APPENDIX B

RUNWAY 13-31 AIRCRAFT PERFORMANCE AND INSTRUMENT PROCEDURE CONSIDERATIONS

HIB Runway 13-31: Aircraft Performance and Instrument Procedure Considerations for the 2020/21 Master Plan

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1 Executive Summary

- **Takeoff Runway Length** The existing runway length of 6,758ft and both the location and orientation of the runway are suitable to ensure regular scheduled service within 1.5 hours flight time of HIB. Additional runway length will be necessary to support service to more distant destinations.
- **Payload capability** Current and future narrowbody or regional aircraft are not expected to be capable of non-stop service to markets beyond 4 hours flight time without payload restrictions, limited times of day for departure and/or seasonal service restrictions
- **Landing Runway Length, dry or wet runway** Landing on either runway 13 or 31 will not limit inbound payload capabilities unless wet or contaminated runway conditions are encountered
- **Landing Runway Length, contaminated runway** Contaminated landing distance requirements has degraded, and will continue to degrade, certain regional jets. Mitigating this restriction will require an increase in the landing distance available (LDA) on both runway directions
- **Landing thresholds** If the runway is extended, relocating one, or both, runway thresholds to match the physical extent of the runway will support all existing approach types and minimums
- **Runway Bearing Strength** The airport should immediately consider a rehabilitation plan to increase the reported PCN from its current level (33 F/C/X/T) to 50 F/C/X/T or a 45 F/B/X/T to avoid potential limitations on takeoff and landing weights for narrowbody (non-regional) aircraft.
- **Effectiveness of Existing Approaches** The existence of ILS on both ends of runway 13/31 provides a very high likelihood of the airport remaining open to arriving aircraft under IFR and Low IFR weather conditions.
- **ILS Ownership** In the event that MnDOT discontinues ownership and operation of the runway 13 ILS, we recommended that the airport consider either requesting the FAA to assume ownership of the ILS or for the airport to independently maintain the ILS under the Non-Federal NAVAID program.
- **Instrument Approach Enhancement runway 13 Glideslope** The current ILS approach to runway 13 has encountered challenges with respect to glideslope interference that could be resolved through the installation of a new GS or through potential enhancements to the GS critical area.
- **Instrument Approach Enhancement runway 13 Vegetative Obstacles** The latest obstacle survey has revealed certain vegetative obstacles to the northwest of the airport that will affect the current RNAV (GPS) Rwy 13 LNAV/VNAV approach minimums requiring either the airport to lower the tree heights or the FAA to adjust the existing approach procedure

- **Recommended Improvements**
    1. Eliminate or lower the vegetative obstructions northwest of the runway 13 approach end and coordinate with FAA to apply changes to obstacles in AIRNAV/OAS
    2. Improve the weight bearing capability of runway 13-31.
    3. Consider a runway length extension, to the south to achieve a physical length of 8,000ft
    4. Relocate the runway 31 landing threshold to the beginning of the new runway extension.
    5. Consider resolving the runway 13 glideslope equipment/critical area terrain deficiency
    6. Consider the addition of a DME to runway 31 followed by decommissioning of the corresponding Outer Marker

2 Objective of This Analysis

The objective of the analysis described in this document is to evaluate the current and future capabilities of runway 13-31, its supporting NAVAIDs, approach lighting and corresponding instrument approach procedures effectiveness to support regular, scheduled, air carrier service. This analysis will guide the Master Plan process when evaluating suitable airfield geometries and obstacle mitigation efforts.

The primary aircraft performance characteristics explored in this analysis involve the use of Monte Carlo simulation and statistical analysis methods to determine the likelihood of different aircraft types being able supporting daily scheduled flight operations over a 12-month period. These data are compliant with 14 CFR parts 25 & 121 certificated aircraft performance requirements. This includes an analysis of the takeoff declared distances, one engine inoperative obstacle clearance, and the effectiveness of instrument approach procedures and LDA based on historical weather conditions.

Additional threshold and NAVAID geometry characteristics were explored ensuring that existing instrument approach and departure procedure capabilities would be preserved across the range of threshold location options.

3 Data Restrictions

Monte Carlo methods are regularly used by aircraft performance and flight operations engineers to analyze disparate information into meaningful data for decision making and risk mitigation. Many domestic and international air carriers use Monte Carlo analysis methods to assist with complex tasks like forecasting payload availability on a route, establishing fuel forecasts for a period of time, or monitoring changes in aerodynamics and engine performance that are too subtle to identify on an individual flight.

This Monte Carlo analysis uses proprietary takeoff and flight planning performance information either provided by aircraft manufacturers or created by the aircraft operators themselves. This information is meant to be used by certificated aircraft operators with personnel who are trained to ensure that the data is never used for incorrect or unsafe purposes either by their own flight operation or by others who do not have the commercial rights or training to replicate the flight operation. This often means that the aircraft performance information used by airlines is not publicly available and must be protected when placed into a public setting like FAA airport planning, environmental analysis or design.

To ensure that any proprietary data shared by an aircraft operator in support of this analysis is kept away from unsafe or unapproved uses, the project team has taken two important steps.

The first step is to ensure that the ultimate results of a runway length analysis, using aircraft performance information, are intentionally obfuscated to achieve the following outcomes:

1. The results cannot be used meaningfully in any flight operation (commercial, private, experimental or otherwise)
2. The results cannot be meaningfully reverse-engineered to reveal detailed aircraft performance characteristics

Thus, low-speed and high-speed performance data obfuscation is achieved by displaying the results of the Monte Carlo analysis in terms of runway lengths necessary to achieve varying likelihoods of a target outcome rather than as a summation of discrete mission planning elements.

The second step is to protect the aircraft performance information provided by an aircraft operator in support of this analysis by only making the data available to FAA and Airport personnel associated with the Master Plan.

4 Acknowledgements

Given the importance of using accurate 14 CFR Parts 25 & 121 aircraft performance information in this Monte Carlo Analysis to determine the range of runway length extension options, the Range Regional Airport and Master Plan Project Team would like to acknowledge the significant contributions provided by American Airlines (AA) and their talented team of aircraft performance and flight operations engineers.

Special thanks to AA's Jay Leitner for his many hours of assistance running the thousands of takeoff performance calculations necessary to help deliver some of the critical inputs necessary to achieve this engineering analysis.

We also wish to acknowledge that the data provided by American Airlines is not an endorsement by American Airlines of the results of the Monte Carlo Analysis, nor does

their sharing performance data with the project team represent an endorsement of any particular recommendations in this analysis.

5 Overview of This Document

This document contains information about the inputs, methods, results and limitations associated with both the Monte Carlo analysis of aircraft performance and instrument procedure assessments used to further identify runway geometry limitations.

Below are several sections describing information that can be used by other stakeholders to consider the accuracy and validity of the methods and results.

Section 6 addresses the aeronautical and geospatial information used to establish baseline aircraft performance and instrument procedure conditions.

Section 7 addresses the airspace and instrument procedures that are currently in use at the airport, how they are anticipated to change following possible landing threshold relocations, and any resulting geometry or NAVAID limitations that may need to be considered.

Section 8 addresses historical weather information used as inputs to the Monte Carlo runway length analysis.

Section 9 identifies the aircraft flight operations and performance computations used as inputs to for the Monte Carlo runway length analysis.

Section 10 discusses the results of the Monte Carlo analysis used to determine potential runway lengths.

Section 11 is the detailed summary of the findings and any limitations.

6 Aeronautical and Geospatial Information

6.1 Baseline Information

Aeronautical and geospatial information was collected by LEAN through a combination of FAA maintained sources available to the public, and surveyed sources provided by the project team as a part of the update to the Masterplan and ALP. The following sections describe the information that was considered for both the instrument procedure assessment and Monte Carlo performance analysis.

6.1.1 Runways

HIB has two runways: runway 13-31 oriented northwest/southeast and runway 4-22 oriented southwest/northeast. Runway 13-31 is the primary runway at HIB and is supported by a full-length parallel taxiway with three entrance and exit taxiways.

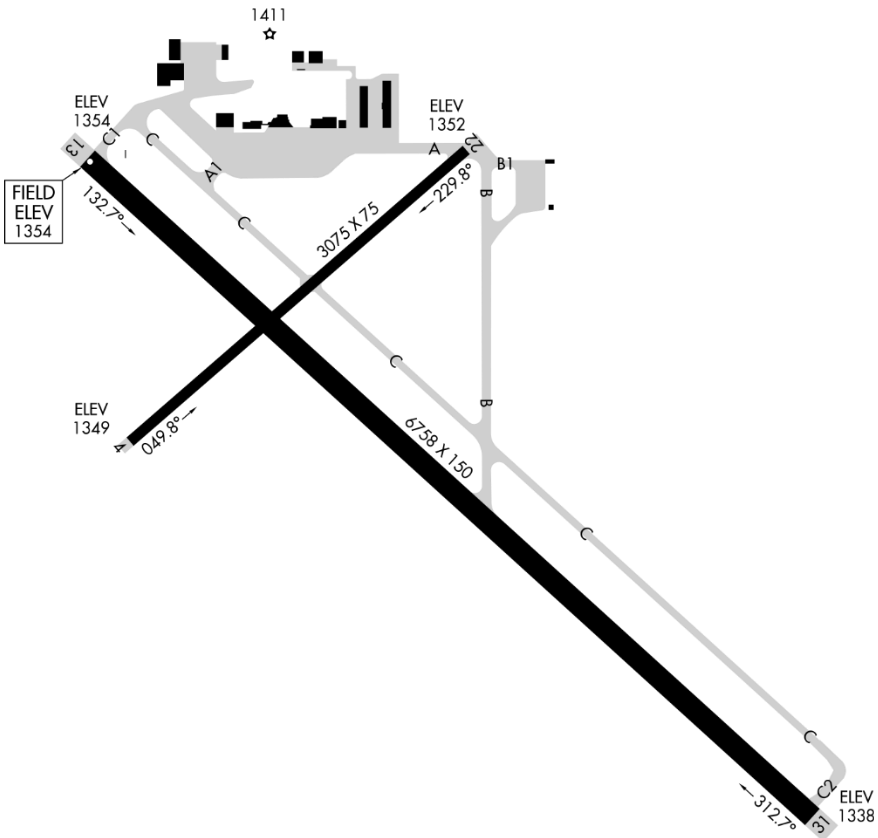

Figure 1 Current Airport Layout (FAA Airfield Diagram)

Despite the airport's status as a CFR 14 Part 139 certification as a class I airport, runway 4-22 is currently not listed as being available for use by "scheduled aircraft operations with more than 9 passenger seats" (FAA Chart Supplement). For detailed information about the runways, and their aeronautical properties, please see Table 1 below.

Table 1 Summary of Existing Declared Distances and Runway Properties at HIB

RWY	BR Elev. (ft. MSL)	DER Elev. (ft. MSL)	TORA (ft.)	TODA (ft.)	ASDA (ft.)	LDA (ft.)	Width (ft)	Entry Angle	PCN
13	1353.7	1338.2	6,758	6,758	6,758	6,758	150	90º	33 F/C/X/T
31	1338.2	1353.7							

All information was compiled from FAA eNASR during the 20MAY21 AIRAC and validated against AC-150-5300-18B VGA survey data collected in 2020. The column titled "BR Elev" refers to the Brake Release point on the runway, which is synonymous with the start of the declared takeoff distances. The DER refers to the departure end of the runway.

Runway 4-22 (3,075ft) is not considered in this analysis.

6.1.1.1 Runway 13-13 Declared Distances

As listed in Table 1, Runway 13-31 does not currently require the use of declared distances to satisfy standard AC-150-5300-13A design criteria.

6.1.1.2 Runway 13-31 Taxiways

Taxiway C is a parallel taxiway to runway 13-31 providing aircraft access to the full length of the runway using a standard 90-degree entry at C1 and C2.

One additional taxiway, Taxiway B, connects at roughly mid-field. Due to the relatively short length of runway 13-31, there is no anticipated usage of intersection departures for scheduled air carriers or large business jet operators. Similarly, there is no expectation for aircraft to come to a full stop landing before this taxiway. Therefore, for the purposes of this analysis, only full-length landing and takeoff will be considered as a part of the baseline operational capability assessment.

6.1.1.3 Runway 13-31 Elevation Profile

The overall elevation profile of runway 13-31 reflects the slope of terrain under the runway. Runway 13 shows a downhill slope of -0.23%, while the reciprocal runway 31 direction shows an uphill slope of 0.23%.

Aircraft performance calculations must account for runway slope. Operators commonly calculate slope between the brake release point (start of TORA/TODA) and the DER (usually the end of the TORA/TODA). This is referred to as a 100%, or full length, slope calculation. In situations where the physical runway profile exhibits significant undulations, or the physical profile dips below the elevation found by using only the starting and finishing elevations, then some aircraft operators may use a different slope calculation using a reduced portion of the runway length and elevation.

The detailed runway elevation profile can be seen in detail in Figure 2 below.

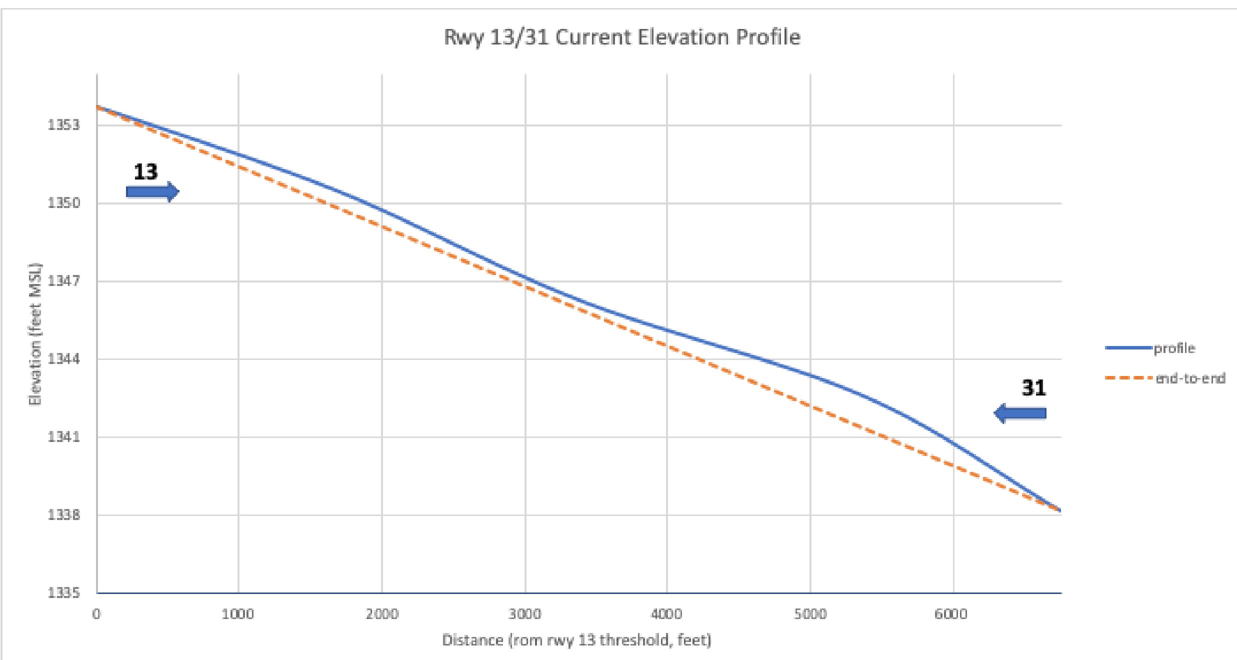

Figure 2 Runway 13-31 Elevation Profile

In Figure 2, the solid line represents the surveyed elevation profile of the runway, while the dashed line represents the 100% slope that would most likely be used for aircraft performance calculations.

For runway 13-31, the physical runway profile and the calculated slope are a relatively close match. This will not result in any adverse effects for obstacle clearance or performance calculations. The project team will therefore utilize the 100% slope calculation and assume that no aircraft operators currently flying into HIB would utilize an alternative slope calculation method.

6.1.1.4 Runway 13-31 Bearing Strength and PCN Limitations

The current reported pavement classification number (PCN) and general weight limitation published in the FAA Chart Supplement for HIB Runway 13-31 create potential limitations for large narrowbody aircraft.

The published PCN value of 33 F/C/X/T will significantly limit operations for 737-800 and A320 aircraft. Based on information from the manufacturers' Airport Planning Manuals, the 737-800 would be limited to 124,000lbs. takeoff weight, and the A320 would be limited to 128,500lbs. Those values are well below both the maximum takeoff weight and the expected typical operational takeoff and landing weights for both types. Even considering the occasional 10% PCN exceedance (specified in ICAO Annex 14), the maximum takeoff weights would only increase to 134,000 and 140,000 pounds, respectively, which are still well below the likely operational weights.

From a PCN point of view, the 737-800 is the more limited of the two types, and would require a PCN upgrade to 50 (assuming the C-level subgrade and flexible pavement remain in place) in order to accommodate the maximum takeoff weight. Conversely, if the subgrade could be upgraded to a B-level, the PCN would only need to be raised to 45. These limitations do not affect the smaller Embraer and Bombardier airplanes.

In the absence of an immediate solution to this problem, operators will likely either impose a runway weight bearing restriction on the calculated maximum allowable takeoff weight, or will be required to receive permission from the airport to operate at weights that would generate an ACN in excess of 10% over the PCN.

Additionally, the overall weight limitation published in the Chart Supplement for the runway is 100,000lbs for dual wheel aircraft. This would create an even greater restriction if that value is interpreted literally, eliminating virtually all narrowbody aircraft operations at HIB. However, because weight limitations are not considered by 14 CFR Part 121/135 operators when a PCN has been published by the airport, the direct weight limitation value is disregarded for this analysis.

If an opportunity arises to enhance the reported PCN via runway rehabilitation, this would mitigate possible operational weight restrictions.

6.1.2 NAVAIDs and Lighting

6.1.2.1 NAVAIDs

The following baseline NAVAIDs, identified in Table 2 were considered for runway 13-31. These NAVAIDs were used to evaluate instrument approach and departure procedures, as well as inform potential frangibility of existing obstacles and localizer critical areas.

Table 2 Existing NAVAIDs Supporting Runway 13-31

NAVAID Ident	Type	RWYs Served	Distance from LDG Threshold (ft.)	Offset from Rwy CL (ft.)	Elevation (ft. MSL)
I-JAE	Glideslope	13	952	400	1349.3
I-JAE	Localizer	13	7920	N/A	1335.2
I-HIB	Glideslope	31	1134	474	1340.0
I-HIB	Localizer	31	7797	N/A	1352.4
OM	NDB / Outer Marker	31	41,790	362	1311.2
HIB	VOR/DME	13 and 31	41.790	N/A	1311.5

All information in Table 2 was compiled from FAA eNASR during the 20MAY21 AIRAC, the FAA Flight Inspection Datasheet for the I-JAE ILS, FAA Flight Inspection Datasheet for the I-HIB ILS and validated against AC-150-5300-18B VGA survey data collected in 2020.

6.1.2.1.1 I-HIB ILS

The I-HIB ILS is an FAA owned and operated Mark 1F, with a 14 element V-Ring that utilizes a capture effect glideslope. The glideslope is sited to produce a 2.90 degree final approach angle with a TCH of 60ft. The standard angle for a glideslope is 3.00 degrees, but most aircraft are capable of flying an ILS approach with glideslopes as low as 2.75 degrees. Therefore, no modification is necessary to achieve the standard 3.00 degrees at this time.

The I-HIB ILS operates under performance class I/B meaning that it can produce ILS CAT I performance to at least 3,500ft prior to the threshold.

The current I-HIB glideslope is sited to a lower than standard angle to utilize the HIB VOR and co-located OM as the PFAF for the ILS or LOC approach. If the glideslope were to remain in its current location and be adjusted to produce a 3.00 degree glidepath, then the resulting TCH would increase to a value outside of the desired tolerances (TCH between 50 – 60 ft); the new angle of the glideslope would not result in an interception point at, or before crossing the OM.

The capture effect glideslope is currently sited to achieve a standard critical area that is 1300ft in length along the runway, as shown below in Figure 3.

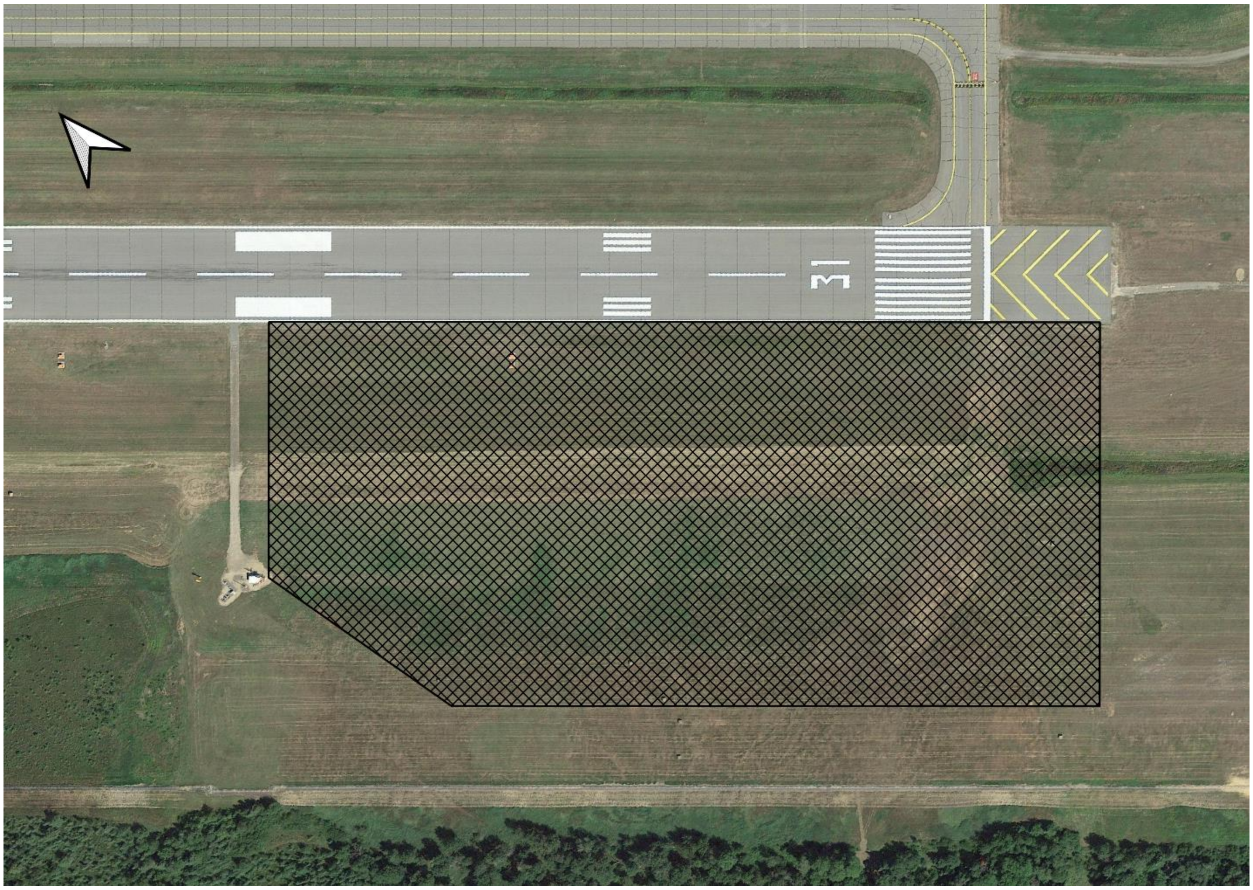

Figure 3 Runway 31 (I-HIB) Glideslope Critical Area Comparison

In Figure 3, the cross hatched area represents the current glideslope critical area. This area does not contain any terrain undulations, ground surface texture changes or man-made objects that could potentially affect the GS performance. This performance was further enhanced by the replacement of the previous VASIs with 4 light PAPIs located just behind (west) of the I-HIB GS.

