amount of based single engine aircraft and an increase in the number of based jet aircraft at FCM. As seen in the table above, as the number of based jet aircraft increases with time, a deficit of hangars capable of storing jets is realized, even with the drop in based single engine aircraft since larger hangars are required for jet aircraft and existing single engine hangars cannot simply be reconfigured for jet use. The LTP evaluated several hangar development alternatives which are presented and discussed in **Chapter 4**.

3.10 Fueling Facilities

There are two existing self-serve fueling facilities, both located in the southwest quadrant of the airport. One is adjacent to the Executive Aviation apron and the other is located adjacent to Taxiway D near the approach end of Runway 36. The FBO's onsite also maintain their own fuel tanks. Through the LTP process, it was observed that fuel deliveries are required nearly every day to keep up with demand, the existing storage tanks do not provide adequate storage capacity to meet the current demand, and that there is little or no room for expansion of the existing fuel storage, with operators often borrowing between each other to meet daily demand.

As the number of operations and based aircraft grows and existing tanks near the end of their lifecycles, a consolidated fuel farm is recommended at FCM. A consolidated fuel farm will provide a single point of access for fuel deliveries to the airport, a means of secondary containment in the case of leaks, and the opportunity for increased fuel storage capacity. **Chapter 4** presents consolidated fuel farm concepts at FCM.

3.11 Maintenance Run Up Location

As discussed in **Section 3.7.5**, aircraft requiring engine maintenance run ups often conduct such tests on the runways at FCM. The FAA has identified the dual use of runway pavement as an increased risk of runway incursions. Therefore, alternate locations for engine maintenance runups were evaluated. A ground runup enclosure (GRE) is a three-sided, open top structure which can accommodate aircraft performing high-powered engine maintenance run ups. GRE's are acoustically and aerodynamically designed to dampen the noise impact from engine maintenance runups. The locations evaluated for a GRE at FCM are presented in **Chapter 4**.

3.12 Holding Bays

FCM has two existing holding bays which can be used for temporary positioning of aircraft while they are waiting for IFR release. The hold bays are located on Taxiway B at the approach ends of Runway 10R and Runway 28L. In the Spring of 2023, MAC reconstructed and reconfigured the hold bay at the Runway 10R approach. The existing hold bay at the Runway 28L approach end only accommodates ADG I aircraft and does not provide clearance for a Group II aircraft to occupy the hold bay while a ADG II aircraft taxies on Taxiway B past the hold bay. A reconfigured hold bay accommodating ADG II aircraft is presented in **Chapter 4**.