The localizer currently supports a service volume of 18 nautical miles, enabling it to be the primary means of lateral navigation from the beginning of the approach to touchdown.

The localizer is sited 1039ft west of the physical end of runway 13 at a published elevation of 1352.4ft. At this elevation, the localizer achieves the necessary line of sight with the current ILS threshold crossing height (TCH) of 60ft.

The I-HIB ILS does not have dedicated distance measurement equipment, relying instead on the use of an outer marker and the HIB VOR to identify the beginning of the final approach course.

Status monitoring of the I-HIB ILS is performed by FAA SSC (based in Duluth) and Duluth TRACON. However, there is no requirement to monitor the ILS under 1B performance level. Therefore, ILS CAT I service 24/7/365 is assumed to be available unless NOTAM'd otherwise.

As of this analysis, there are no known issues with the ILS serving runway 31 relative to CAT IB performance and no restrictions on the flight procedures associated with the ILS.

6.1.2.1.2 I-JAE ILS

The I-JAE ILS is an MnDOT owned and operated ASII ILS, with an 8 element log-perf localizer and null-reference glideslope. The glideslope is sited to produce a standard 3.00 degree final approach angle with a TCH of 48ft.

Similar to the I-HIB ILS, the I-JAE ILS operated under performance class I/B. However, the glideslope is reported as unmonitored and FAA flight inspection has determined that the GS cannot be used by pilots as a part of a coupled approach (autopilot guided) below an altitude of 2388ft. This means that the current GS must be flown manually once the aircraft descends below approximately 2400ft MSL (or approximately 1100ft above the runway). The reason for the inability to use the glideslope below 2388ft MSL was not determined by LEAN. This kind of restriction is most often related to NAVAID performance issues discovered either during flight inspection or during real world operations and later verified by FAA flight inspection. We suspect 1 of 3 possible factors:

1) Non-standard terrain features in the GS critical area
2) Snow conditions that can degrade null-reference glideslope performance
3) Off airport interference issues created by undulating terrain west of the airport, starting along Barber Creek west of highway 37.

The null-reference glideslope is currently sited to achieve a standard critical area that is 2000ft in length along the runway and is shown below in Figure 4.

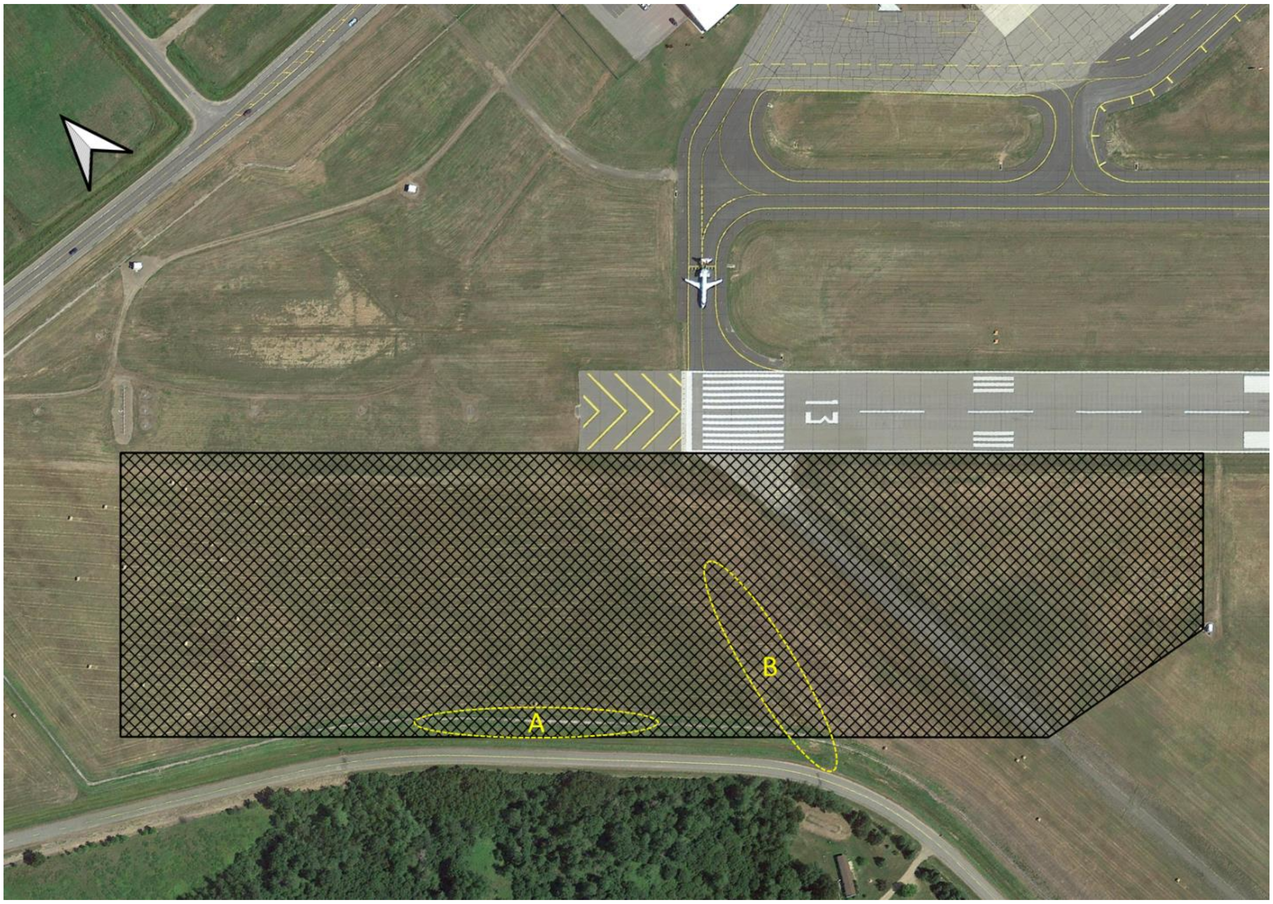

Figure 4 Runway 13 (I-JAE) Glideslope Critical Area

The larger critical area required for the I-JAE glideslope, when compared to the I-HIB glideslope, is related to the type of equipment installed. This larger critical area on runway 13 introduces two areas that could create performance challenges for the current, or future, glideslopes shown in Figure 4. Area A represents an area on the perimeter fence of the airport along S Dublin Rd where naturally occurring (or man-made) drainage ditches exist on the public side of the boundary. Area B represents what appears to be a natural, or man-made, depression that runs from the drainage area along S Dublin Rd, under the perimeter fence into the GS critical area.

On their own, both of these critical area challenges could be mitigated through flight test and equipment modification. However, given the established restriction for using GS coupled approaches below 1100ft HAR (2400 ft MSL), some benefit may be gained by improving the grading in this area.

The localizer has been sited 1,161ft east of the end of runway 31, at an elevation of 1335.2 ft MSL and provides a standard service volume of 18 nautical miles. At this location and elevation, the localizer also provides the necessary line of site for the 48ft TCH on the ILS CAT I approach.

The I-JAE ILS does not have dedicated distance measurement equipment, relying instead on the use of the HIB VOR/DME to create fixes along the approach.

Status monitoring of the I-JAE ILS is performed by MnDOT and Duluth TRACON. However, there is no requirement to monitor the ILS under 1B performance level; ILS CAT I service 24/7/365 is assumed to be available unless NOTAM'd otherwise.

6.1.2.1.3 Resolving the I-HIB and I-JAE Similar Frequency Issue

As of July 2021, both the I-HIB and I-JAE system are being modified to upgrade power and communications. The modifications are intended to fix a frequency interference issue that occurs when both the I-HIB and I-JAE are operating at the same time. Because both ILS utilize adjacent frequencies (I-JAE 110.5 vs I-HIB 109.5), when both NAVAIDs are broadcasting aircraft have encountered challenges remaining coupled to the desired ILS.

The historical solution to the challenge of adjacent frequencies has been to utilize an FAA-installed interlock controller to ensure that only one ILS radiated and transmitted at a time. In the absence of a local ATCT, the interlock control and ILS activation are controlled by Duluth TRACON via a FOTS loop connected to a cellular network. While this has been a workable solution for FAA and MnDOT for several years, pilots were required to heed an unusual chart note on FAA ILS instrument approach procedures stating:

- "Contact Duluth Approach Control to activate ILS"

The resolution to this anomaly will involve upgrading communication capabilities (fiber-optic replaces copper lines) and a change in the frequency for one of the two ILS to eliminate the interference issues.

6.1.2.2 Lighting

The following baseline runway, approach lighting and VGSI, identified in Table 3, were considered for runway 13-31. Approach lighting elements were used to examine instrument approach and departure procedures, as well as inform potential frangibility and lightplane protection areas.

Table 3 Existing Approach Lighting Elements Supporting Runway 13-31

RWY	Lighting	Type	Length (ft.)	Elevation (ft. MSL)	Slope / TCH (ft. AGL)
13	ALS	MALSR	2,400	1374.7 *	N/A
31				1340.8 *	N/A
13	VGSI	PAPI (4L)	969.7	1348.8 **	3.00 / 50
31			1165.4	1338.8 **	2.90 / 62

* Elevation listed is for the final light station of the MALSR

**Elevation listed is the average elevation between the light housing assemblies

All information in Table 3 was compiled from FAA eNASR during the 20MAY21 AIRAC and validated against AC-150-5300-18B VGA survey data collected in 2020.

In addition to the information listed in table 3, runway 13-31 is supported by high intensity runway edge lighting, which could support both current and lower-minimum ILS operations. Both the runway edge lights and MALSRs are activated by pilot controlled lighting.

Both runway directions are served by 4-box Precision Approach Path Indicators (PAPIs) which remain active 24/7/365.

6.1.3 Obstacles and Terrain

6.1.3.1 Overall Obstacles

Obstacle information considered in this analysis originated from a combination of FAA and airport/project team sources intended to cover a 50 nmi area surrounding the HIB airport. This included obstacle information specific to HIB and other obstacle information in the vicinity of the airport as seen in Figure 5 below.

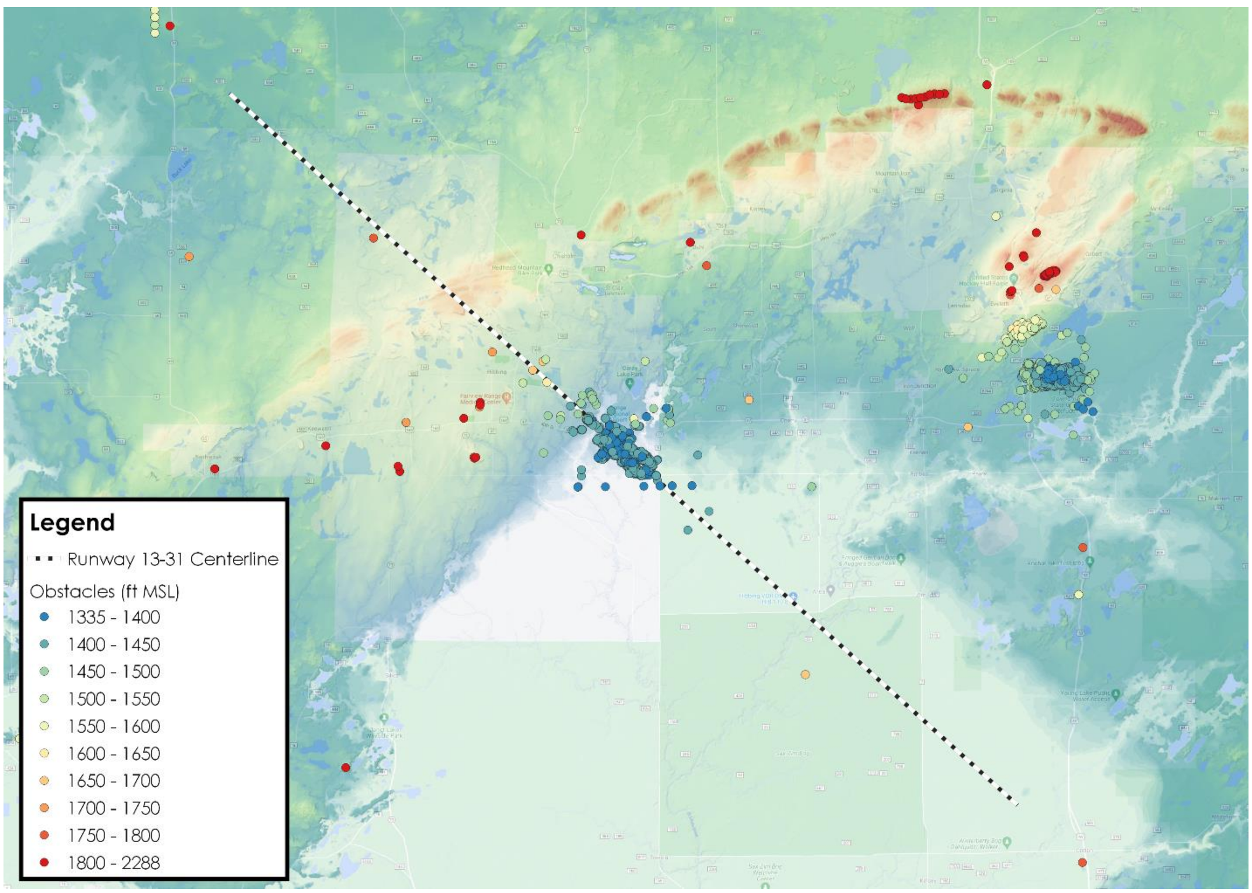

Figure 5 Obstructions and Terrain Considered for HIB (Only values higher than the runway threshold elevations shown)

The first source used to gather existing obstacle information in the vicinity of the airport was the FAA Obstacle Authoritative Source, which was accessed via the FAA AIRNAV download available from the Aeronautical Data Information Portal (ADIP). This data was obtained using a radius-based search for obstacles information located within 15 nmi of HIB.

Obstacles in AIRNAV represent a combination of previous AC-150-5300-18B compliant obstacle surveys, surveys performed for airport surface clearance and FAA flight inspection obstacles. Obstacles obtained from this source contain FAA assigned accuracy values which introduce a horizontal and vertical uncertainty that translates an obstacle referenced using WGS-84 coordinates to define a point with an elevation, into a 3 dimensional cylindrical shape. The uncertainty associated with the accuracy of cylinder must be considered for instrument procedure design, but is often not required (or considered) for airport planning surfaces, airspace protection surfaces or one engine inoperative calculations performed by 14 CFR 121 and 135 aircraft operators.

For aircraft performance calculations, the obstacles available in AIRNAV are considered to be both known to airlines and currently considered when determining limiting takeoff weights, ultimately influencing payload range decisions.

The second source used for this project were specific AC-150-5300-18B and NOAA 405 specification surveys. These were also downloaded from FAA ADIP and overlaid on top of the AIRNAV obstacles. In cases where the previous survey identified a point that was in the same latitude and longitude as current AIRNAV/OAS obstacle, then the elevation and accuracy of the AIRNAV/OAS obstacle was used. However, there exist certain supplemental object information contained in previous surveys which were not submitted to the FAA as obstacles through the Airports GIS process. These objects were considered to be valid unless a scan of aerial imagery, or feedback from the project team, indicated that the object was no longer valid or had been removed or relocated.

In addition to the previous obstacle surveys, the Masterplan team contracted for an updated obstacle survey to be performed. This survey revealed several hundred additional obstacles with the same horizontal and vertical accuracy of 1A (3 ft vertical, 20ft horizontal) as previous surveys.

As of July 2021, the new obstacle survey has been directly accepted into AIRNAV/OAS and replaced all previously known obstacle information.

The final obstacle source considered in this analysis was the obstacle information available from the FAA Obstacle Evaluation and Airport Airspace Analysis (OEAAA) website. Determined OE cases, which represent proposed structures off of the airport, and determined NRA cases, which represent proposed projects and structures on the airport, were collected from 2018 to Q1 2021 and evaluated. Any determined obstacle that would result in a structure which could affect instrument procedures or aircraft performance was considered to exist today. The only exceptions were cases where the OE was seen to either be temporary, and not resulting in a new structure after the temporary action was completed, or cases where an NRA identified a temporary project on the airfield.

Proposed obstructions are assigned an accuracy of 4D (50 ft vertical accuracy, 250ft horizontal accuracy). This is likely both larger and taller than the accuracy values that will be determined by survey following the construction of the structure. However, proposed objects which are determined by the FAA to have no substantial impact on the surrounding airspace often do not receive an updated survey definition following the OE review.

Terrain information was sourced from USGS 3DEP at a 30m – 90m spacing across the 50 nautical mile (nm) area surrounding HIB. On top of this information a 100 ft. vegetative allowance was applied for aircraft performance considerations. FAA required 200 ft. Adverse Assumption Obstacle values were also applied to all terrain points outside of the HIB VGA collection extents.

The terrain surrounding the airport is not significant enough to require mountainous terrain considerations for instrument procedure design on either runway 13 or runway 31.

Runway 13-31 is oriented in such a way that requires aircraft departing on runway 31 fly over terrain features associated with the Hull-Rust-Mahoning Mine northwest of the airport. The terrain in this area rises to approximately 500ft above the airport elevation.

Additional terrain north and east of the airport is encountered along the Mesabi Range but which does not pose a challenge to flights arriving or departing runway 13-31.

The highest terrain point located within 100 nmi of HIB is Pike Mountain at 1,950ft MSL, however the tallest obstacle in the vicinity are windmills near Pike Mountain that reach approximately 2,300ft MSL.

6.1.3.2 Obstacle and Terrain Considerations: Runway 13

The following figures, located in Appendix 1, depict the obstacles that were considered for one engine inoperative (OEI) takeoff performance calculations from runway 13 used in the Monte Carlo analysis.

Runway 13
FAA AREA OEA, Close-In

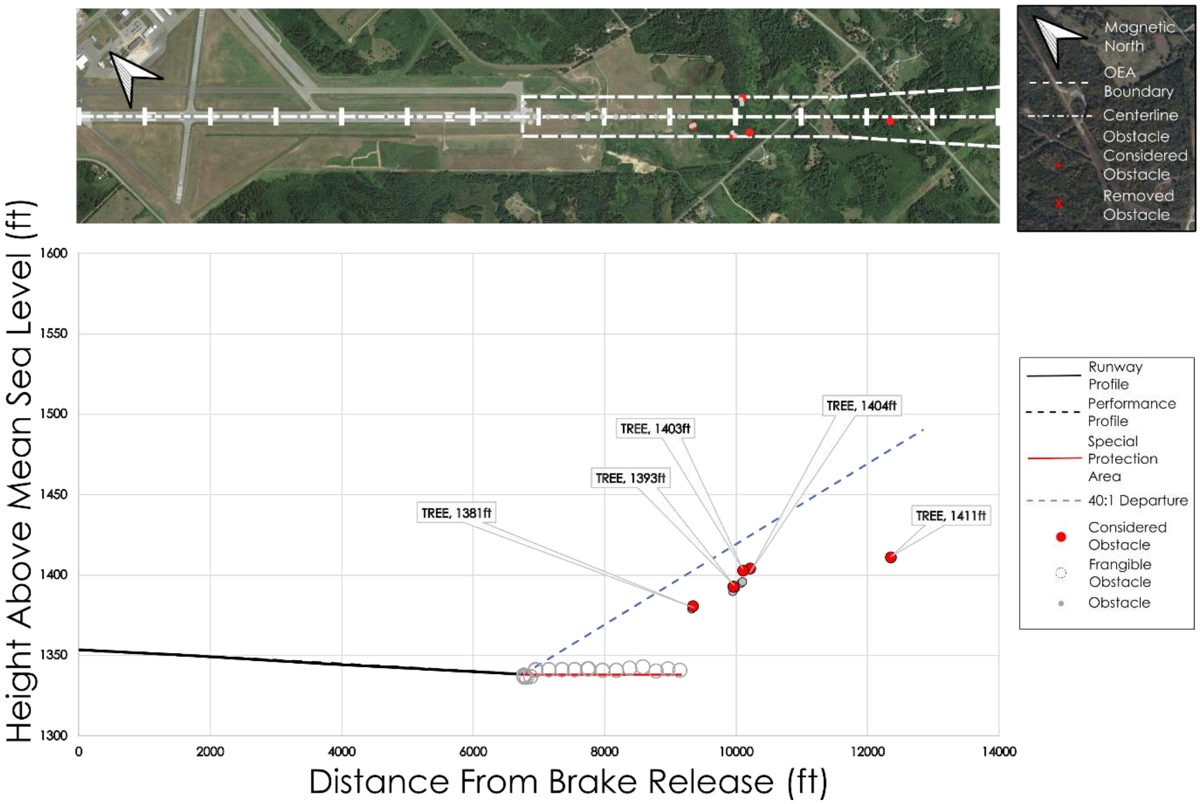

Figure 6 Rwy 13 Close-In OEI Considerations

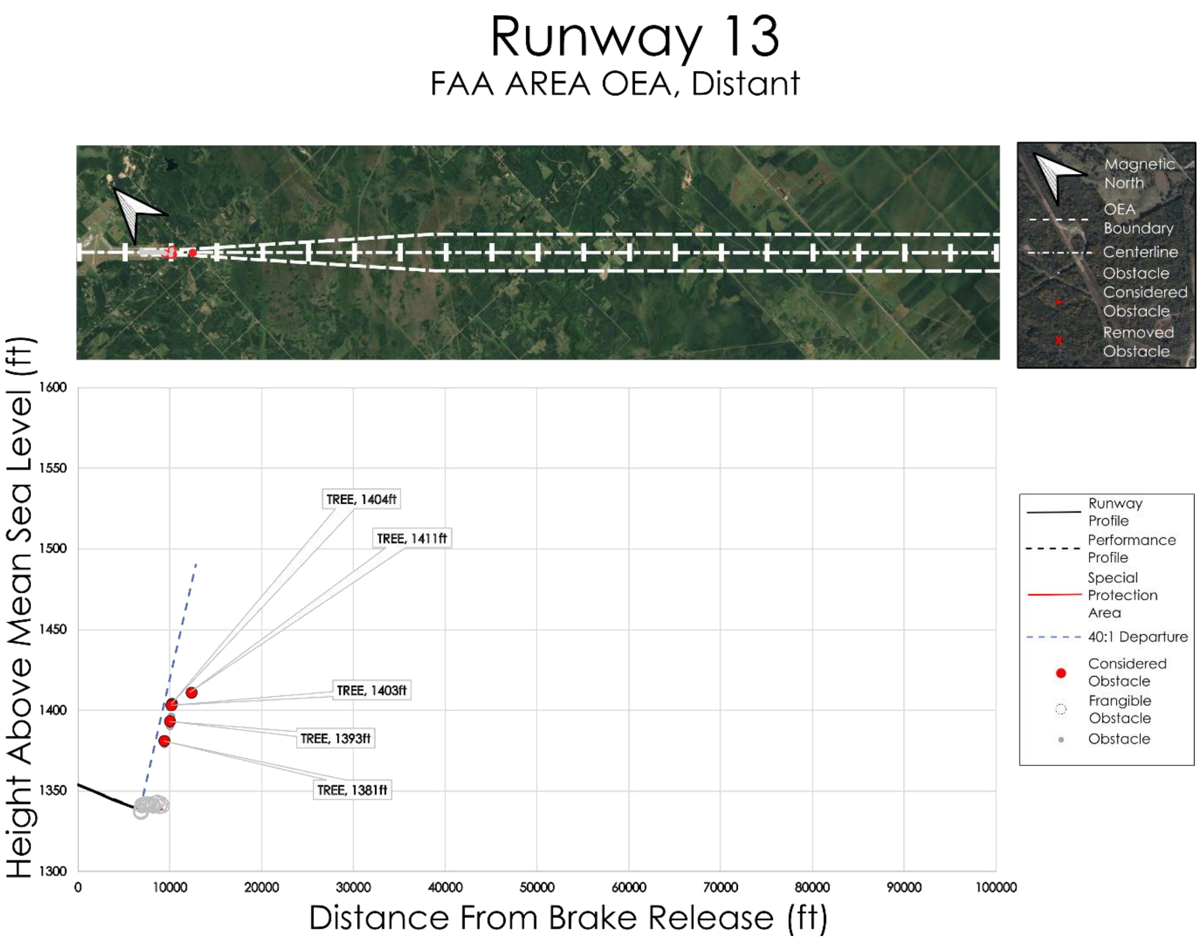

Figure 7 Rwy 13 Distance OEI Considerations

Obstacles considered for OEI takeoff performance were identified using the FAA AC-120-91A Area Analysis Method. The project team created one engine inoperative departure procedures (OEI DP) which represent the most likely solutions for both current and future aircraft operators. The procedure utilizes the standard method of climbing on runway heading until reaching an operator determined safe altitude, which is assumed to be 1,500ft AFE (Approximately 2,900ft MSL).

In accordance with current industry practice, the obstacles identified in the OEI DP were used without the application of any obstacle accuracy. Any terrain values encountered included the application of a 100ft additive to account for the possibility of vegetation or other, un-surveyed, land cover.

6.1.3.3 Obstacle and Terrain Considerations: Runway 31

The following figures depict the obstacles that were considered for one engine inoperative takeoff performance calculations from runway 31 used in the Monte Carlo analysis.

Runway 31
FAA AREA OEA, Close-In

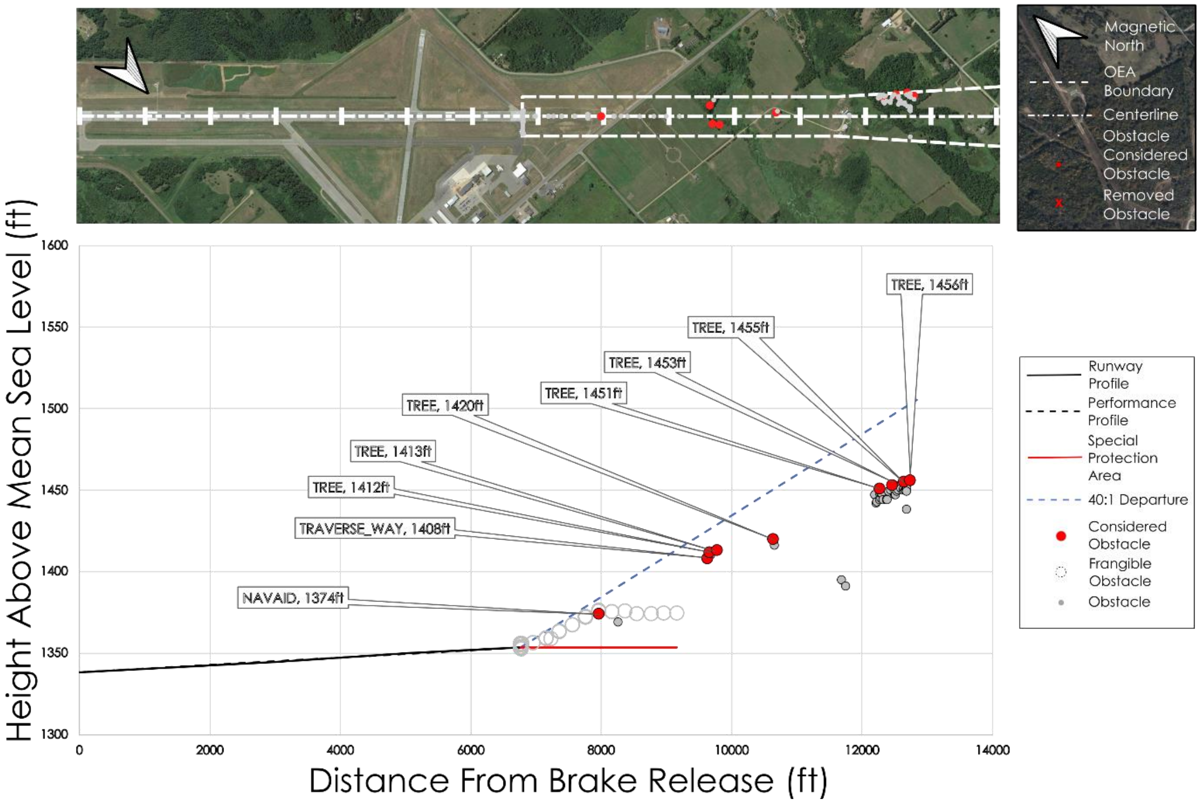

Figure 8 Rwy 31 Close-In OEI Obstacle Considerations

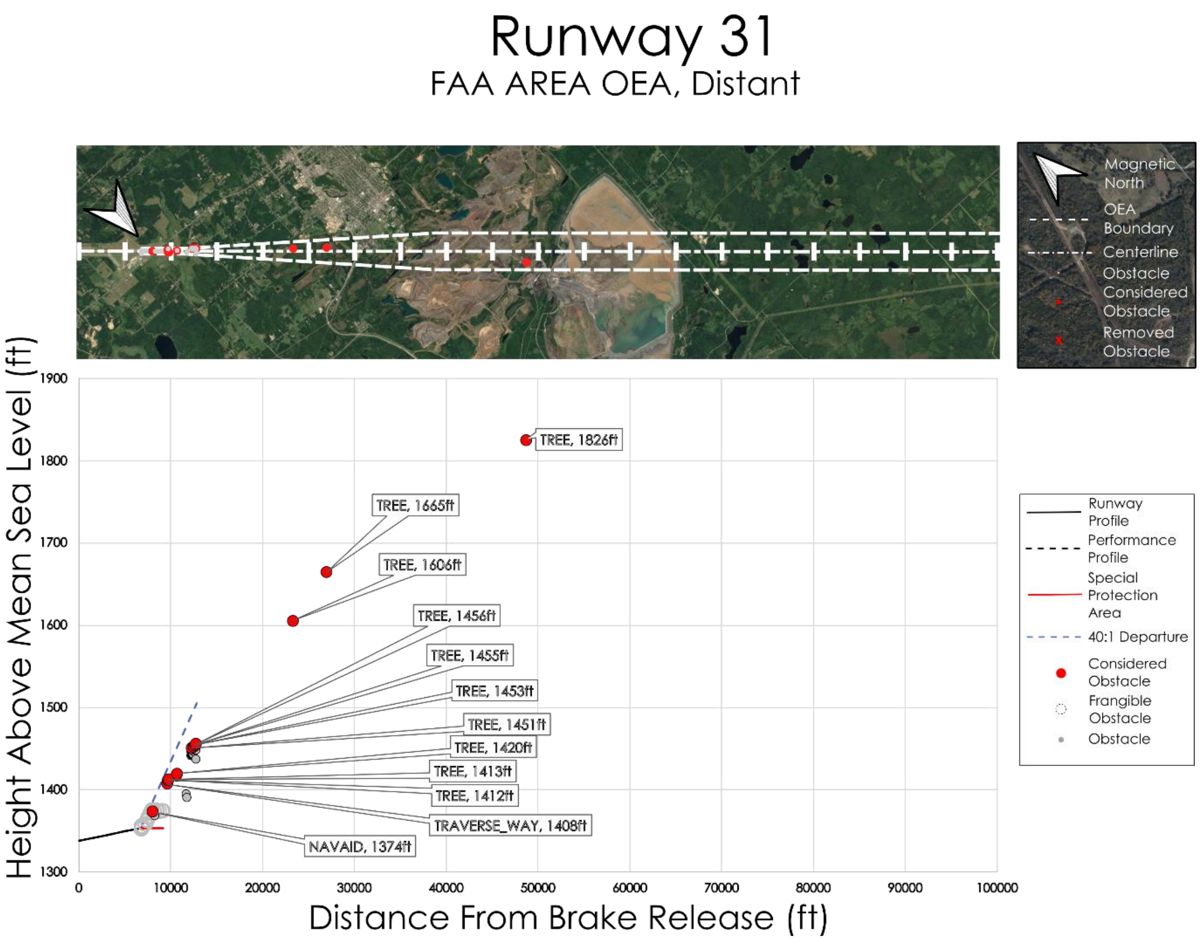

Figure 9 Rwy 31 Distance OEI Obstacle Considerations

Similar to runway 13, runway 31 takeoff performance utilized a basic one engine inoperative departure procedure. While this will take aircraft directly over the top of the hills associated with the mining operation, the distance to the terrain (and relatively sparse vegetative coverage) do not create a significant impact on takeoff performance and thus it was assumed that no air carriers would utilize an alternative OEI procedure.

6.2 Extension of Runway 13-31

To determine the required runway length necessary to satisfy current, and future, aircraft operations at HIB, we examined a potential extension to the existing runway beyond its current length of 6,758 ft. The following section describes how a possible runway extension was considered for the purposes of evaluating aircraft performance (for input into the Monte Carlo Simulations) and evaluating any potential changes to instrument procedures and associated NAVAIDs.

6.2.1 Runway Threshold Locations

The primary change in the runway considered in this analysis was to extend runway 13-31 to the southeast up to a maximum analyzed length of 8,000ft. This would involve the relocation of the runway 31 landing threshold to be co-located with the physical end of the extended runway. A possible layout of the airfield, showing the area of runway 13-31 that was considered for extension can be seen in Figure 10. A detailed elevation profile of the resulting runway, performance profile and threshold locations can be seen in Figure 11.

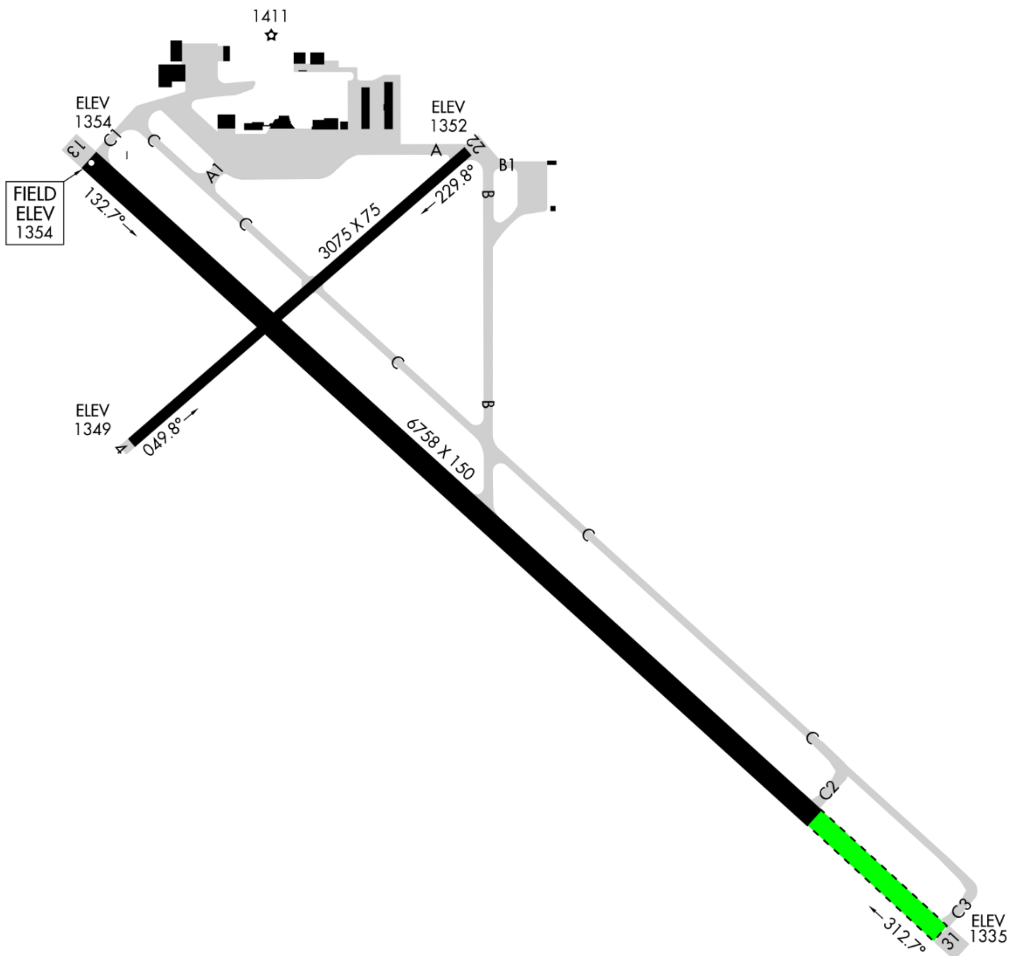

Figure 10 Area of Possible Runway Extension Considered for Runway Length Determination and Instrument Procedure Effects (Green)

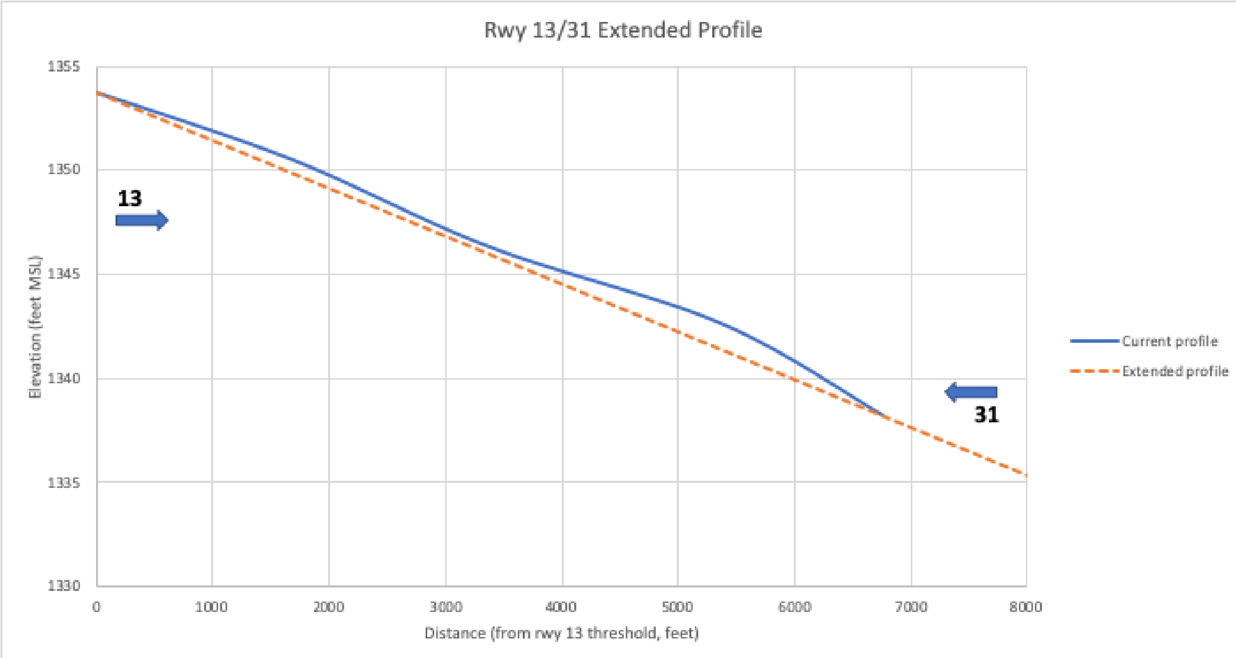

Figure 11 Elevation Profile of Runway 13-31 following an extension to the Southeast

Table 4 shows the runway lengths which were used for evaluating aircraft performance and instrument procedure impacts following the threshold relocations.

Table 4 Runway Characteristics and Declared Distance Combinations Considered for Extension of Runway 13-31 LDAs

RWY	BR Elev. (ft. MSL)	DER Elev. (ft. MSL)	TORA (ft.)	TODA (ft.)	ASDA (ft.)	LDA (ft.)	Entry Angle	PCN
13	1353.7	1335.4	8,000	8,000	8,000	8,000	90°	50 F/C/X/T
31	1335.4	1353.7						

The runway 31 BR Elevation assumes a constant slope beyond the existing runway at the same value as the current 100% runway slope. The PCN value is assumed to increase to a value that will accommodate maximum structural takeoff weights for the 737-800 and A320 aircraft.

While not listed in Table 4, several incremental runway length extensions were considered for takeoff performance evaluation purposes between the current physical length of 6,758 and 8,000ft. Each incremental runway extension was considered as an additional 250ft added to the southeast direction, extended along the same slope shown in Figure 11. This resulted in discrete takeoff performance results at 7,000, 7,250, 7,500, 7,750 and 8,000ft.

6.2.2 NAVAIDs and Lighting

The potential extension of runway 13-31 would also require relocation of the runway 13 localizer, runway 31 glideslope, runway 31 PAPI and runway 31approach lighting system

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(ALS) components to positions that would support existing instrument procedure capabilities on both runways.

6.2.2.1 NAVAIDs

Table 5 describes the assumptions regarding the primary NAVAIDs following the proposed threshold relocation to match the maximum extended runway length of 8,000ft.

Table 5 NAVAID Locations Considered During Runway 31 Threshold Relocation to 8,000ft

NAVAID Ident	Type	RWYs Served	Distance From LDG Threshold (ft.)	Offset From Rwy CL (ft.)	Elevation (ft. MSL)
I-JAE	Glideslope	13	952	400	1349.3
I-JAE	Localizer	13	9,162	N/A	1332
I-HIB	Glideslope	31	1,005	474	1337
I-HIB	Localizer	31	9,039	N/A	1352.4
OM	NDB / Outer Marker	Eliminate and replace with airport ILS DME			

*Distance and elevation are approximate position of the glideslope relative to the threshold

Runway extensions between 6,758ft and 8,000ft would each yield unique location of the NAVAIDs not listed above. However, the instrument procedure feasibility performed for this project focused on a single value for the maximum possible runway extension (8,000ft). No additional NAVIAD combinations were considered.

6.2.2.1.1 I-HIB Glideslope and I-JAE Localizer Location

To support the relocation of the runway 31 threshold, two NAVAID location changes are necessary. The first change is that the I-HIB glideslope (GS) will need to shift to the southeast and be sited at point 1,005 ft. from the relocated threshold of runway 31. A similar centerline offset of 474ft could be maintained even though reducing centerline separation would likely be successful to as close as 400ft. The resulting GS antennae base elevation was tentatively considered at an elevation of 1337ft MSL. At this location, the estimated TCH for the GS would still be within the design limits for ILS CAT I (or CAT II) service of 55ft and the glideslope would yield a standard 3.00 degree glidepath rather than the current 2.90 value.

In addition to the I-HIB localizer, serving approaches to runway 31, the I-JAE localizer serving approaches to runway 13 would need to be relocated to keep the NAVAID out of the standard runway safety area. For the purposes of this analysis, the I-JAE localizer was considered to maintain its existing offset from runway 31 of 1,162 ft, placing it at a potential elevation of 1332ft MSL. At this location, the localizer would still have a clear line of site to the existing 49ft TCH and ILS CAT I decision altitude points requiring no additional elevation of the antenna array.

Both the critical area for the I-JAE localizer and I-HIB glideslope would not require any special modifications or considerations beyond those that would already be addressed by ROFA/RSA design for an extension of a runway in compliance with AC-150-5300-13A.

6.2.2.1.2 Rwy 31 ILS OM

Runway extensions to the southeast will most likely create one of three situations for the current Outer Marker serving the runway 31 ILS approach:

1) The outer marker will need to be relocated to the southeast, further from the current HIB VOR location.
2) The glideslope angle will need to be lowered below an angle of 2.90 degrees
3) The outer marker will need to be decommissioned and a new DME will be added to the ILS.

Due to the decreasing inventory of outer marker/NDB components across the NAS, combined with a general preference by the FAA to utilize DME (or RNAV where possible) the relocation of the outer marker would not likely be an approved expense. This is due to the increased separation between the OM and the HIB VOR would result in only one of those two NAVAIDs being usable as a PFAF reference point. Because the HIB VOR is already a critical component in the procedure, relocating the OM would not likely be a desirable solution, leading the FAA to focus on option 2 or 3.

Option 2, lowering the glideslope angle following the relocation, would only occur if the FAA felt it was important to keep the outer marker in its current location. However, lowering the glideslope has the potential risk of decreasing performance, especially during snow events which are common at HIB. The glideslope would likely need to be reduced to an angle of approximately 2.83 degrees (if the runway were to be extended to 8,000ft) which may also reduce the overall usability of the ILS approach procedure.

Option 3 therefore seems the most likely option for FAA consideration. This would involve the removal of the OM and the addition of an ILS/DME located close to the I-HIB LOC near the existing FAA shelter located 275ft offset from the runway centerline.

6.2.2.2 Lighting

The following approach lighting and VGSI, identified in Table 6, were considered for runway 13-31 following the runway extension to the southeast. Approach lighting elements were used to examine instrument approach and departure procedures, as well as inform potential frangibility and lightplane protection areas.

Table 6 Approach Lighting Locations Considered During Runway 13-31 Threshold Relocation

RWY	Lighting	Type	Length (ft.)	Elevation (ft. MSL)	Slope / TCH (ft. AGL)
13	ALS	MALSR	2,400	1374.7 *	N/A
31		MALSR		1337.8 *	N/A
13	VGSI	PAPI (4L)	969.7	1348.8 **	3.00 / 50
31			1305	1336 **	3.00 / 65

Table 6 includes a reference to a modified PAPI on runway 31to match an anticipated glideslope update to 3.00. The resulting PAPI location would enable a standard siting, 300ft behind the glideslope and would yield a TCH of 65ft.

6.2.3 Obstacles and Terrain

6.2.3.1 Obstruction Removal

The current assumption for obstruction clearance that would accompany a runway extension to the southeast involves the design of any future runway 31 approach threshold or runway 13 departure end to clear obstructions that penetrate the following surfaces in order of priority:

1. A standard RSA/ROFA
2. A 1000 ft. long LOC Critical Area
3. A 2400ft MALSR lightplane
4. Current AC-150-5300-13A described 40:1 Departure Surface updated to match EB-99A

Based on the current results of the instrument procedure analysis conducted in Section 7.2, the surfaces described by 1. – 4. above will be controlling for the proposed runway extension.

6.2.3.2 Terrain Changes

There are no significant changes in terrain considered for a possible extension of runway 13-31.

7 Airspace and Instrument Procedures

7.1 Airspace/Air Traffic Control

The Hibbing Range Regional airport is a non-towered facility located in class E airspace. See Figure 12 for the current image of the FAA Sectional which includes HIB.

The airport has a unique relationship with the Duluth Tower/Approach Control facility whereby Duluth Approach Control is available to provide approach vectors and monitors NAVAID status. Duluth Tower/Approach Control also provides departure clearances either through radio contact (assisted by an RCOG on the airfield) or through calling the clearance delivery service directly. The area in which Duluth Approach Control/Tower provide services can be seen in Figure 13, in the hatched area. Within that airspace, which includes the Eveleth-Virginia Airport (EVM/KEVM), DLH Approach control provides air traffic services from ground to 8,000ft. Above that altitude, or outside of the cross hatched area, primary air traffic responsibility generally rests with Minneapolis Center (ZMP).

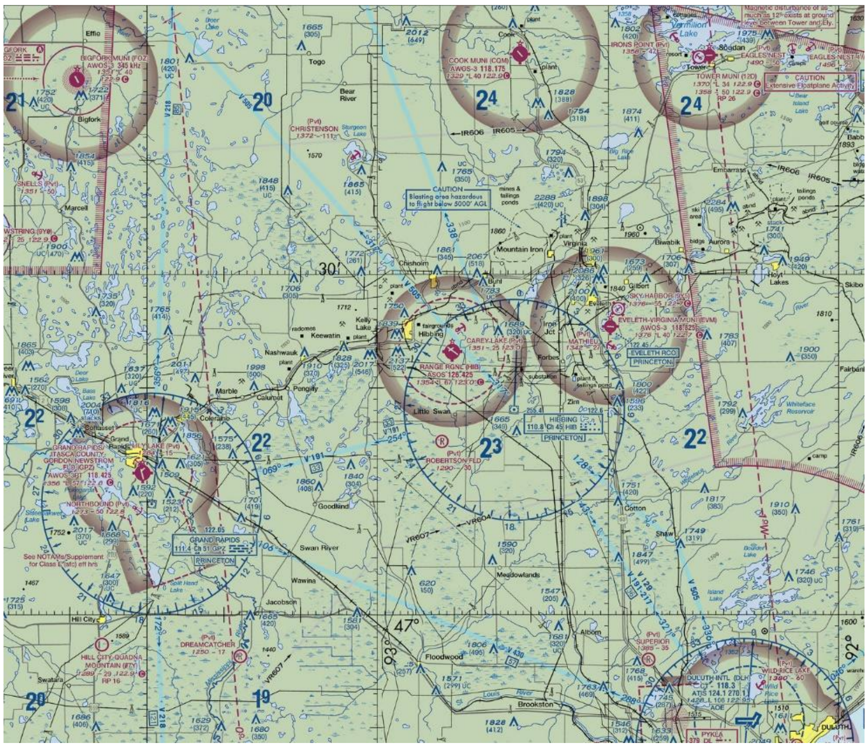


Figure 12 Image of FAA Sectional Chart Depicting Airspace Classes Surrounding HIB

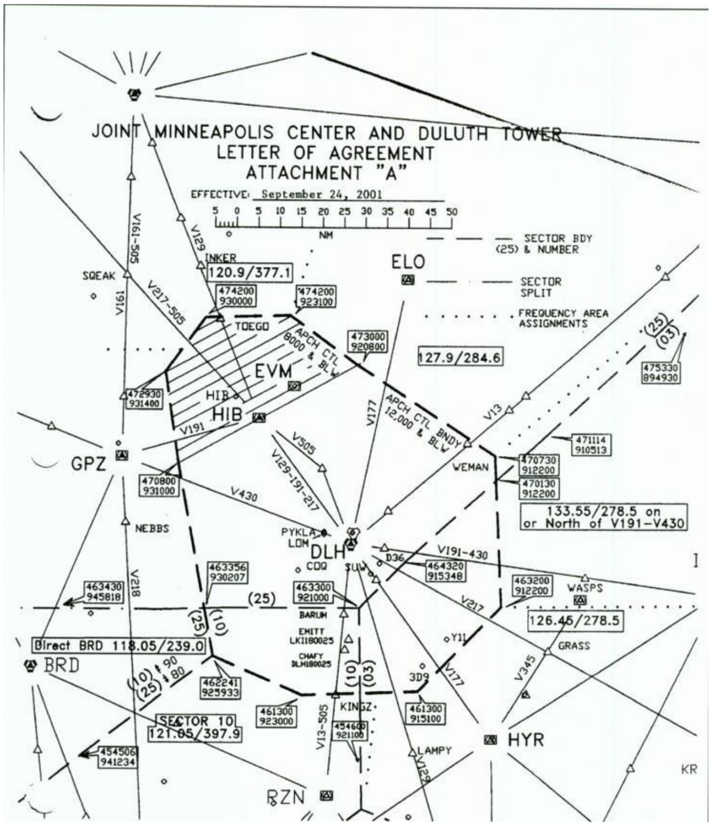


Figure 13 Image from ZMP and DLH Tower Depicting Shared Control Responsibility for HIB (Hashed Area)

The absence of a local air traffic control tower prohibits certain advanced instrument approach and departure procedures from being considered at HIB including RNP-AR departures as well as SA CAT II, CAT II and CAT III approaches. However, the presence of approach control supported by radar vectors, does permit the opportunity for RNAV to xLS, A-RNP and RNP-AR should these procedures become feasible or necessary in the future.

7.1.1 Air Traffic Selection for Monte Carlo Analysis

From the perspective of modeling air traffic influence in any Monte Carlo Level simulations for the determination of runway length availability, no ATC preference will be given to runway 13 over 31.

7.2 Existing Instrument Procedures

7.2.1 Arrivals

HIB is not currently supported by any published Standard Terminal Arrival Procedures (STARs) instead relying on approach control services described in the previous section.

At this time, the overall frequency of operations and the nature of flight operations activity on the airfield do not suggest that there is a need to introduce STARs. Therefore, no further analysis was undertaken for the development of STARs in this report.

7.2.2 Approaches to Rwy 13

HIB is currently served by two instrument approach procedures to runway 13, each of which utilize different methods of navigation. These approaches are published by the FAA either on independent approach plates or combined together on a single approach plate. The approaches to runway 11 are summarized as follows:

Table 7 Instrument Approach Options to Rwy 13

Procedure Name	Owner	Amendment, Date	Type	CAT C/D Decision Height (ft)	CAT C/D Visibility (Miles)	NAV Requirements
ILS or LOC/DME Rwy 13	FAA	1A, 26JUN14	ILS CAT I / Precision Approach	200	1/2	I-JAE ILS and HIB DME
ILS or LOC/DME Rwy 13	FAA	1A, 26JUN14	LOC / DME Non-Precision Approach	706	1 1/2 - C 1 3/4 - D	I-JAE LOC and HIB DME
ILS or LOC/DME Rwy 13	FAA	1A, 26JUN14	Circling (with or without Stepdown)	706	1 1/2 - D 2 – D	I-JAE LOC and HIB DME
RNAV (GPS) Rwy 13	FAA	1C 17JUN21	LPV	250	3/4	WAAS
RNAV (GPS) Rwy 13	FAA	1C 17JUN21	LNAV/VNAV	260	3/4	VNAV
RNAV (GPS) Rwy 13	FAA	1C 17JUN21	LNAV	446	7/8	
RNAV (GPS) Rwy 13	FAA	1C 17JUN21	Circling	486 – C 606 - D	1 1/2 - C 2 - D	

7.2.2.1 ILS or LOC/DME RWY 13

The primary approach to runway 13 is the ILS or LOC/DME Rwy 13 approach, Amendment 1A, last revised on 26JUN14. Even though I-JAE is owned and operated by MnDOT, this is an FAA published precision approach procedure to runway 13 utilizing the I-JAE localizer and glideslope. It is capable of providing standard Category I approach minimums to a decision height of 200ft and a visibility of ½ mile. In the event that the MALSR is inoperative, then the visibility will increase to ¾ mile.

The same instrument approach procedure also supports a localizer only method of navigation using the same waypoints. This procedure utilizes the same NAVAIDs as the ILS, but does not rely on the glideslope, instead providing only lateral guidance to the aircraft as it approaches the runway. It is capable of bringing the aircraft to a minimum descent height of 706ft above the runway with a visibility of 1 ½ miles for CAT C aircraft and 1 ¾ miles for CAT D. In the event that the MALSR is inoperative, then the visibility will increase by ½ mile for both CAT C and D aircraft.

The runway 13 ILS approach originates west of the airport at the PUPCI waypoint as a hold in lieu of procedure turn. This enables aircraft that are not in contact with Duluth

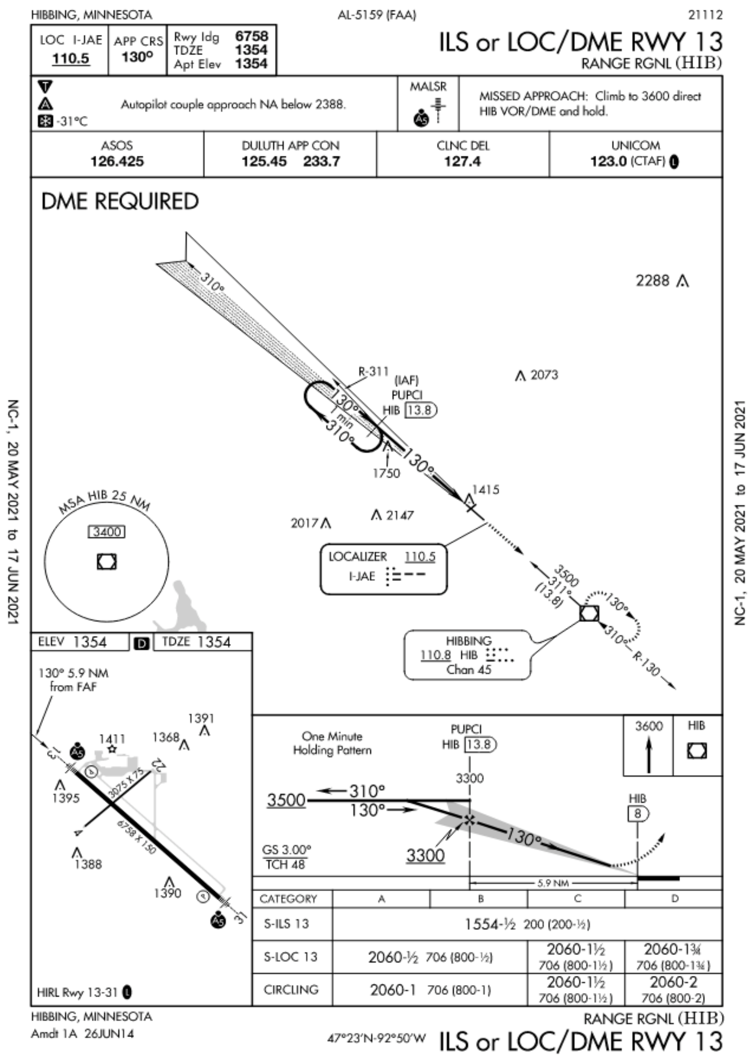


Figure 14 ILS or LOC/DME Rwy 13

Approach Control to enter the hold pattern, defined in relation to the HIB VOR, and descend until intercepting the localizer and glideslope.

Once the flight crew has intercepted the LOC and glideslope, they will follow the course guidance displayed onboard until gaining the runway in sight, or until reaching the decision height/decision altitude following a 3.00 degree glideslope to a TCH of 48ft.

In the event that the flight crew does not maintain visual contact with the runway environment, then they will execute a missed approach by climbing directly towards the HIB VOR/DME. If the aircraft does not cross the HIB VOR at or above 3600ft Pressure Altitude, then the aircraft must enter the published hold pattern to climb to the missed approach altitude (3,600ft) or follow guidance from Duluth Approach Control.

As discussed in the NAVAIDs section of this report, the current ILS approach to runway 13 has an important note that restricts pilots from using their autopilot to complete the instrument approach below an altitude of 2,388ft. This note does not mean that a flight crew would be unable to fly the ILS approach down to a decision height of 200ft (1554ft Pressure Altitude), but it does mean that the flight crew will have to manually guide the aircraft for the remainder of the approach.

7.2.2.2 RNAV (GPS) RWY 13

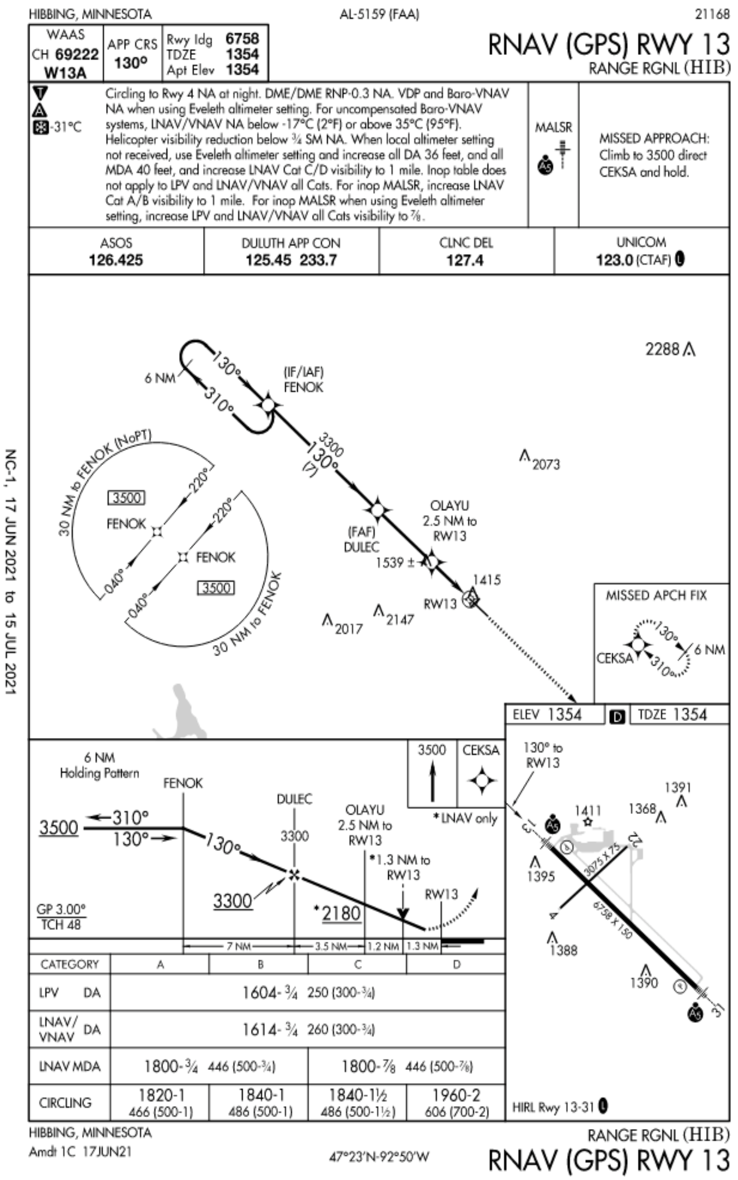


Figure 15 RNAV (GPS) Rwy 13

The second approach considered in this analysis is the RNAV (GPS) Rwy 13. This approach supports LPV, LNAV/VNAV and LNAV methods of making an approach to runway 13, including the option to circle to land.

This approach utilizes a terminal area arrival (TAA) to enhance the ability of aircraft commonly arriving from the southwest, south and southeast to avoid executing the same hold in lieu of procedure turn method as the one utilized on the ILS or LOC/DME Rwy 13. The TAA, depicted on the approach plate as a divided MSA segment, indicates that aircraft arriving from the west, northwest and north, are not permitted to execute a procedure turn from the prescribed altitude of 3,500ft. However, aircraft arriving from the south, southeast or east are permitted execute a procedure turn towards FENOK as long as they execute the turn at or above 3,500ft pressure altitude.

From FENOK, aircraft descend towards the final approach fix at DULEC at which point, or shortly before, the aircraft will switch from basic GPS navigation (either LNAV or LNAV/VNAV) into the method used to execute the final approach to landing.

For aircraft that are capable of using WAAS, the localizer performance with vertical guidance (LPV) method will result in standard CAT I approach like minimums, using a 3.00 glidepath angle to a TCH of 48ft with minimums of a 250ft DH and ¾ mile visibility.

For aircraft that are not capable of using WAAS, the LNAV/VNAV option will permit approaches as low as 260ft DH with a ¾ mi visibility. For those aircraft that use barometric sources to determine vertical navigation, a temperature restriction limits its use to outside air temperatures above -17C and below 35C.

The final option is to use LNAV only and consider the use of a stepdown fix located at OLAYU to achieve approach minimums of 446 ft minimum descent height and 7/8 mi visibility. In the event that the MALSR is unavailable, then the visibility for CAT C and D aircraft would be increased from 7/8 mi to 1 3/8 mi. However, an inoperative MALSR will not affect the LPV or LNAV/VNAV approach minimums.

The circling approach minimums listed on this approach would be used by aircraft flying LNAV only until the point at which the decision is made to execute the circle to land maneuver. This results in similar circling minimums to those on the ILS or LOC/DME Rwy 13 approach.

The missed approach procedure for the RNAV (GPS) approach is similar to the ILS or LOC procedure in that it also requires flight crews to climb straight ahead terminating the missed approach at the CEKSA RNAV waypoint rather than at the HIB VOR.

The RNAV (GPS) approach also presents restrictions related to the use of alternative altimeter settings should this procedure be used by flight crews during periods when the on airport ASOS is not reporting an altimeter setting or when crews are conducting a short flight using altimeter values from the nearby Eveleth airport.

7.2.3 Approaches to Runway 31

HIB is currently served by two instrument approach procedures to runway 13, each of which utilize different methods of navigation. These approaches are published by the FAA either on independent approach plates or combined together on a single approach plate. The approaches to runway 31 are summarized as follows:

Table 8Instrument Approach Options to Rwy 31

Procedure Name	Owner	Amendment, Date	Type	CAT C/D Decision Height (ft)	CAT C/D Visibility (Miles)	NAV Requirements
ILS or LOC Rwy 31	FAA	13A, 17JUN21	ILS CAT I / Precision Approach	200	½	I-HIB ILS and HIB VOR/DME
ILS or LOC Rwy 31	FAA	13A, 17JUN21	LOC Non-Precision Approach (with BOYAC)	337	1/2 - C 3/4 - D	I-HIB LOC OM HIB VOR/DME
ILS or LOC Rwy 31	FAA	13A, 17JUN21	LOC Non-Precision Approach (without BOYAC)	397	1/2 - C 3/4 - D	
ILS or LOC Rwy 31	FAA	13A, 17JUN21	Circling	486 – C 606 - D	1 ½ - D 2 – D	
RNAV (GPS) Rwy 31	FAA	1B 17JUN21	LPV	200	1/2	WAAS
RNAV (GPS) Rwy 31	FAA	1B 17JUN21	LNAV/VNAV	250	1/2	VNAV
RNAV (GPS) Rwy 31	FAA	1B 17JUN21	LNAV	335	5/8	
RNAV (GPS) Rwy 31	FAA	1B 17JUN21	Circling	486 – C 606 - D	1 ½ - C 2 - D	

7.2.3.1 ILS or LOC RWY 31

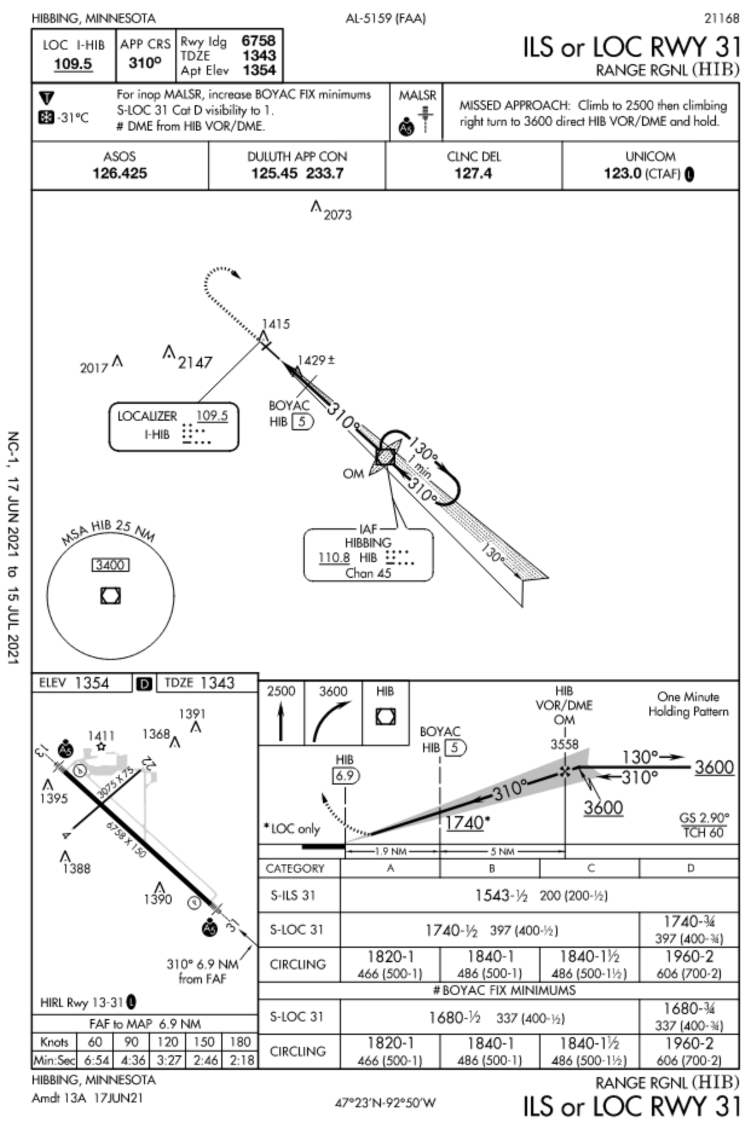


Figure 16 ILS or LOC Rwy 31

The primary approach to runway 31 is the ILS or LOC Rwy 31 approach, Amendment 13A, last revised on 17JUN21. This is an FAA published precision approach procedure to runway 31 utilizing the I-HIB localizer and glideslope. It is capable of providing standard Category I approach minimums to a decision height of 200ft and a visibility of ½ mile. In the event that the MALSR is inoperative, then the visibility will increase to ¾ mile.

The same instrument approach procedure also supports a localizer only method of navigation using the same waypoints. This procedure utilizes the same NAVAIDs as the ILS, but does not rely on the glideslope, instead providing only lateral guidance to the aircraft as it approaches the runway. It is capable of bringing the aircraft and flight crew to a minimum descent height of 397ft above the runway with a visibility of ½ miles for CAT C aircraft and ¾ miles for CAT D. In the event that the MALSR is inoperative, then the visibility will increase by ½ mile for both CAT C and D aircraft.

For aircraft and flight crews that can use the HIB VOR/DME simultaneous to the ILS (which is all airlines and many general aviation/business jet aircraft) then crews can utilize a stepdown fix (BOYAC) in the final approach segment to further reduce the minimums down to an MDH of 337ft, with the same visibility.

The runway 31 ILS approach originates east of the airport at the HIB VOR/DME which constitutes a hold in lieu of procedure turn. This enables aircraft that are not in contact with Duluth Approach Control to enter the hold pattern, formed at the HIB VOR, and descend until intercepting the localizer and glideslope.

Once the flight crew has intercepted the LOC and glideslope, they will follow the course guidance displayed onboard until gaining the runway in sight, or until reaching the decision height/decision altitude following a 2.90 degree glideslope to a TCH of 60ft.

In the event that the flight crew does not maintain visual contact with the runway environment, then they will execute a missed approach by climbing to 2500ft MSL before turning right direct to the HIB VOR/DME. If the aircraft does not cross the HIB VOR at or above 3600ft Pressure Altitude, then the aircraft must enter the published hold pattern to climb to the missed approach altitude (3,600ft) or follow guidance from Duluth Approach Control.

7.2.3.2 RNAV (GPS) RWY 31

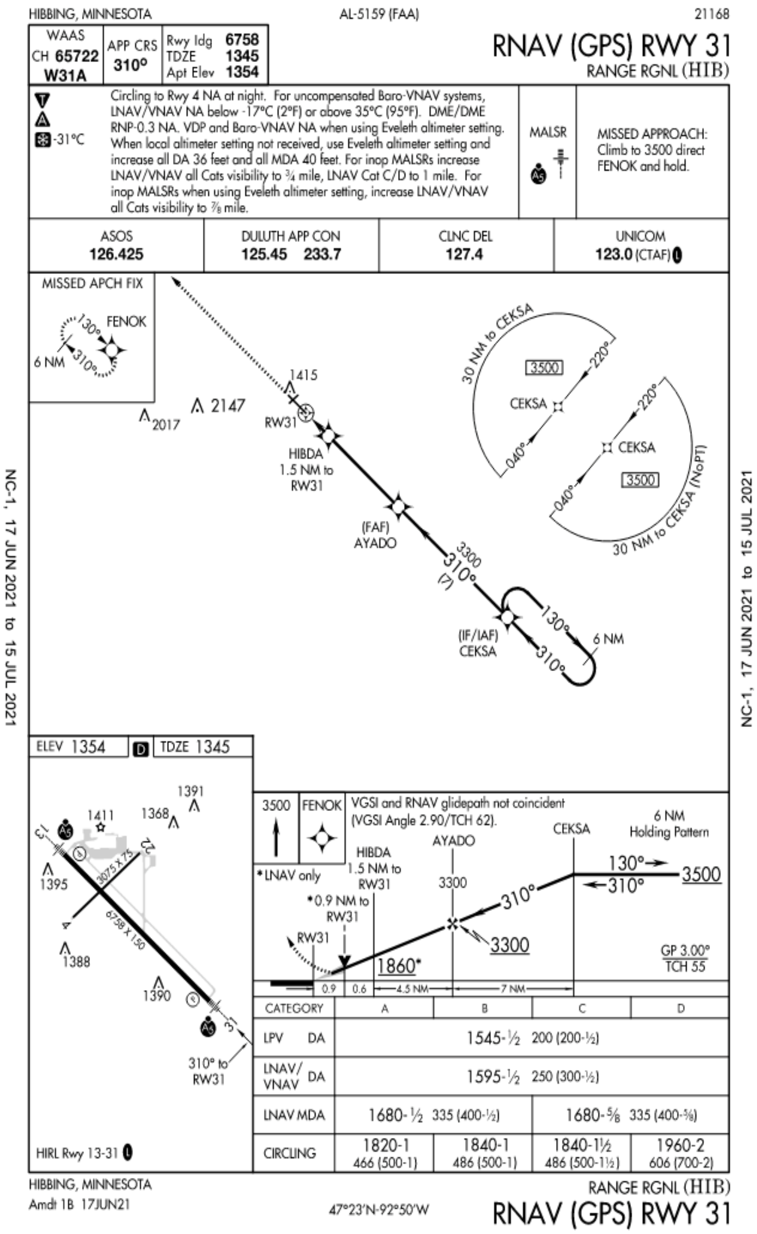


Figure 17 RNAV (GPS) Rwy 31

The second approach considered in this analysis is the RNAV (GPS) Rwy 31. This approach supports LPV, LNAV/VNAV and LNAV methods of making an approach to runway 31, including the option to circle to land.

This approach utilizes a terminal area arrival (TAA) to enhance the ability of aircraft commonly arriving from the west, northwest and north to avoid executing the same hold in lieu of procedure turn method as the one utilized on the ILS or LOC/DME Rwy 31. The TAA, depicted on the approach plate as a divided MSA segment, indicates that aircraft arriving from the south, southeast, and east are not permitted to execute a procedure turn from the prescribed altitude of 3,500ft. However, aircraft arriving from the north, northwest, and west are permitted execute a procedure turn towards CEKSA as long as they execute the turn at or above 3,500ft pressure altitude.

From CEKSA, aircraft descend towards the final approach fix at AYADO at which point, or shortly before, the aircraft will switch from basic GPS navigation (either LNAV or LNAV/VNAV) into the method used to execute the final approach to landing.

For aircraft that are capable of using WAAS, the localizer performance with vertical guidance (LPV) method will result in standard CAT I approach like minimums, using a 3.00 glidepath angle to a TCH of 55ft with minimums of a 200ft DH and ½ mile visibility.

For aircraft that are not capable of using WAAS, the LNAV/VNAV option will permit approaches as low as 250ft DH, still with a ½ mi visibility. For those aircraft that use barometric sources to determine vertical navigation, a temperature restriction limits its use to outside air temperatures above -17C and below 35C.

The final option is to use LNAV only and consider the use of a stepdown fix located at HIBDA to achieve approach minimums of 335 ft minimum descent height and 5/8 mi visibility. In the event that the MALSR is unavailable, then the visibility for CAT C and D aircraft would be increased from 5/8 mi to 1 1/8 mi. However, an inoperative MALSR will not affect the LPV or LNAV/VNAV approach minimums.

The circling approach minimums listed on this approach would be used by aircraft flying LNAV only until the point at which the decision is made to execute the circle to land maneuver. This results in similar circling minimums to those on the ILS or LOC/DME Rwy 13 approach.

The missed approach procedure for the RNAV (GPS) approach requires flight crews to climb straight ahead to 3500ft MLS and terminate the missed approach to the FENOK RNAV waypoint.

The RNAV (GPS) approach also presents restrictions related to the use of alternative altimeter settings should this procedure be used by flight crews during periods when the on airport ASOS is not reporting an altimeter setting or when crews are conducting a short flight using altimeter values from the nearby Eveleth airport.

7.2.4 Analysis of Existing Approaches

All existing approach procedures to Runway 13 and 31 were built in both MDA Global Procedure Developer and FAA TARGETs platforms to compare the aeronautical and geospatial inputs identified in section 6.1.3 against the latest FAA TERPS and PBN criteria.

Upon rebuilding the approach and departure procedures in both platforms, no significant discrepancies were detected between the current procedures, waypoints, altitudes, speeds and minimums. This means that the information used to model aircraft performance and instrument procedures has a high likelihood of matching the existing FAA instrument procedure criteria. This also means that any analysis of possible threshold location changes is likely to be replicated by other FAA air traffic and flight procedure specialists.

7.2.4.1 ILS or LOC/DME Rwy 13

The current approach is compliant with all current TERPS standards and will not require any modifications resulting from the latest obstacle survey. The final approach segment is nearly penetrated by the MALSR shelter (less than 1 ft of clearance when obstacle accuracy is considered) but there are no penetrations that require any changes to the procedure or its minimums.

The initial approach application as a hold in lieu of procedure turn which introduces a more sizeable obstacle accountability area. As a result, the current minimum altitude at the beginning of the approach is controlled by the WIRT TV towers located approximately 4.5 nautical miles west of the airport. These towers limit the minimum altitude at the initial approach to 3,200ft MSL. However, the current minimum altitude of 3,500ft is already higher than this value.

The missed approach is also clear of any obstructions, though the initial section of the missed approach clears trees immediately west of the runway 13 threshold by less than 13ft.

7.2.4.2 RNAV (GPS) Rwy 13

The RNAV (GPS) Rwy 13 LPV and LNAV navigation methods were analyzed and found to match all current TERPS/PBN standards, with the exception of an FAA imposed limitation on the lowest visibility restricting the analyzed value of ½ mi to ¾ mi due to an FAA reported "34:1 surface not clear".

The LNAV/VNAV navigation method was analyzed and found to have new penetrations to the final approach OCS which will need to be addressed by the airport, FAA or both parties.

7.2.4.2.1 Rwy 13 34:1 Surface Penetration and Restriction of ¾ mi Visibility

The FAA noted, in its 2016 update to the RNAV (GPS) Rwy 13, that the 34:1 surface was not clear at that time. This resulted in the FAA placing a visibility restriction of ¾ mi on the LPV and LNAV/VNAV approaches.

In past cases the FAA has used the 34:1 not clear database entry to indicate that other restrictions exist which are more closely related to runway design elements (discussed in greater detail on the ALP and in the masterplan). For example, if the current approach RPZ standards are such that state road 37 prevents approach minimums below ¾ mi from being considered, the FAA may have used the 34:1 not clear flag to capture the concept that approach minimums to runway 13 should not be published with visibilities below ¾ mi.

The analysis in GPD and TARGETS, using the current obstacle survey results, reveal that the 34:1 surface to runway 13 appears to be clear of penetrations. If the RPZ issue is not a limiting factor, we recommend that the airport reach out to the FAA Central Flight Procedures team to discuss a change to this limitation which will enhance the effectiveness of the approach.

If the RPZ is a limiting factor, the airport should consider a displaced threshold for landing on runway 13 to both achieve the RPZ compliance and reduce the instrument approach minimums back down to the lowest value supported by the MALSR and instrument procedure design of 200ft – ½ mi.

7.2.4.2.2 Vegetative Penetrations to LNAV/VNAV Final Approach OCS

The latest obstacle survey performed by the airport introduced several new, or previously unreported, vegetative obstructions northwest of the airport. Several of the tree heights now create a penetration to the current final approach OCS for the LNAV/VNAV navigation method of the RNAV (GPS) Rwy 13.

Figure 18, below, is a screen shot taken from GPD which depicts the 2D representation of the LNAV/VNAV obstacle clearance surfaces for the final approach and missed approach as black lines. A green triangle highlights one of three trees which was identified as a penetration to the existing surface, which were identified in the survey as follows:

- Tree, 47° 24' 07.35 N", 092° 51' 59.43 W", 1456 ft MSL (1A Accuracy)
- Tree, 47° 24' 07.74 N", 092° 51' 58.91 W", 1455 ft MSL (1A Accuracy)
- Tree, 47° 24' 06.68 N"092° 52' 00.40 W", 1452 ft MSL (1A Accuracy)

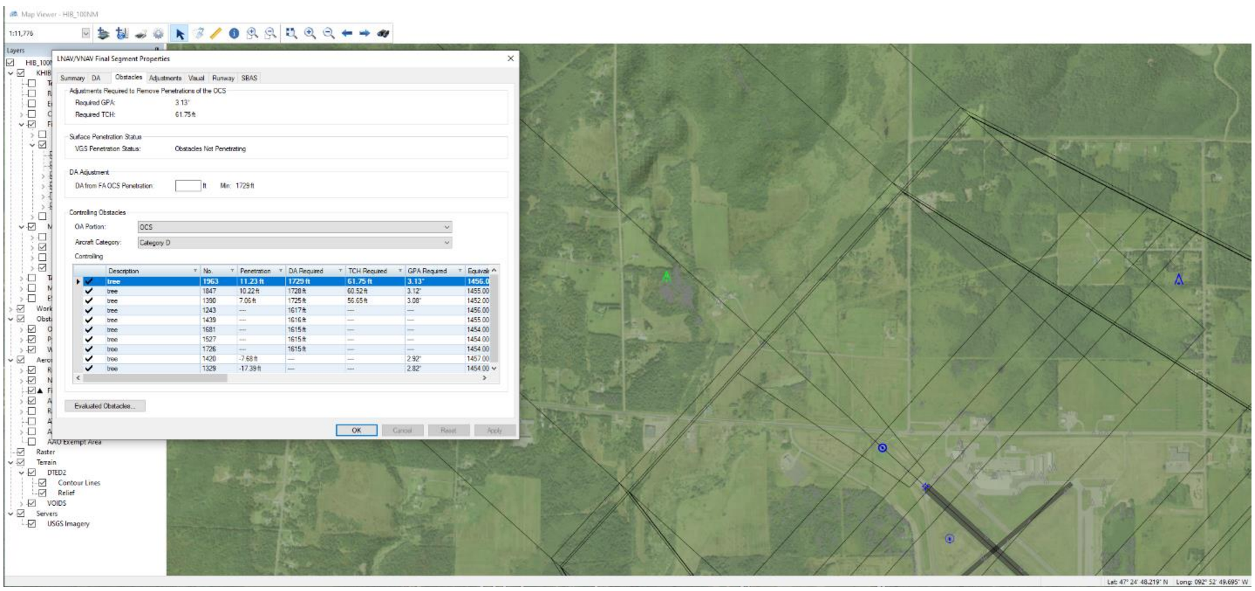


Figure 18 Image from GPD Showing Penetrations to the RNAV (GPS) Rwy 13 LNAV/VNAV Final Approach OCS

These penetrations have not yet been identified by the FAA Central Flight Procedures Team, but the successful upload of the survey to AGIS/ADIP and AIRNAV means that at some point in the near future, the instrument procedure will need to be modified. At that point in time, one of three solutions will need to be implemented.

Option 1. Reduce the tree heights by 12ft or more

If the airport has the ability to reduce the heights of trees in this area (and not just the three that have specific points that have been surveyed), by 12 ft, then the FAA will not take any actions to modify the approach procedure. The airport and FAA will need to work together to update the AIRNAV/OAS database with the reduced tree heights once the trimming has been performed to document that these obstacles are no longer penetrating the OCS.

Option 2. Modify the existing approach to a higher GPA

The analysis in GPD found that the RNAV (GPS) Rwy 13 can be modified to eliminate the current vegetative penetrations to the LNAV/VNAV approach by increasing the GPA from 3.00º to 3.19º and by increasing the TCH from 48ft to 62ft.

These changes would apply to the LPV, LNAV/VNAV and LNAV approach procedure, but would not fundamentally change the approach minimums for any of these navigation methods. The change would, however, separate the GPA for this approach from the ILS; this is not the FAA's preferred state for a runway that supports both an ILS and an RNAV approach. The steeper GPA would still be supported by the PAPI on runway 13, but it would be within 0.01 degree of the maximum 0.20 degree limitation. Any additional growth in the trees in the future might ultimately require further changes to the approach procedure that would push the approach out of tolerances for the PAPI.

Option 3. Increase the LNAV/VNAV approach minimums

The simplest, but most impactful, option the FAA can impose would be to increase the approach minimums, specifically for the LNAV/VNAV navigation method, from the current value of 260ft – ¾ mi to 375ft – 5/8 mi (when the MALSR is operational) and 375ft – 1 mi (when the MALSR is inoperative). This change would reduce the effectiveness of the LNAV/VNAV approach to a level similar to the current ILS or LOC/DME Rwy 13 approach, using only the localizer navigation method.

While this method may not be preferable, it would not render the approach less effective than other navigation methods and may be an interim solution if the airport needs time to negotiate the reduction of the tree heights identified in option 1.

7.2.4.3 ILS or LOC Rwy 31

The current approach is compliant with all current TERPS standards and will not require any modifications resulting from the latest obstacle survey.

The missed approach is also clear of any obstructions, with clearance of all obstructions in Section1 by approximate 25ft and Section 2 by 200 ft or more.

7.2.4.4 RNAV (GPS) Rwy 31

The current approach is compliant with all current TERPS/PBN standards and will not require any modifications resulting from the latest obstacle survey.

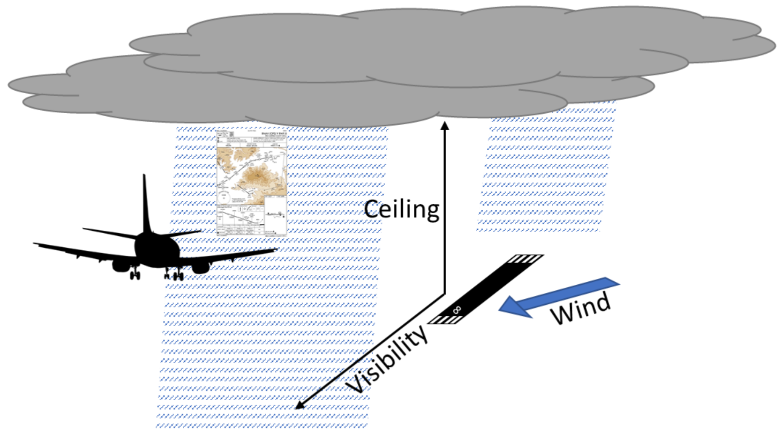
The initial approach/TAA altitudes are currently limited by windmills (2,248ft MSL), located north of the MinnTac Mine and the WEVE FM Antenna (also 2,248ft MSL). Both of these structures limit the lowest possible TAA/IAF altitudes to 3,300ft MSL.

7.2.5 Effectiveness of Existing Approaches

To understand the effectiveness of an airport's existing approach procedures, those approaches need to be examined relative to historical weather conditions when each runway is in use and when all runway/approach options are available for use by pilots and air traffic controllers.

7.2.5.1 Runway Effectiveness of An Approach Procedure

Historical weather data was analyzed (described in more detail in section 8) for combinations of runway use, ceilings and visibility to examine the effectiveness of an approach procedure for a specific runway and for the airport as a whole.

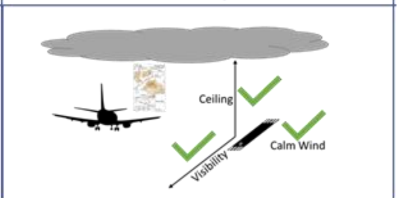
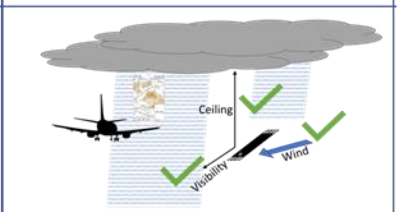
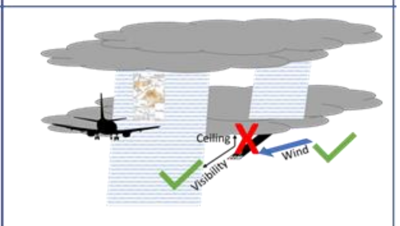


For runway effectiveness, descriptive statistics were generated from time weighted weather observations to determine the likelihood that a specific runway direction was capable of supporting approach and landing based on wind conditions, and the ceiling and visibility was greater than or equal to the approach procedure serving the runway. This means that when runway 13 would have been capable of supporting an approach, we determined the likelihood (as a percent of operational success) that the ceilings and visibility in that time weighted period would be enough to support an approach. This analysis shows how effective an approach is when a specific runway is in use, but not how beneficial the approach is to the entire airport.

7.2.5.2 Overall Effectiveness of An Approach Procedure

Understanding the effectiveness of an approach at enabling aircraft to land on the designated runway is important, but it does not reveal how often that particular approach would benefit the overall operation of aircraft into HIB. To determine the effectiveness of a specific approach to the overall airport, the ceilings and visibility supported by the approach, and the capability of the runway to support approaches by wind, are analyzed within the overall hourly availability of the runway.

In the image below, the overall effectiveness of the approach at enabling aircraft to arrive into HIB would be high from 09:00 – 10:00 and 22:00 – 22:20. Because the ceiling was lower than the approach procedure minimums between 22:20 – 22:40, the procedure would not be effective at enabling arrivals into HIB during that time.

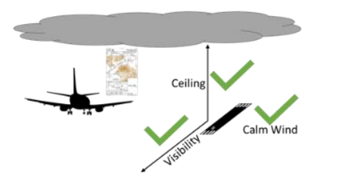
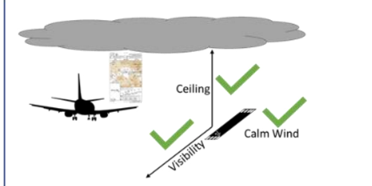
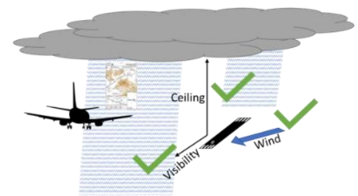
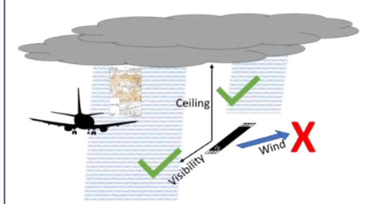
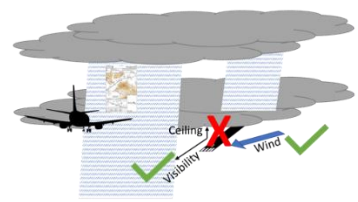
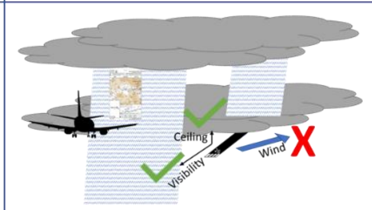
	Runway 13
March 09:00 – 10:00 Airport Likely to Be Open	
March 22:00 – 22:20 Airport Likely to Be Open	
March 22:20 – 22:40 Airport Not Likely to Be Open	

7.2.5.3 Ability of the Airport to Support Approach Operations

To determine how effective the airport is at enabling pilots to successfully arrive at a given hour and month, we made a similar analysis to overall effectiveness. This analysis combines multiple approach and runway end availability together into an airport-wide capability. This must also take into consideration the different kinds of aircraft navigation technologies and pilot training amongst operators anticipated to serve HIB now and in the future.

Determining whether an airport is likely to remain open involves examining which runway would likely have been the one available by wind preference/capability and then considering whether the aircraft/flight crew has the navigation capability to use the approach within the required weather minimums. For sophisticated aircraft operators, with advanced onboard navigation technology, the range of options can permit a higher likelihood of being able to arrive at the airport at the desired month/hour. However, for pilots with less training, or who are operating less capable aircraft, the number of approach procedure options may create a reduced likelihood of arriving at the desired time.

The figure below demonstrates the general analysis process of when the airport would be considered to be likely to be open to arrivals.

	Runway 13	Runway 31
March 09:00 – 10:00 Airport Likely to Be Open		
March 22:00 – 22:20 Airport Likely to Be Open		
March 22:20 – 22:40 Airport Not Likely to Be Open		

7.2.5.4 Runway, Overall and Airport Open to Operations Likelihoods

The process of statistically expressing the likelihood for an approach, or combination of approaches to different runway ends, to enable arrivals at the airport is expressed as a percentage of likely availability for the given hour and month.

The following relationship translates that statistical likelihood, detailed in sections 7.2.5.5 through 7.2.5.9, into qualitative likelihoods determined by LEAN based on observations of aircraft, and airline, operations at airports of varying sizes over the past 20 years.

100% - 95% Pilots are successfully able to land with little to no delay
94% - 90% Pilots may experience small delays but often arrive on time and will generally maintain scheduled service
89% - 80% Pilots experience delays when attempting to arrive at the airport and occasionally divert. Scheduled service may be performed with block time and cancellation contingencies.
79% - 60% Pilots expect delays when attempting to arrive at the airport and often consider gate holds and/or cancellations. Scheduled service is unlikely.
<59% Pilots don't often expect to arrive on schedule, consider planned diversions destinations or plan for alternate passenger transport. Scheduled service is not possible.

By considering these real-world relationships to discrete likelihood values, we can not only determine how effective an approach is, but we can also measure how effective a change in the approach procedure might be. Therefore, while the following sections will all utilize a similar color coding relative to the likelihood values presented, this relationship only applies to real-world operations to the tables describing whether the airport is open to a specific type of operation.

7.2.5.5 ILS or LOC/DME RWY 13

The effectiveness of the ILS approach to runway 13, even under category I conditions, is extremely high at all hours and all months, with a slight decrease in effectiveness during the early morning hours of August and September. The small decrease in effectiveness, which does not lead to a significant increase in delays or diversions, could be improved through the introduction of lower approach minimums resulting from SA CAT I or SA CAT II minimums. However, this would require the addition of a manned, or remote, ATCT which could be cost prohibitive if installed solely for this purpose.

From the perspective of supporting overall approach and arrival operations into HIB, prevailing winds limit the ability to utilize runway 13 for operations, thus limiting the effectiveness of the existing ILS to periods of time in the morning and evening. This means that other approach options to runway 31 are necessary to enable continued access to HIB 24/7/365.

Table 9 ILS or LOC/DME Rwy 13 - Runway Effectiveness

ILS Runway 13 - Runway Effectiveness

200 ft - 1/2 mi

Hour (Local)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	98.0%	100.0%	98.6%	99.2%	98.6%	98.2%	97.8%	95.0%	95.8%	98.1%	96.8%	98.5%
1:00	98.7%	99.9%	99.1%	99.3%	98.0%	97.2%	96.3%	95.0%	95.1%	98.1%	97.0%	99.5%
2:00	98.7%	100.0%	98.1%	98.0%	97.4%	98.0%	92.7%	92.1%	93.3%	99.2%	97.3%	98.8%
3:00	99.0%	99.8%	98.2%	97.7%	97.9%	93.8%	93.2%	89.7%	90.4%	98.7%	98.4%	98.3%
4:00	98.2%	99.4%	98.5%	97.7%	96.9%	93.3%	91.3%	87.5%	89.1%	98.6%	97.3%	99.0%
5:00	99.0%	99.1%	98.6%	97.9%	94.9%	91.7%	89.3%	86.7%	86.5%	98.7%	98.0%	99.0%
6:00	98.2%	99.1%	98.3%	98.2%	95.9%	96.4%	93.5%	83.3%	85.4%	97.6%	97.6%	98.4%
7:00	98.1%	97.6%	95.0%	96.1%	97.7%	98.1%	97.0%	91.5%	87.9%	96.5%	96.3%	99.3%
8:00	97.7%	98.7%	95.2%	98.6%	98.9%	98.6%	97.8%	96.6%	95.1%	97.4%	96.1%	98.4%
9:00	97.9%	98.0%	97.0%	98.8%	99.1%	100.0%	98.9%	98.7%	98.3%	97.8%	98.0%	97.4%
10:00	98.7%	99.1%	97.0%	97.6%	100.0%	99.8%	99.9%	99.3%	99.7%	98.7%	99.2%	99.5%
11:00	99.0%	98.7%	98.2%	99.7%	99.6%	99.6%	100.0%	99.9%	100.0%	99.3%	99.6%	99.2%
12:00	98.1%	98.4%	98.5%	98.2%	99.6%	99.3%	99.4%	99.4%	100.0%	100.0%	99.9%	99.0%
13:00	99.5%	98.6%	98.3%	99.6%	98.9%	100.0%	100.0%	100.0%	100.0%	99.6%	99.7%	99.1%
14:00	98.9%	97.7%	95.8%	99.4%	99.6%	99.9%	100.0%	100.0%	100.0%	99.1%	99.1%	98.7%
15:00	99.6%	99.0%	97.5%	99.9%	100.0%	100.0%	100.0%	100.0%	99.3%	99.9%	99.6%	99.0%
16:00	99.5%	98.9%	98.2%	99.8%	99.6%	100.0%	99.6%	100.0%	100.0%	99.6%	98.6%	99.9%
17:00	99.3%	99.8%	97.9%	99.5%	100.0%	100.0%	100.0%	99.6%	100.0%	99.5%	99.5%	99.7%
18:00	98.8%	100.0%	98.2%	99.7%	100.0%	99.7%	100.0%	99.7%	99.8%	100.0%	99.2%	99.7%
19:00	99.4%	100.0%	99.4%	99.7%	100.0%	100.0%	100.0%	100.0%	99.7%	100.0%	98.7%	99.8%
20:00	98.6%	100.0%	99.3%	100.0%	100.0%	100.0%	100.0%	99.8%	99.4%	99.8%	98.3%	99.8%
21:00	98.6%	99.5%	99.6%	99.9%	99.8%	99.4%	99.8%	99.8%	99.5%	99.4%	99.1%	99.5%
22:00	98.8%	100.0%	98.9%	99.4%	99.7%	99.5%	98.8%	98.9%	98.4%	99.2%	98.7%	99.2%
23:00	98.3%	99.8%	99.2%	99.7%	99.5%	98.5%	98.2%	96.4%	97.5%	98.8%	97.6%	99.4%

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Day	98.8%	98.6%	97.2%	98.9%	99.2%	98.9%	98.5%	97.5%	98.3%	98.9%	98.6%	98.8%
Night	98.7%	99.7%	98.8%	98.9%	98.3%	97.2%	96.0%	94.6%	94.2%	99.0%	98.1%	99.2%
24 Hours	98.7%	99.2%	98.0%	98.9%	98.8%	98.4%	97.6%	96.2%	96.3%	98.9%	98.3%	99.1%

Table 10 ILS or LOC/DME Rwy 13 - Overall Effectiveness

ILS Runway 13 - Overall Effectiveness

200 ft - 1/2 mi

Hour (Local)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	81.3%	81.5%	86.1%	87.4%	92.2%	93.2%	95.4%	92.2%	88.9%	86.2%	80.9%	82.2%
1:00	80.7%	88.3%	87.7%	87.6%	92.6%	92.4%	93.3%	92.2%	89.6%	86.9%	80.6%	84.0%
2:00	81.6%	84.6%	87.7%	85.6%	90.9%	94.0%	90.1%	87.7%	87.6%	85.1%	84.5%	83.5%
3:00	82.2%	85.7%	86.9%	87.3%	91.5%	89.7%	90.8%	86.9%	83.5%	88.8%	82.3%	80.0%
4:00	79.4%	84.3%	87.5%	86.3%	90.7%	89.7%	89.1%	83.9%	83.7%	88.4%	80.2%	83.7%
5:00	81.1%	84.3%	89.3%	86.1%	89.5%	88.7%	85.9%	84.1%	81.3%	84.0%	83.9%	83.5%
6:00	79.5%	83.8%	86.5%	84.3%	87.7%	91.3%	89.9%	80.2%	79.5%	85.4%	81.7%	82.3%
7:00	80.9%	83.4%	84.0%	80.3%	86.7%	90.4%	89.1%	86.4%	80.8%	85.5%	81.4%	84.6%
8:00	79.8%	80.5%	81.7%	79.7%	85.2%	87.7%	87.4%	89.1%	85.1%	83.7%	78.2%	81.7%
9:00	75.3%	77.4%	80.9%	76.5%	80.3%	84.0%	83.4%	87.1%	83.2%	77.9%	76.1%	80.3%
10:00	74.4%	73.7%	77.0%	73.5%	76.1%	80.3%	81.8%	80.4%	81.4%	72.9%	72.7%	78.2%
11:00	70.9%	72.4%	77.0%	65.8%	71.2%	75.7%	74.0%	78.9%	75.9%	72.5%	76.4%	79.2%
12:00	70.1%	71.3%	73.6%	66.2%	68.6%	73.5%	75.0%	75.9%	74.3%	70.0%	71.7%	78.4%
13:00	68.9%	68.1%	72.0%	63.8%	68.6%	74.1%	72.2%	76.3%	73.9%	68.6%	71.3%	79.0%
14:00	68.1%	65.2%	69.6%	62.2%	68.9%	72.4%	72.2%	77.2%	72.8%	70.8%	70.5%	80.3%
15:00	72.2%	66.8%	69.2%	65.6%	66.7%	72.0%	69.9%	76.2%	75.4%	72.0%	75.4%	83.0%
16:00	78.2%	70.2%	71.9%	66.2%	72.1%	74.6%	73.2%	78.7%	78.6%	72.6%	79.8%	89.1%
17:00	78.4%	80.8%	77.2%	68.3%	75.0%	78.1%	75.5%	82.8%	83.9%	77.6%	80.0%	87.7%
18:00	77.9%	82.6%	82.0%	77.3%	76.9%	82.2%	84.6%	88.5%	91.8%	85.5%	81.5%	83.3%
19:00	79.3%	83.5%	85.3%	84.3%	86.3%	88.1%	90.9%	95.2%	92.1%	86.7%	80.7%	86.3%
20:00	77.3%	81.4%	85.3%	87.5%	93.0%	97.0%	96.8%	96.0%	92.4%	86.5%	81.8%	84.3%
21:00	80.2%	83.2%	85.3%	90.4%	91.6%	96.5%	96.4%	96.4%	92.2%	86.5%	81.2%	83.8%
22:00	79.7%	81.8%	85.8%	88.9%	92.4%	95.9%	95.7%	96.2%	91.7%	84.9%	79.8%	86.1%
23:00	78.3%	84.9%	86.8%	88.4%	92.5%	95.1%	95.6%	93.7%	90.1%	85.2%	79.5%	84.1%

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Day	73.1%	73.6%	76.3%	70.4%	76.4%	81.9%	81.4%	81.4%	79.8%	74.9%	74.9%	80.0%
Night	79.8%	83.8%	86.7%	87.0%	91.7%	93.3%	93.3%	91.3%	87.7%	86.2%	81.2%	84.3%
24 Hours	77.3%	79.1%	81.5%	78.7%	82.8%	85.7%	85.3%	85.9%	83.7%	81.0%	78.8%	82.9%

The LOC only portion of the ILS approach to runway 13 is still relatively effective at allowing aircraft to arrive at any given time into HIB, but the increased minimums of 800ft and 1 ½ mile visibility are not adequate to support early morning operations. In addition, the months of November, December and January all require visibilities of less than 1 ½ miles due to blowing snow.

Table 11 ILS or LOC/DME Rwy 13 (LOC Only) - Runway Effectiveness

LOC Runway 13 - Runway Effectiveness

706 ft - 1 1/2 mi

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	86.2%	92.0%	92.2%	92.4%	93.2%	90.0%	89.1%	83.5%	81.4%	93.9%	85.5%	81.4%
1:00	85.3%	92.2%	92.0%	91.9%	91.8%	85.3%	85.9%	80.7%	79.9%	92.3%	83.5%	79.8%
2:00	82.9%	92.7%	89.0%	91.6%	89.9%	84.9%	80.1%	74.4%	79.2%	91.2%	84.0%	79.8%
3:00	81.0%	91.8%	89.4%	90.7%	88.5%	80.9%	78.8%	70.3%	72.8%	91.1%	83.6%	80.1%
4:00	80.9%	91.5%	90.1%	89.6%	86.9%	79.6%	77.5%	69.1%	72.8%	89.1%	83.2%	79.7%
5:00	78.0%	87.6%	88.5%	92.0%	85.3%	79.8%	76.4%	69.7%	68.9%	89.4%	85.7%	76.8%
6:00	77.2%	87.6%	87.1%	90.0%	86.5%	85.1%	88.2%	69.4%	69.3%	86.3%	86.7%	75.9%
7:00	78.3%	86.1%	83.6%	87.4%	85.9%	87.3%	91.1%	81.0%	74.3%	85.8%	83.8%	75.3%
8:00	75.2%	88.0%	83.4%	88.4%	86.9%	87.0%	91.5%	82.6%	80.4%	86.4%	84.1%	70.0%
9:00	77.7%	84.4%	86.4%	89.8%	91.5%	91.4%	94.1%	84.7%	86.2%	84.9%	82.7%	71.7%
10:00	81.6%	90.6%	85.3%	89.2%	93.1%	91.5%	95.4%	90.2%	90.4%	87.2%	87.4%	75.6%
11:00	85.5%	87.4%	85.4%	92.8%	93.5%	94.7%	98.0%	95.1%	91.6%	87.4%	88.0%	81.1%
12:00	86.4%	89.1%	90.3%	94.0%	95.1%	95.1%	97.6%	96.1%	92.8%	90.7%	88.7%	80.3%
13:00	88.7%	89.8%	89.5%	94.3%	94.6%	96.2%	99.2%	97.8%	96.4%	92.4%	91.4%	82.0%
14:00	89.6%	89.9%	88.3%	93.8%	95.7%	97.2%	99.2%	98.2%	96.9%	91.0%	89.5%	83.2%
15:00	92.2%	94.1%	91.8%	94.4%	95.7%	97.6%	99.1%	98.5%	95.3%	91.3%	89.3%	85.3%
16:00	92.4%	93.2%	92.9%	95.5%	96.7%	95.8%	99.0%	98.7%	97.9%	92.8%	89.8%	87.0%
17:00	91.5%	94.7%	92.8%	95.4%	96.6%	97.7%	98.8%	98.4%	96.5%	94.7%	89.9%	86.2%
18:00	92.1%	96.3%	93.0%	95.3%	96.8%	97.1%	98.7%	98.1%	97.2%	94.5%	91.2%	86.2%
19:00	91.2%	95.9%	92.7%	96.5%	96.2%	97.9%	99.7%	99.3%	96.1%	95.6%	89.9%	87.1%
20:00	86.7%	95.4%	94.2%	96.1%	96.0%	96.8%	99.4%	97.8%	95.0%	96.3%	88.4%	80.9%
21:00	88.1%	94.5%	93.9%	96.7%	95.6%	96.8%	98.2%	97.3%	94.0%	94.4%	87.1%	84.4%
22:00	86.4%	92.0%	92.0%	95.5%	93.5%	95.7%	96.0%	92.5%	90.6%	94.0%	85.7%	83.8%
23:00	85.4%	93.1%	92.7%	96.2%	95.2%	92.0%	94.5%	86.6%	85.7%	93.3%	86.8%	83.2%
Day	85.5%	89.8%	88.5%	92.5%	93.2%	93.0%	95.3%	91.4%	91.3%	89.5%	87.2%	78.6%
Night	84.7%	92.5%	91.2%	93.3%	91.6%	88.2%	87.5%	83.7%	82.2%	92.4%	86.7%	81.7%
24 Hours	85.0%	91.3%	89.8%	92.9%	92.5%	91.4%	92.7%	87.9%	86.7%	91.1%	86.9%	80.7%

Table 12 ILS or LOC/DME Rwy 13 (LOC Only) - Overall Effectiveness

LOC Runway 13 - Overall Effectiveness
706 ft - 1 1/2 mi

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	71.5%	75.0%	80.5%	81.5%	87.1%	85.4%	87.0%	81.0%	75.6%	82.4%	71.5%	67.9%
1:00	69.7%	81.5%	81.5%	81.0%	86.7%	81.2%	83.2%	78.4%	75.3%	81.8%	69.4%	67.4%
2:00	68.5%	78.4%	79.6%	80.0%	83.9%	81.5%	77.8%	70.9%	74.3%	78.3%	72.9%	67.4%
3:00	67.3%	78.9%	79.1%	81.0%	82.6%	77.3%	76.8%	68.2%	67.3%	81.9%	69.9%	65.2%
4:00	65.4%	77.6%	80.1%	79.1%	81.4%	76.5%	75.7%	66.3%	68.4%	79.9%	68.6%	67.4%
5:00	63.8%	74.5%	80.1%	80.9%	80.5%	77.1%	73.5%	67.5%	64.8%	76.1%	73.4%	64.8%
6:00	62.5%	74.1%	76.7%	77.2%	79.2%	80.6%	84.9%	66.8%	64.5%	75.5%	72.6%	63.5%
7:00	64.5%	73.6%	73.9%	73.0%	76.2%	80.4%	83.6%	76.5%	68.3%	76.0%	70.8%	64.1%
8:00	61.4%	71.7%	71.5%	71.5%	74.8%	77.4%	81.8%	76.3%	71.9%	74.2%	68.5%	58.1%
9:00	59.7%	66.6%	72.0%	69.6%	74.1%	76.8%	79.4%	74.8%	73.0%	67.7%	64.2%	59.1%
10:00	61.5%	67.3%	67.6%	67.1%	70.8%	73.6%	78.1%	73.0%	73.8%	64.4%	64.0%	59.4%
11:00	61.2%	64.1%	67.0%	61.2%	66.8%	72.0%	72.5%	75.1%	69.5%	63.8%	67.5%	64.8%
12:00	61.8%	64.5%	67.5%	63.4%	65.5%	70.4%	73.6%	73.3%	69.0%	63.5%	63.7%	63.6%
13:00	61.4%	62.0%	65.6%	60.4%	65.6%	71.2%	71.6%	74.7%	71.3%	63.6%	65.3%	65.4%
14:00	61.7%	60.0%	64.1%	58.7%	66.2%	70.4%	71.7%	75.8%	70.6%	65.1%	63.6%	67.7%
15:00	66.8%	63.5%	65.2%	61.9%	63.8%	70.3%	69.2%	75.0%	72.4%	65.7%	67.6%	71.5%
16:00	72.6%	66.1%	68.0%	63.4%	70.0%	71.5%	72.8%	77.6%	77.0%	67.6%	72.6%	77.6%
17:00	72.3%	76.6%	73.2%	65.4%	72.4%	76.3%	74.6%	81.8%	81.0%	73.9%	72.3%	75.7%
18:00	72.6%	79.6%	77.6%	73.9%	74.5%	80.1%	83.6%	87.1%	89.3%	80.8%	75.0%	72.0%
19:00	72.7%	80.1%	79.6%	81.7%	83.0%	86.3%	90.7%	94.5%	88.8%	82.9%	73.5%	75.3%
20:00	67.9%	77.6%	81.0%	84.0%	89.4%	93.9%	96.2%	94.1%	88.3%	83.4%	73.6%	68.3%
21:00	71.7%	79.0%	80.4%	87.5%	87.8%	94.0%	94.9%	94.0%	87.2%	82.1%	71.3%	71.0%
22:00	69.6%	75.3%	79.9%	85.4%	86.6%	92.3%	93.0%	89.9%	84.5%	80.5%	69.4%	72.8%
23:00	68.0%	79.2%	81.1%	85.3%	88.5%	88.7%	91.9%	84.1%	79.2%	80.5%	70.7%	70.4%
Day	63.1%	66.9%	69.4%	65.8%	71.6%	76.8%	78.6%	76.0%	73.9%	67.8%	66.2%	63.7%
Night	68.5%	77.8%	80.0%	82.1%	85.4%	84.6%	85.0%	80.8%	76.5%	80.5%	71.8%	69.4%
24 Hours	66.5%	72.8%	74.7%	73.9%	77.4%	79.4%	80.7%	78.2%	75.2%	74.6%	69.7%	67.5%

7.2.5.6 RNAV (GPS) RWY 13

Similar to the ILS or LOC Rwy 13, the effectiveness of the RNAV (GPS) LPV and LNAV/VNAV approach to runway 13, is extremely high at all hours and all months, with a slight decrease in effectiveness during the early morning hours of August and September.

From the perspective of supporting overall approach and arrival operations into HIB, the prevailing winds limit the ability to utilize runway 13 for operations, thus limiting the overall effectiveness of the existing LPV and LNAV/VNAV to periods of time in the morning and evening. This means that other approach options to runway 31 are necessary to enable continued access to HIB 24/7/365.

The similarity in approach minimums between the LPV and LNAV/VNAV enables a broad range of aircraft to successfully use the approach to runway 13 during inclement weather, which is especially useful for regional jet and narrowbody aircraft that are commonly VNAV capable but not LPV capable.

While the lowest minimums that can be achieved on an LPV approach are 200ft and ½ mile, those minimums were analyzed for runway 13 for the ILS or LOC Rwy 13 effectiveness analysis (Table 10). A reduction in the visibility from ¾ mi to ½ mi would increase the likelihood of success in the early morning hours of March and December.

Table 13 RNAV(GPS) Rwy 13 (LPV) - Runway Effectiveness

LPV Runway 13 - Runway Effectiveness

250 ft - 3/4 mi

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	96.2%	97.9%	98.1%	97.5%	97.3%	95.6%	93.2%	91.0%	88.9%	97.1%	95.7%	94.1%
1:00	96.2%	98.6%	97.2%	96.9%	96.1%	92.9%	90.9%	87.9%	88.1%	96.2%	93.9%	95.6%
2:00	95.8%	98.5%	95.8%	96.1%	95.8%	93.9%	86.5%	82.4%	87.7%	97.4%	94.1%	95.1%
3:00	96.8%	98.3%	95.6%	96.8%	94.4%	88.6%	85.4%	79.9%	83.7%	97.2%	95.0%	95.0%
4:00	96.2%	97.6%	95.6%	95.9%	92.1%	87.9%	84.1%	78.8%	82.6%	96.2%	94.4%	94.5%
5:00	96.6%	96.5%	94.6%	95.6%	90.6%	87.6%	82.1%	78.7%	79.0%	97.1%	94.9%	94.3%
6:00	96.1%	95.7%	93.9%	95.1%	92.9%	93.0%	91.2%	77.4%	78.8%	95.5%	94.4%	94.4%
7:00	95.3%	92.1%	89.5%	94.6%	93.8%	94.6%	94.7%	88.1%	83.6%	93.5%	93.8%	95.2%
8:00	93.9%	95.5%	90.4%	95.2%	97.0%	94.9%	95.5%	92.2%	90.4%	95.0%	94.1%	90.1%
9:00	93.3%	95.7%	93.5%	96.7%	97.6%	98.4%	98.1%	95.6%	94.4%	96.0%	94.5%	90.7%
10:00	95.5%	96.9%	92.8%	96.4%	99.2%	99.5%	99.8%	97.7%	98.3%	96.5%	96.1%	93.4%
11:00	95.9%	95.1%	94.2%	98.4%	98.8%	99.6%	100.0%	99.5%	98.9%	97.9%	96.8%	95.8%
12:00	95.7%	95.1%	96.6%	97.9%	99.2%	99.3%	99.3%	99.4%	99.6%	98.6%	97.6%	95.9%
13:00	94.9%	95.0%	95.5%	98.1%	98.5%	99.9%	100.0%	100.0%	100.0%	98.2%	97.6%	95.6%
14:00	95.6%	95.7%	94.5%	98.1%	99.2%	99.9%	100.0%	99.8%	100.0%	98.7%	97.4%	94.8%
15:00	96.5%	97.1%	95.3%	98.9%	99.6%	99.8%	99.9%	100.0%	99.3%	99.1%	97.3%	95.3%
16:00	97.8%	96.8%	96.5%	99.1%	99.3%	99.9%	99.6%	100.0%	99.9%	99.6%	96.9%	97.0%
17:00	97.6%	98.4%	97.2%	98.8%	100.0%	99.9%	100.0%	99.6%	99.6%	99.0%	98.1%	96.6%
18:00	97.1%	99.8%	97.0%	98.2%	99.8%	99.6%	100.0%	99.7%	99.1%	99.6%	98.1%	96.1%
19:00	97.6%	98.9%	98.6%	99.2%	99.6%	99.9%	99.9%	100.0%	98.6%	99.4%	98.2%	97.2%
20:00	97.0%	99.3%	98.6%	99.3%	99.6%	99.9%	100.0%	99.8%	98.6%	98.6%	96.9%	96.2%
21:00	96.7%	98.6%	99.1%	99.2%	99.2%	99.2%	99.3%	99.5%	97.5%	98.5%	96.6%	96.0%
22:00	95.8%	98.4%	97.3%	98.1%	97.8%	97.8%	97.9%	97.1%	95.4%	98.3%	96.6%	95.6%
23:00	96.1%	99.0%	98.1%	98.7%	98.2%	96.7%	96.5%	92.7%	92.8%	97.0%	95.7%	95.5%

Day	95.4%	95.8%	94.4%	97.5%	98.2%	97.8%	97.5%	96.1%	96.9%	97.5%	96.1%	93.9%
Night	96.5%	98.2%	96.9%	97.4%	96.1%	94.1%	91.7%	89.8%	89.3%	97.5%	96.0%	95.5%
24 Hours	96.1%	97.1%	95.6%	97.5%	97.3%	96.6%	95.6%	93.2%	93.1%	97.5%	96.0%	95.0%

Table 14 RNAV(GPS) Rwy 13 (LPV) - Overall Effectiveness

LPV Runway 13 - Overall Effectiveness

250 ft - 3/4 mi

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	79.8%	79.8%	85.6%	85.9%	91.0%	90.8%	91.0%	88.3%	82.5%	85.2%	80.0%	78.6%
1:00	78.7%	87.1%	86.1%	85.4%	90.7%	88.3%	88.0%	85.4%	83.0%	85.2%	78.0%	80.7%
2:00	79.3%	83.3%	85.7%	84.0%	89.3%	90.1%	84.1%	78.5%	82.3%	83.6%	81.7%	80.3%
3:00	80.4%	84.4%	84.6%	86.5%	88.1%	84.8%	83.2%	77.4%	77.3%	87.5%	79.5%	77.3%
4:00	77.8%	82.8%	85.0%	84.7%	86.2%	84.5%	82.1%	75.6%	77.6%	86.2%	77.8%	79.9%
5:00	79.1%	82.0%	85.7%	84.1%	85.5%	84.7%	79.0%	76.3%	74.2%	82.6%	81.3%	79.5%
6:00	77.8%	80.9%	82.7%	81.6%	85.0%	88.1%	87.7%	74.4%	73.4%	83.6%	79.0%	79.0%
7:00	78.6%	78.7%	79.2%	79.0%	83.3%	87.2%	86.9%	83.2%	76.9%	82.8%	79.3%	81.1%
8:00	76.7%	77.9%	77.6%	77.0%	83.5%	84.5%	85.3%	85.1%	80.9%	81.6%	76.6%	74.8%
9:00	71.7%	75.6%	78.0%	74.9%	79.1%	82.6%	82.7%	84.4%	79.9%	76.5%	73.4%	74.8%
10:00	72.0%	72.0%	73.6%	72.5%	75.5%	80.0%	81.7%	79.1%	80.3%	71.3%	70.4%	73.4%
11:00	68.6%	69.8%	73.9%	64.9%	70.7%	75.7%	74.0%	78.6%	75.1%	71.5%	74.2%	76.5%
12:00	68.4%	68.8%	72.2%	66.0%	68.3%	73.5%	74.9%	75.9%	74.0%	69.0%	70.1%	75.9%
13:00	65.7%	65.6%	70.0%	62.8%	68.3%	74.0%	72.2%	76.3%	73.9%	67.6%	69.7%	76.2%
14:00	65.8%	63.9%	68.6%	61.4%	68.6%	72.4%	72.2%	77.0%	72.8%	70.6%	69.3%	77.1%
15:00	69.9%	65.5%	67.7%	64.9%	66.4%	71.9%	69.8%	76.1%	75.4%	71.4%	73.6%	79.9%
16:00	76.9%	68.7%	70.6%	65.8%	71.9%	74.5%	73.2%	78.7%	78.6%	72.6%	78.4%	86.5%
17:00	77.0%	79.6%	76.7%	67.8%	75.0%	78.0%	75.5%	82.8%	83.6%	77.2%	78.9%	84.9%
18:00	76.6%	82.4%	81.0%	76.1%	76.8%	82.2%	84.6%	88.4%	91.1%	85.2%	80.6%	80.3%
19:00	77.8%	82.6%	84.7%	83.9%	85.9%	88.0%	90.8%	95.2%	91.1%	86.1%	80.2%	84.0%
20:00	76.0%	80.7%	84.8%	86.9%	92.7%	96.9%	96.8%	96.0%	91.7%	85.4%	80.6%	81.2%
21:00	78.7%	82.5%	84.8%	89.8%	91.0%	96.3%	96.0%	96.2%	90.3%	85.7%	79.1%	80.8%
22:00	77.2%	80.5%	84.4%	87.8%	90.6%	94.3%	94.9%	94.4%	88.9%	84.1%	78.2%	83.0%
23:00	76.5%	84.2%	85.8%	87.5%	91.3%	93.3%	93.9%	90.2%	85.7%	83.7%	77.9%	80.8%

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Day	70.6%	71.5%	74.1%	69.4%	75.6%	80.9%	80.5%	80.0%	78.5%	73.8%	73.0%	76.1%
Night	78.1%	82.6%	85.0%	85.7%	89.6%	90.3%	89.1%	86.7%	83.2%	84.9%	79.4%	81.1%
24 Hours	75.3%	77.5%	79.5%	77.6%	81.4%	84.0%	83.4%	83.1%	80.8%	79.8%	77.0%	79.5%

Table 15 RNAV(GPS) Rwy 13 (VNAV) - Runway Effectiveness

LNAV/VNAV Runway 13 - Runway Effectiveness

260 ft - 3/4 mi

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	96.2%	97.9%	98.1%	97.5%	97.3%	95.6%	93.2%	91.0%	88.9%	97.1%	95.7%	94.1%
1:00	96.2%	98.6%	97.2%	96.9%	96.1%	92.9%	90.9%	87.9%	88.1%	96.2%	93.9%	95.6%
2:00	95.8%	98.5%	95.8%	96.1%	95.8%	93.9%	86.5%	82.4%	87.7%	97.4%	94.1%	95.1%
3:00	96.8%	98.3%	95.6%	96.8%	94.4%	88.6%	85.4%	79.9%	83.7%	97.2%	95.0%	95.0%
4:00	96.2%	97.6%	95.6%	95.9%	92.1%	87.9%	84.1%	78.8%	82.6%	96.2%	94.4%	94.5%
5:00	96.6%	96.5%	94.6%	95.6%	90.6%	87.6%	82.1%	78.7%	79.0%	97.1%	94.9%	94.3%
6:00	96.1%	95.7%	93.9%	95.1%	92.9%	93.0%	91.2%	77.4%	78.8%	95.5%	94.4%	94.4%
7:00	95.3%	92.1%	89.5%	94.6%	93.8%	94.6%	94.7%	88.1%	83.6%	93.5%	93.8%	95.2%
8:00	93.9%	95.5%	90.4%	95.2%	97.0%	94.9%	95.5%	92.2%	90.4%	95.0%	94.1%	90.1%
9:00	93.3%	95.7%	93.5%	96.7%	97.6%	98.4%	98.1%	95.6%	94.4%	96.0%	94.5%	90.7%
10:00	95.5%	96.9%	92.8%	96.4%	99.2%	99.5%	99.8%	97.7%	98.3%	96.5%	96.1%	93.4%
11:00	95.9%	95.1%	94.2%	98.4%	98.8%	99.6%	100.0%	99.5%	98.9%	97.9%	96.8%	95.8%
12:00	95.7%	95.1%	96.6%	97.9%	99.2%	99.3%	99.3%	99.4%	99.6%	98.6%	97.6%	95.9%
13:00	94.9%	95.0%	95.5%	98.1%	98.5%	99.9%	100.0%	100.0%	100.0%	98.2%	97.6%	95.6%
14:00	95.6%	95.7%	94.5%	98.1%	99.2%	99.9%	100.0%	99.8%	100.0%	98.7%	97.4%	94.8%
15:00	96.5%	97.1%	95.3%	98.9%	99.6%	99.8%	99.9%	100.0%	99.3%	99.1%	97.3%	95.3%
16:00	97.8%	96.8%	96.5%	99.1%	99.3%	99.9%	99.6%	100.0%	99.9%	99.6%	96.9%	97.0%
17:00	97.6%	98.4%	97.2%	98.8%	100.0%	99.9%	100.0%	99.6%	99.6%	99.0%	98.1%	96.6%
18:00	97.1%	99.8%	97.0%	98.2%	99.8%	99.6%	100.0%	99.7%	99.1%	99.6%	98.1%	96.1%
19:00	97.6%	98.9%	98.6%	99.2%	99.6%	99.9%	99.9%	100.0%	98.6%	99.4%	98.2%	97.2%
20:00	97.0%	99.3%	98.6%	99.3%	99.6%	99.9%	100.0%	99.8%	98.6%	98.6%	96.9%	96.2%
21:00	96.7%	98.6%	99.1%	99.2%	99.2%	99.2%	99.3%	99.5%	97.5%	98.5%	96.6%	96.0%
22:00	95.8%	98.4%	97.3%	98.1%	97.8%	97.8%	97.9%	97.1%	95.4%	98.3%	96.6%	95.6%
23:00	96.1%	99.0%	98.1%	98.7%	98.2%	96.7%	96.5%	92.7%	92.8%	97.0%	95.7%	95.5%

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Day	95.4%	95.8%	94.4%	97.5%	98.2%	97.8%	97.5%	96.1%	96.9%	97.5%	96.1%	93.9%
Night	96.5%	98.2%	96.9%	97.4%	96.1%	94.1%	91.7%	89.8%	89.3%	97.5%	96.0%	95.5%
24 Hours	96.1%	97.1%	95.6%	97.5%	97.3%	96.6%	95.6%	93.2%	93.1%	97.5%	96.0%	95.0%

Table 16 RNAV(GPS) Rwy 13 (VNAV) - Overall Effectiveness

LNAV/VNAV Runway 13 - Overall Effectiveness

260 ft - 3/4 mi

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	79.8%	79.8%	85.6%	85.9%	91.0%	90.8%	91.0%	88.3%	82.5%	85.2%	80.0%	78.6%
1:00	78.7%	87.1%	86.1%	85.4%	90.7%	88.3%	88.0%	85.4%	83.0%	85.2%	78.0%	80.7%
2:00	79.3%	83.3%	85.7%	84.0%	89.3%	90.1%	84.1%	78.5%	82.3%	83.6%	81.7%	80.3%
3:00	80.4%	84.4%	84.6%	86.5%	88.1%	84.8%	83.2%	77.4%	77.3%	87.5%	79.5%	77.3%
4:00	77.8%	82.8%	85.0%	84.7%	86.2%	84.5%	82.1%	75.6%	77.6%	86.2%	77.8%	79.9%
5:00	79.1%	82.0%	85.7%	84.1%	85.5%	84.7%	79.0%	76.3%	74.2%	82.6%	81.3%	79.5%
6:00	77.8%	80.9%	82.7%	81.6%	85.0%	88.1%	87.7%	74.4%	73.4%	83.6%	79.0%	79.0%
7:00	78.6%	78.7%	79.2%	79.0%	83.3%	87.2%	86.9%	83.2%	76.9%	82.8%	79.3%	81.1%
8:00	76.7%	77.9%	77.6%	77.0%	83.5%	84.5%	85.3%	85.1%	80.9%	81.6%	76.6%	74.8%
9:00	71.7%	75.6%	78.0%	74.9%	79.1%	82.6%	82.7%	84.4%	79.9%	76.5%	73.4%	74.8%
10:00	72.0%	72.0%	73.6%	72.5%	75.5%	80.0%	81.7%	79.1%	80.3%	71.3%	70.4%	73.4%
11:00	68.6%	69.8%	73.9%	64.9%	70.7%	75.7%	74.0%	78.6%	75.1%	71.5%	74.2%	76.5%
12:00	68.4%	68.8%	72.2%	66.0%	68.3%	73.5%	74.9%	75.9%	74.0%	69.0%	70.1%	75.9%
13:00	65.7%	65.6%	70.0%	62.8%	68.3%	74.0%	72.2%	76.3%	73.9%	67.6%	69.7%	76.2%
14:00	65.8%	63.9%	68.6%	61.4%	68.6%	72.4%	72.2%	77.0%	72.8%	70.6%	69.3%	77.1%
15:00	69.9%	65.5%	67.7%	64.9%	66.4%	71.9%	69.8%	76.1%	75.4%	71.4%	73.6%	79.9%
16:00	76.9%	68.7%	70.6%	65.8%	71.9%	74.5%	73.2%	78.7%	78.6%	72.6%	78.4%	86.5%
17:00	77.0%	79.6%	76.7%	67.8%	75.0%	78.0%	75.5%	82.8%	83.6%	77.2%	78.9%	84.9%
18:00	76.6%	82.4%	81.0%	76.1%	76.8%	82.2%	84.6%	88.4%	91.1%	85.2%	80.6%	80.3%
19:00	77.8%	82.6%	84.7%	83.9%	85.9%	88.0%	90.8%	95.2%	91.1%	86.1%	80.2%	84.0%
20:00	76.0%	80.7%	84.8%	86.9%	92.7%	96.9%	96.8%	96.0%	91.7%	85.4%	80.6%	81.2%
21:00	78.7%	82.5%	84.8%	89.8%	91.0%	96.3%	96.0%	96.2%	90.3%	85.7%	79.1%	80.8%
22:00	77.2%	80.5%	84.4%	87.8%	90.6%	94.3%	94.9%	94.4%	88.9%	84.1%	78.2%	83.0%
23:00	76.5%	84.2%	85.8%	87.5%	91.3%	93.3%	93.9%	90.2%	85.7%	83.7%	77.9%	80.8%
Day	70.6%	71.5%	74.1%	69.4%	75.6%	80.9%	80.5%	80.0%	78.5%	73.8%	73.0%	76.1%
Night	78.1%	82.6%	85.0%	85.7%	89.6%	90.3%	89.1%	86.7%	83.2%	84.9%	79.4%	81.1%
24 Hours	75.3%	77.5%	79.5%	77.6%	81.4%	84.0%	83.4%	83.1%	80.8%	79.8%	77.0%	79.5%

The LNAV portion of the RNAV (GPS) Rwy 13 approach is still effective at allowing aircraft to arrive at any given time into HIB, but the increased minimums of 446ft and 7/8 mile visibility are not ideal for supporting early morning operations.

Table 17 RNAV(GPS) Rwy 13 (LNAV) - Runway Effectiveness

LNAV Runway 13 - Runway Effectiveness

446 ft - 7/8 mi

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	92.1%	95.9%	95.6%	95.9%	96.2%	93.8%	92.1%	89.3%	86.7%	96.0%	91.6%	91.0%
1:00	93.1%	95.9%	95.2%	95.1%	94.8%	90.5%	89.9%	85.4%	85.3%	94.7%	90.2%	91.9%
2:00	91.2%	96.2%	92.7%	95.0%	93.3%	90.6%	84.5%	79.9%	85.4%	94.4%	90.0%	89.4%
3:00	91.9%	95.1%	92.5%	95.4%	91.1%	84.5%	84.0%	76.5%	80.8%	95.3%	90.4%	88.1%
4:00	92.4%	94.8%	93.2%	93.6%	90.0%	84.4%	83.0%	75.8%	77.8%	93.7%	89.8%	87.7%
5:00	89.9%	94.2%	92.7%	94.2%	87.9%	84.8%	80.8%	75.6%	75.5%	93.0%	89.7%	87.3%
6:00	88.6%	93.0%	92.5%	93.3%	91.7%	88.4%	90.3%	74.1%	75.0%	93.1%	90.9%	87.5%
7:00	89.6%	90.9%	87.4%	93.4%	91.2%	91.1%	93.1%	84.5%	81.1%	91.1%	90.7%	87.5%
8:00	87.4%	92.9%	87.8%	92.1%	93.0%	92.6%	94.3%	88.0%	85.6%	92.8%	90.6%	83.5%
9:00	88.5%	93.7%	89.9%	95.7%	95.7%	96.1%	96.4%	91.5%	90.0%	93.2%	89.2%	85.1%
10:00	91.5%	95.6%	90.0%	94.6%	97.5%	97.6%	99.3%	95.1%	94.2%	93.9%	93.1%	89.3%
11:00	92.9%	94.2%	90.3%	97.7%	97.3%	98.6%	99.9%	97.8%	96.9%	95.7%	94.4%	91.3%
12:00	94.8%	95.0%	95.4%	97.4%	97.8%	98.8%	99.3%	98.9%	97.2%	97.7%	95.6%	91.2%
13:00	94.6%	94.7%	93.7%	97.3%	97.0%	99.9%	100.0%	99.2%	99.0%	96.6%	95.9%	92.1%
14:00	95.4%	95.3%	93.0%	97.8%	98.4%	99.7%	100.0%	99.3%	98.5%	97.5%	94.9%	91.9%
15:00	96.0%	97.0%	94.5%	98.0%	99.1%	99.8%	99.8%	99.9%	98.2%	97.0%	95.1%	94.6%
16:00	97.5%	96.3%	96.0%	98.2%	99.1%	99.6%	99.4%	100.0%	99.3%	98.6%	94.6%	94.6%
17:00	97.5%	98.1%	96.9%	98.0%	98.9%	99.7%	100.0%	99.5%	98.7%	98.1%	95.3%	95.4%
18:00	95.4%	99.1%	96.4%	97.9%	99.5%	99.6%	100.0%	99.3%	98.1%	97.4%	96.1%	94.6%
19:00	95.6%	98.5%	97.8%	98.9%	98.8%	99.7%	99.9%	100.0%	97.2%	97.9%	95.4%	93.6%
20:00	94.0%	98.5%	97.8%	99.0%	98.0%	99.3%	100.0%	99.4%	96.7%	97.5%	94.6%	89.4%
21:00	94.3%	98.1%	98.4%	98.6%	98.0%	98.4%	99.2%	99.2%	96.0%	97.3%	93.6%	91.6%
22:00	91.7%	97.3%	95.7%	97.0%	95.4%	97.6%	97.3%	96.7%	93.1%	97.1%	94.1%	91.4%
23:00	92.9%	97.1%	95.8%	97.8%	97.1%	95.1%	96.0%	91.4%	90.6%	95.9%	91.8%	93.1%
Day	93.2%	94.9%	92.6%	96.5%	96.8%	96.6%	97.0%	94.4%	94.7%	95.6%	93.3%	89.9%
Night	92.7%	96.4%	95.0%	96.2%	94.2%	91.9%	90.7%	88.1%	86.7%	95.6%	92.5%	90.9%
24 Hours	92.9%	95.7%	93.8%	96.3%	95.7%	95.0%	94.9%	91.5%	90.7%	95.6%	92.8%	90.5%

Table 18 RNAV(GPS) Rwy 13 (LNAV) - Overall Effectiveness

LNAV Runway 13 - Overall Effectiveness

446 ft - 7/8 mi

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	76.4%	78.2%	83.4%	84.5%	89.9%	89.0%	89.9%	86.7%	80.5%	84.3%	76.5%	75.9%
1:00	76.2%	84.7%	84.3%	83.8%	89.5%	86.0%	87.1%	83.0%	80.3%	83.9%	75.0%	77.6%
2:00	75.4%	81.3%	82.9%	83.0%	87.0%	86.9%	82.1%	76.1%	80.1%	81.0%	78.1%	75.5%
3:00	76.4%	81.7%	81.8%	85.2%	85.1%	80.8%	81.8%	74.2%	74.7%	85.8%	75.7%	71.7%
4:00	74.7%	80.4%	82.9%	82.7%	84.2%	81.1%	81.0%	72.7%	73.1%	83.9%	74.1%	74.1%
5:00	73.6%	80.1%	84.0%	82.9%	83.0%	81.9%	77.7%	73.3%	70.9%	79.2%	76.9%	73.7%
6:00	71.7%	78.6%	81.4%	80.0%	83.9%	83.8%	86.9%	71.4%	69.8%	81.4%	76.1%	73.2%
7:00	73.9%	77.7%	77.3%	78.0%	80.9%	84.0%	85.5%	79.8%	74.6%	80.7%	76.7%	74.5%
8:00	71.4%	75.7%	75.4%	74.5%	80.1%	82.4%	84.2%	81.2%	76.5%	79.7%	73.8%	69.3%
9:00	68.0%	74.0%	74.9%	74.1%	77.5%	80.7%	81.3%	80.8%	76.2%	74.3%	69.2%	70.2%
10:00	69.0%	71.0%	71.4%	71.2%	74.2%	78.5%	81.3%	77.0%	76.9%	69.4%	68.2%	70.2%
11:00	66.5%	69.1%	70.9%	64.4%	69.5%	75.0%	73.9%	77.3%	73.6%	69.9%	72.4%	72.9%
12:00	67.8%	68.8%	71.3%	65.7%	67.3%	73.2%	74.9%	75.4%	72.2%	68.3%	68.6%	72.3%
13:00	65.5%	65.5%	68.6%	62.3%	67.3%	74.0%	72.2%	75.7%	73.1%	66.5%	68.5%	73.4%
14:00	65.7%	63.6%	67.5%	61.2%	68.1%	72.2%	72.2%	76.6%	71.7%	69.7%	67.5%	74.8%
15:00	69.5%	65.5%	67.1%	64.3%	66.1%	71.9%	69.8%	76.1%	74.5%	69.8%	72.0%	79.3%
16:00	76.7%	68.3%	70.2%	65.2%	71.8%	74.3%	73.0%	78.7%	78.1%	71.8%	76.5%	84.4%
17:00	77.0%	79.3%	76.5%	67.3%	74.2%	77.9%	75.5%	82.7%	82.8%	76.5%	76.6%	83.9%
18:00	75.2%	81.8%	80.5%	75.9%	76.6%	82.2%	84.6%	88.1%	90.1%	83.3%	79.0%	79.0%
19:00	76.2%	82.2%	83.9%	83.7%	85.2%	87.8%	90.8%	95.2%	89.8%	84.9%	78.0%	80.9%
20:00	73.7%	80.2%	84.0%	86.6%	91.3%	96.3%	96.8%	95.6%	89.9%	84.5%	78.7%	75.5%
21:00	76.7%	82.1%	84.2%	89.3%	89.9%	95.6%	95.9%	95.8%	89.0%	84.6%	76.7%	77.1%
22:00	73.9%	79.6%	83.1%	86.8%	88.4%	94.1%	94.3%	94.0%	86.7%	83.1%	76.2%	79.4%
23:00	74.0%	82.6%	83.8%	86.8%	90.3%	91.7%	93.4%	88.9%	83.7%	82.7%	74.7%	78.7%
Day	68.9%	70.8%	72.6%	68.7%	74.5%	79.7%	80.0%	78.5%	76.7%	72.4%	70.8%	72.8%
Night	75.0%	81.0%	83.3%	84.6%	87.9%	88.2%	88.2%	85.0%	80.7%	83.3%	76.6%	77.2%
24 Hours	72.7%	76.3%	78.0%	76.6%	80.0%	82.6%	82.8%	81.5%	78.7%	78.3%	74.4%	75.7%

7.2.5.7 ILS or LOC RWY 31

The effectiveness of the ILS approach to runway 31, even under category I conditions, is extremely high at all hours and all months, with a slight decrease in effectiveness during the early morning hours of August and September. The small decrease in effectiveness, which does not lead to a significant increase in significant delays or diversions, could be improved through the introduction of lower approach minimums resulting from SA CAT I or SA CAT II minimums. However, this would require the addition of a manned, or remote, ATCT which could be cost prohibitive if installed solely for this purpose.

From the perspective of supporting overall approach and arrival operations into HIB, prevailing winds limit the ability to utilize runway 31 for operations, thus limiting the effectiveness of the existing ILS to periods of time in the morning and evening. This means that other approach options to runway 13 are necessary to enable continued access to HIB 24/7/365. However, as discussed in Section 8.1.6, the historical wind conditions at HIB tend to favor the use of runway 31. This is reflected in the increased overall effectiveness of the ILS or LOC Rwy 31 approach into HIB when compared to either of the approach procedure options for runway 13.

Table 19 ILS or LOC Rwy 31 - Runway Effectiveness

ILS Runway 31 - Runway Effectiveness

200 ft - 1/2 mi

Hour (Local)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	98.3%	100.0%	98.7%	99.4%	98.6%	98.2%	97.8%	95.0%	95.9%	98.3%	97.3%	98.7%
1:00	98.9%	99.9%	99.1%	99.4%	98.1%	97.3%	96.4%	95.1%	95.3%	98.3%	97.4%	99.5%
2:00	98.9%	100.0%	98.2%	98.0%	97.5%	98.0%	92.9%	92.4%	93.6%	99.3%	97.6%	99.0%
3:00	99.1%	99.8%	98.3%	98.1%	98.0%	93.9%	93.3%	89.8%	90.9%	98.8%	98.6%	98.7%
4:00	98.5%	99.5%	98.6%	97.8%	97.0%	93.4%	91.4%	87.8%	89.6%	98.7%	97.7%	99.1%
5:00	99.2%	99.2%	98.7%	98.0%	95.0%	91.8%	89.7%	86.9%	86.9%	98.8%	98.2%	99.1%
6:00	98.5%	99.2%	98.4%	98.2%	96.1%	96.4%	93.7%	83.8%	86.0%	97.8%	97.9%	98.6%
7:00	98.3%	97.8%	95.3%	96.4%	97.8%	98.1%	97.2%	91.9%	88.6%	96.8%	96.7%	99.4%
8:00	98.0%	98.9%	95.5%	98.9%	99.0%	98.8%	98.0%	96.8%	95.4%	98.0%	96.7%	98.6%
9:00	98.4%	98.4%	97.2%	98.7%	99.2%	100.0%	99.2%	98.8%	98.4%	98.0%	98.2%	97.7%
10:00	99.1%	99.3%	97.5%	98.0%	100.0%	99.8%	99.9%	99.4%	99.7%	98.9%	99.1%	99.2%
11:00	99.3%	98.9%	98.7%	99.7%	99.7%	100.0%	100.0%	99.6%	100.0%	99.4%	99.7%	99.3%
12:00	98.9%	98.7%	98.3%	98.5%	99.6%	99.7%	99.5%	99.5%	100.0%	100.0%	99.6%	99.2%
13:00	99.7%	99.4%	97.9%	99.7%	98.9%	100.0%	99.7%	100.0%	100.0%	99.7%	99.7%	99.1%
14:00	99.4%	98.3%	97.1%	99.5%	99.3%	99.9%	100.0%	100.0%	100.0%	99.4%	99.1%	99.0%
15:00	99.9%	99.4%	98.2%	99.9%	100.0%	100.0%	100.0%	100.0%	99.4%	99.9%	99.7%	99.1%
16:00	99.8%	99.2%	98.1%	100.0%	99.7%	100.0%	99.7%	100.0%	99.9%	99.7%	98.9%	99.9%
17:00	99.4%	99.7%	98.1%	99.7%	100.0%	100.0%	100.0%	99.7%	100.0%	99.6%	99.6%	99.8%
18:00	99.0%	100.0%	98.3%	99.4%	100.0%	99.6%	100.0%	99.7%	99.8%	100.0%	99.3%	99.8%
19:00	99.5%	100.0%	99.4%	99.2%	100.0%	100.0%	100.0%	99.9%	99.7%	100.0%	98.9%	99.8%
20:00	99.1%	100.0%	99.3%	100.0%	100.0%	100.0%	100.0%	99.8%	99.4%	99.9%	98.5%	99.8%
21:00	98.8%	99.6%	99.6%	99.9%	99.8%	99.6%	99.8%	99.8%	99.5%	99.5%	99.1%	99.6%
22:00	99.0%	100.0%	99.0%	99.7%	99.7%	99.5%	98.8%	98.9%	98.4%	99.3%	98.6%	99.2%
23:00	98.6%	99.8%	99.3%	99.7%	99.5%	98.5%	98.3%	96.5%	97.6%	98.9%	98.0%	99.5%

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Day	99.1%	98.9%	97.5%	99.0%	99.2%	99.0%	98.5%	97.6%	98.4%	99.0%	98.7%	98.9%
Night	98.9%	99.8%	98.9%	99.0%	98.3%	97.3%	96.1%	94.7%	94.4%	99.0%	98.4%	99.3%
24 Hours	99.0%	99.4%	98.2%	99.0%	98.9%	98.4%	97.7%	96.3%	96.4%	99.0%	98.5%	99.2%

Table 20 ILS or LOC Rwy 31 - Overall Effectiveness

ILS Runway 31 - Overall Effectiveness

200 ft - 1/2 mi

Hour (Local)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	95.5%	97.3%	94.1%	93.3%	95.9%	96.3%	97.2%	93.9%	92.5%	94.0%	93.8%	94.3%
1:00	95.7%	97.9%	96.1%	93.1%	95.8%	94.9%	94.5%	94.2%	92.1%	94.4%	94.0%	95.5%
2:00	96.6%	97.1%	94.0%	91.6%	94.5%	95.2%	92.3%	91.5%	91.7%	95.2%	94.1%	95.5%
3:00	95.7%	96.8%	92.9%	93.0%	95.3%	92.2%	92.3%	88.2%	88.7%	95.6%	92.8%	94.1%
4:00	95.9%	96.6%	93.9%	92.6%	94.4%	90.9%	90.3%	86.0%	87.7%	95.4%	94.3%	95.6%
5:00	95.6%	95.1%	93.8%	91.9%	92.8%	89.1%	88.8%	85.7%	84.4%	94.5%	94.1%	95.6%
6:00	95.4%	96.6%	93.7%	91.3%	93.3%	92.5%	92.9%	83.3%	83.6%	93.1%	93.9%	96.1%
7:00	94.4%	93.9%	89.4%	87.3%	92.1%	93.2%	94.7%	90.9%	86.0%	93.6%	92.2%	95.7%
8:00	95.7%	95.1%	86.6%	86.7%	90.6%	90.5%	94.1%	94.2%	91.3%	92.9%	90.0%	94.7%
9:00	93.6%	92.1%	86.6%	80.3%	83.6%	85.9%	95.0%	94.9%	90.1%	87.8%	88.2%	94.0%
10:00	93.3%	92.5%	83.0%	77.0%	79.6%	84.4%	91.4%	92.0%	87.4%	85.8%	88.1%	93.6%
11:00	92.6%	91.1%	81.2%	75.6%	76.1%	81.0%	88.7%	89.0%	83.2%	83.0%	85.2%	93.1%
12:00	91.2%	90.5%	79.1%	73.3%	71.7%	78.7%	89.0%	87.1%	80.6%	83.0%	85.2%	94.1%
13:00	91.6%	89.2%	77.0%	72.7%	74.0%	80.7%	87.2%	88.3%	81.8%	82.6%	84.7%	92.0%
14:00	90.5%	89.8%	80.2%	76.2%	76.2%	80.2%	87.2%	86.8%	79.1%	81.7%	85.2%	93.4%
15:00	91.1%	91.3%	79.5%	74.7%	76.6%	79.1%	89.4%	87.9%	81.3%	82.3%	87.0%	94.4%
16:00	93.3%	92.7%	82.2%	76.1%	77.0%	81.3%	90.3%	89.9%	84.5%	82.7%	92.0%	96.3%
17:00	93.3%	94.9%	87.4%	80.4%	79.9%	82.9%	91.8%	91.9%	87.6%	89.4%	93.0%	96.6%
18:00	94.2%	96.6%	89.9%	83.9%	82.9%	85.7%	94.4%	95.7%	92.4%	94.8%	93.1%	95.3%
19:00	93.8%	96.9%	92.3%	87.6%	90.9%	90.2%	96.4%	98.2%	94.4%	93.2%	91.7%	96.4%
20:00	94.9%	95.5%	91.6%	90.2%	92.3%	93.7%	98.0%	96.6%	92.8%	94.2%	94.0%	96.2%
21:00	94.4%	95.8%	92.8%	92.6%	93.3%	94.1%	97.6%	96.5%	94.5%	93.0%	93.4%	97.6%
22:00	95.5%	97.5%	93.8%	94.3%	94.6%	96.2%	96.7%	97.7%	93.5%	93.3%	93.8%	95.4%
23:00	95.2%	97.4%	94.8%	95.7%	96.8%	94.7%	97.1%	95.7%	93.3%	93.4%	92.5%	95.4%

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Day	92.6%	92.1%	83.5%	78.7%	81.8%	85.6%	91.8%	90.2%	85.4%	85.9%	87.3%	93.7%
Night	95.1%	96.7%	93.7%	92.3%	94.6%	94.3%	94.8%	93.1%	90.8%	94.2%	93.4%	95.7%
24 Hours	94.1%	94.6%	88.6%	85.5%	87.1%	88.5%	92.8%	91.5%	88.1%	90.4%	91.1%	95.0%

The LOC only portion of the ILS approach to runway 31 is also effective at allowing aircraft to arrive at any given time into HIB, due to the low visibility allowed by the use of the stepdown fix (BOYAC) requiring the use of the HIB VOR/DME.

Table 21 ILS or LOC Rwy 31 (LOC with BOYAC) - Runway Effectiveness

LOC with BOYAC FIX Runway 31 - Runway Effectiveness

337 ft - 1/2 mi (Cat C), 3/4 mi (Cat D)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	96.5%	98.9%	97.8%	97.5%	97.4%	96.6%	95.5%	93.0%	92.8%	97.1%	94.6%	93.5%
1:00	96.7%	98.5%	96.9%	98.3%	97.2%	92.9%	94.0%	91.7%	90.5%	96.2%	94.0%	95.5%
2:00	96.2%	98.2%	95.7%	96.6%	95.2%	94.4%	89.7%	87.1%	88.9%	96.5%	94.3%	93.8%
3:00	96.4%	98.3%	95.1%	96.4%	92.7%	88.7%	89.2%	82.9%	84.9%	96.7%	94.2%	94.0%
4:00	95.6%	98.0%	95.4%	95.7%	91.3%	87.5%	88.7%	80.9%	82.7%	95.5%	94.6%	92.8%
5:00	95.3%	97.7%	95.2%	95.9%	90.6%	87.5%	86.2%	80.6%	80.2%	95.3%	94.8%	93.2%
6:00	94.4%	95.7%	94.9%	95.9%	92.9%	89.5%	91.3%	78.1%	80.1%	95.3%	94.3%	92.9%
7:00	94.1%	95.3%	92.2%	95.1%	92.9%	93.8%	93.8%	87.7%	83.9%	93.2%	94.8%	92.8%
8:00	94.3%	96.9%	93.2%	95.1%	95.8%	94.8%	95.4%	90.9%	89.5%	95.3%	95.0%	92.4%
9:00	95.1%	96.5%	94.3%	96.8%	97.1%	97.6%	98.3%	95.1%	92.9%	95.8%	95.0%	92.8%
10:00	96.5%	99.0%	95.4%	96.9%	99.2%	98.7%	99.7%	97.0%	96.5%	95.8%	96.7%	95.0%
11:00	97.3%	98.6%	96.7%	99.1%	99.6%	99.3%	100.0%	98.7%	98.2%	96.9%	96.9%	95.8%
12:00	97.6%	98.4%	98.0%	98.4%	99.6%	99.3%	99.5%	99.5%	99.0%	98.9%	97.9%	95.8%
13:00	98.8%	99.0%	97.1%	99.0%	98.7%	100.0%	99.7%	100.0%	99.9%	98.3%	98.7%	95.1%
14:00	98.9%	97.9%	96.8%	99.2%	99.3%	99.9%	100.0%	99.8%	99.7%	99.2%	98.1%	96.4%
15:00	99.5%	99.2%	98.1%	99.8%	100.0%	100.0%	100.0%	100.0%	98.8%	99.9%	99.2%	97.6%
16:00	99.3%	99.1%	97.4%	99.6%	99.7%	100.0%	99.7%	100.0%	99.4%	99.3%	98.1%	97.6%
17:00	98.5%	99.7%	97.9%	98.7%	100.0%	100.0%	100.0%	99.7%	99.4%	99.6%	98.6%	97.0%
18:00	98.0%	99.6%	98.1%	98.7%	100.0%	99.6%	100.0%	99.7%	99.0%	99.0%	98.2%	97.6%
19:00	98.1%	99.8%	98.4%	99.1%	99.7%	99.8%	100.0%	99.9%	98.1%	98.9%	97.8%	97.6%
20:00	96.3%	99.4%	98.8%	99.9%	99.7%	99.6%	100.0%	99.8%	97.9%	98.7%	97.0%	95.0%
21:00	96.8%	99.1%	99.2%	99.3%	99.0%	98.9%	99.8%	99.6%	97.7%	98.4%	96.2%	95.3%
22:00	96.0%	99.9%	98.4%	99.2%	97.6%	98.3%	98.1%	98.1%	96.9%	97.6%	96.4%	95.6%
23:00	95.7%	99.1%	97.8%	98.7%	97.9%	96.7%	97.9%	95.3%	95.5%	96.7%	95.7%	96.2%
Day	97.5%	98.1%	96.3%	98.0%	98.2%	97.5%	97.7%	95.9%	96.4%	97.5%	96.9%	95.1%
Night	96.3%	98.6%	97.0%	97.7%	95.8%	94.2%	94.1%	91.7%	90.5%	97.1%	95.9%	95.0%
24 Hours	96.8%	98.4%	96.6%	97.9%	97.2%	96.4%	96.5%	94.0%	93.4%	97.3%	96.3%	95.1%

Table 22 ILS or LOC Rwy 31 (LOC with BOYAC) - Overall Effectiveness

LOC with BOYAC FIX Runway 31 - Overall Effectiveness
337 ft - 1/2 mi (Cat C), 3/4 mi (Cat D)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	95.5%	97.3%	94.1%	93.3%	95.9%	96.3%	97.2%	93.9%	92.5%	94.0%	93.8%	94.3%
1:00	95.7%	97.9%	96.1%	93.1%	95.8%	94.9%	94.5%	94.2%	92.1%	94.4%	94.0%	95.5%
2:00	96.6%	97.1%	94.0%	91.6%	94.5%	95.2%	92.3%	91.5%	91.7%	95.2%	94.1%	95.5%
3:00	95.7%	96.8%	92.9%	93.0%	95.3%	92.2%	92.3%	88.2%	88.7%	95.6%	92.8%	94.1%
4:00	95.9%	96.6%	93.9%	92.6%	94.4%	90.9%	90.3%	86.0%	87.7%	95.4%	94.3%	95.6%
5:00	95.6%	95.1%	93.8%	91.9%	92.8%	89.1%	88.8%	85.7%	84.4%	94.5%	94.1%	95.6%
6:00	95.4%	96.6%	93.7%	91.3%	93.3%	92.5%	92.9%	83.3%	83.6%	93.1%	93.9%	96.1%
7:00	94.4%	93.9%	89.4%	87.3%	92.1%	93.2%	94.7%	90.9%	86.0%	93.6%	92.2%	95.7%
8:00	95.7%	95.1%	86.6%	86.7%	90.6%	90.5%	94.1%	94.2%	91.3%	92.9%	90.0%	94.7%
9:00	93.6%	92.1%	86.6%	80.3%	83.6%	85.9%	95.0%	94.9%	90.1%	87.8%	88.2%	94.0%
10:00	93.3%	92.5%	83.0%	77.0%	79.6%	84.4%	91.4%	92.0%	87.4%	85.8%	88.1%	93.6%
11:00	92.6%	91.1%	81.2%	75.6%	76.1%	81.0%	88.7%	89.0%	83.2%	83.0%	85.2%	93.1%
12:00	91.2%	90.5%	79.1%	73.3%	71.7%	78.7%	89.0%	87.1%	80.6%	83.0%	85.2%	94.1%
13:00	91.6%	89.2%	77.0%	72.7%	74.0%	80.7%	87.2%	88.3%	81.8%	82.6%	84.7%	92.0%
14:00	90.5%	89.8%	80.2%	76.2%	76.2%	80.2%	87.2%	86.8%	79.1%	81.7%	85.2%	93.4%
15:00	91.1%	91.3%	79.5%	74.7%	76.6%	79.1%	89.4%	87.9%	81.3%	82.3%	87.0%	94.4%
16:00	93.3%	92.7%	82.2%	76.1%	77.0%	81.3%	90.3%	89.9%	84.5%	82.7%	92.0%	96.3%
17:00	93.3%	94.9%	87.4%	80.4%	79.9%	82.9%	91.8%	91.9%	87.6%	89.4%	93.0%	96.6%
18:00	94.2%	96.6%	89.9%	83.9%	82.9%	85.7%	94.4%	95.7%	92.4%	94.8%	93.1%	95.3%
19:00	93.8%	96.9%	92.3%	87.6%	90.9%	90.2%	96.4%	98.2%	94.4%	93.2%	91.7%	96.4%
20:00	94.9%	95.5%	91.6%	90.2%	92.3%	93.7%	98.0%	96.6%	92.8%	94.2%	94.0%	96.2%
21:00	94.4%	95.8%	92.8%	92.6%	93.3%	94.1%	97.6%	96.5%	94.5%	93.0%	93.4%	97.6%
22:00	95.5%	97.5%	93.8%	94.3%	94.6%	96.2%	96.7%	97.7%	93.5%	93.3%	93.8%	95.4%
23:00	95.2%	97.4%	94.8%	95.7%	96.8%	94.7%	97.1%	95.7%	93.3%	93.4%	92.5%	95.4%
Day	92.6%	92.1%	83.5%	78.7%	81.8%	85.6%	91.8%	90.2%	85.4%	85.9%	87.3%	93.7%
Night	95.1%	96.7%	93.7%	92.3%	94.6%	94.3%	94.8%	93.1%	90.8%	94.2%	93.4%	95.7%
24 Hours	94.1%	94.6%	88.6%	85.5%	87.1%	88.5%	92.8%	91.5%	88.1%	90.4%	91.1%	95.0%

7.2.5.8 RNAV (GPS) RWY 31

Similar to the ILS or LOC Rwy 13, the effectiveness of the RNAV (GPS) LPV and LNAV/VNAV approach to runway 13, is extremely high at all hours and all months, with a slight decrease in effectiveness during the early morning hours of August and September

From the perspective of supporting overall approach and arrival operations into HIB, the prevailing winds limit the ability to utilize runway 13 for operations, thus limiting the overall effectiveness of the existing LPV and LNAV/VNAV to periods of time in the morning and evening. This means that other approach options to runway 31 are necessary to enable continued access to HIB 24/7/365.

The similarity in approach minimums between the LPV and LNAV/VNAV enables a broad range of aircraft to successfully use the approach to runway 13 during inclement weather, which is especially useful for regional jet and narrowbody aircraft that are commonly VNAV capable but not LPV capable.

While the lowest minimums that can be achieved on an LPV approach are 200ft and ½ mile, those minimums were analyzed for runway 13 for the ILS or LOC Rwy 13 effectiveness analysis (Table 10). A reduction in the visibility from ¾ mi to ½ mi would increase the likelihood of success in the early morning hours of March and December.

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Table 23 RNAV (GPS) Rwy 31 (LPV) - Runway Effectiveness

LPV Runway 31 - Runway Effectiveness

200 ft - 1/2 mi

Hour (Local)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	98.3%	100.0%	98.7%	99.4%	98.6%	98.2%	97.8%	95.0%	95.9%	98.3%	97.3%	98.7%
1:00	98.9%	99.9%	99.1%	99.4%	98.1%	97.3%	96.4%	95.1%	95.3%	98.3%	97.4%	99.5%
2:00	98.9%	100.0%	98.2%	98.0%	97.5%	98.0%	92.9%	92.4%	93.6%	99.3%	97.6%	99.0%
3:00	99.1%	99.8%	98.3%	98.1%	98.0%	93.9%	93.3%	89.8%	90.9%	98.8%	98.6%	98.7%
4:00	98.5%	99.5%	98.6%	97.8%	97.0%	93.4%	91.4%	87.8%	89.6%	98.7%	97.7%	99.1%
5:00	99.2%	99.2%	98.7%	98.0%	95.0%	91.8%	89.7%	86.9%	86.9%	98.8%	98.2%	99.1%
6:00	98.5%	99.2%	98.4%	98.2%	96.1%	96.4%	93.7%	83.8%	86.0%	97.8%	97.9%	98.6%
7:00	98.3%	97.8%	95.3%	96.4%	97.8%	98.1%	97.2%	91.9%	88.6%	96.8%	96.7%	99.4%
8:00	98.0%	98.9%	95.5%	98.9%	99.0%	98.8%	98.0%	96.8%	95.4%	98.0%	96.7%	98.6%
9:00	98.4%	98.4%	97.2%	98.7%	99.2%	100.0%	99.2%	98.8%	98.4%	98.0%	98.2%	97.7%
10:00	99.1%	99.3%	97.5%	98.0%	100.0%	99.8%	99.9%	99.4%	99.7%	98.9%	99.1%	99.2%
11:00	99.3%	98.9%	98.7%	99.7%	99.7%	100.0%	100.0%	99.6%	100.0%	99.4%	99.7%	99.3%
12:00	98.9%	98.7%	98.3%	98.5%	99.6%	99.7%	99.5%	99.5%	100.0%	100.0%	99.6%	99.2%
13:00	99.7%	99.4%	97.9%	99.7%	98.9%	100.0%	99.7%	100.0%	100.0%	99.7%	99.7%	99.1%
14:00	99.4%	98.3%	97.1%	99.5%	99.3%	99.9%	100.0%	100.0%	100.0%	99.4%	99.1%	99.0%
15:00	99.9%	99.4%	98.2%	99.9%	100.0%	100.0%	100.0%	100.0%	99.4%	99.9%	99.7%	99.1%
16:00	99.8%	99.2%	98.1%	100.0%	99.7%	100.0%	99.7%	100.0%	99.9%	99.7%	98.9%	99.9%
17:00	99.4%	99.7%	98.1%	99.7%	100.0%	100.0%	100.0%	99.7%	100.0%	99.6%	99.6%	99.8%
18:00	99.0%	100.0%	98.3%	99.4%	100.0%	99.6%	100.0%	99.7%	99.8%	100.0%	99.3%	99.8%
19:00	99.5%	100.0%	99.4%	99.2%	100.0%	100.0%	100.0%	99.9%	99.7%	100.0%	98.9%	99.8%
20:00	99.1%	100.0%	99.3%	100.0%	100.0%	100.0%	100.0%	99.8%	99.4%	99.9%	98.5%	99.8%
21:00	98.8%	99.6%	99.6%	99.9%	99.8%	99.6%	99.8%	99.8%	99.5%	99.5%	99.1%	99.6%
22:00	99.0%	100.0%	99.0%	99.7%	99.7%	99.5%	98.8%	98.9%	98.4%	99.3%	98.6%	99.2%
23:00	98.6%	99.8%	99.3%	99.7%	99.5%	98.5%	98.3%	96.5%	97.6%	98.9%	98.0%	99.5%

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Day	99.1%	98.9%	97.5%	99.0%	99.2%	99.0%	98.5%	97.6%	98.4%	99.0%	98.7%	98.9%
Night	98.9%	99.8%	98.9%	99.0%	98.3%	97.3%	96.1%	94.7%	94.4%	99.0%	98.4%	99.3%
24 Hours	99.0%	99.4%	98.2%	99.0%	98.9%	98.4%	97.7%	96.3%	96.4%	99.0%	98.5%	99.2%

Table 24 RNAV (GPS) Rwy 31 (LPV) - Overall Effectiveness

LPV Runway 31 - Overall Effectiveness

200 ft - 1/2mi

Hour (Local)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	95.5%	97.3%	94.1%	93.3%	95.9%	96.3%	97.2%	93.9%	92.5%	94.0%	93.8%	94.3%
1:00	95.7%	97.9%	96.1%	93.1%	95.8%	94.9%	94.5%	94.2%	92.1%	94.4%	94.0%	95.5%
2:00	96.6%	97.1%	94.0%	91.6%	94.5%	95.2%	92.3%	91.5%	91.7%	95.2%	94.1%	95.5%
3:00	95.7%	96.8%	92.9%	93.0%	95.3%	92.2%	92.3%	88.2%	88.7%	95.6%	92.8%	94.1%
4:00	95.9%	96.6%	93.9%	92.6%	94.4%	90.9%	90.3%	86.0%	87.7%	95.4%	94.3%	95.6%
5:00	95.6%	95.1%	93.8%	91.9%	92.8%	89.1%	88.8%	85.7%	84.4%	94.5%	94.1%	95.6%
6:00	95.4%	96.6%	93.7%	91.3%	93.3%	92.5%	92.9%	83.3%	83.6%	93.1%	93.9%	96.1%
7:00	94.4%	93.9%	89.4%	87.3%	92.1%	93.2%	94.7%	90.9%	86.0%	93.6%	92.2%	95.7%
8:00	95.7%	95.1%	86.6%	86.7%	90.6%	90.5%	94.1%	94.2%	91.3%	92.9%	90.0%	94.7%
9:00	93.6%	92.1%	86.6%	80.3%	83.6%	85.9%	95.0%	94.9%	90.1%	87.8%	88.2%	94.0%
10:00	93.3%	92.5%	83.0%	77.0%	79.6%	84.4%	91.4%	92.0%	87.4%	85.8%	88.1%	93.6%
11:00	92.6%	91.1%	81.2%	75.6%	76.1%	81.0%	88.7%	89.0%	83.2%	83.0%	85.2%	93.1%
12:00	91.2%	90.5%	79.1%	73.3%	71.7%	78.7%	89.0%	87.1%	80.6%	83.0%	85.2%	94.1%
13:00	91.6%	89.2%	77.0%	72.7%	74.0%	80.7%	87.2%	88.3%	81.8%	82.6%	84.7%	92.0%
14:00	90.5%	89.8%	80.2%	76.2%	76.2%	80.2%	87.2%	86.8%	79.1%	81.7%	85.2%	93.4%
15:00	91.1%	91.3%	79.5%	74.7%	76.6%	79.1%	89.4%	87.9%	81.3%	82.3%	87.0%	94.4%
16:00	93.3%	92.7%	82.2%	76.1%	77.0%	81.3%	90.3%	89.9%	84.5%	82.7%	92.0%	96.3%
17:00	93.3%	94.9%	87.4%	80.4%	79.9%	82.9%	91.8%	91.9%	87.6%	89.4%	93.0%	96.6%
18:00	94.2%	96.6%	89.9%	83.9%	82.9%	85.7%	94.4%	95.7%	92.4%	94.8%	93.1%	95.3%
19:00	93.8%	96.9%	92.3%	87.6%	90.9%	90.2%	96.4%	98.2%	94.4%	93.2%	91.7%	96.4%
20:00	94.9%	95.5%	91.6%	90.2%	92.3%	93.7%	98.0%	96.6%	92.8%	94.2%	94.0%	96.2%
21:00	94.4%	95.8%	92.8%	92.6%	93.3%	94.1%	97.6%	96.5%	94.5%	93.0%	93.4%	97.6%
22:00	95.5%	97.5%	93.8%	94.3%	94.6%	96.2%	96.7%	97.7%	93.5%	93.3%	93.8%	95.4%
23:00	95.2%	97.4%	94.8%	95.7%	96.8%	94.7%	97.1%	95.7%	93.3%	93.4%	92.5%	95.4%

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Day	92.6%	92.1%	83.5%	78.7%	81.8%	85.6%	91.8%	90.2%	85.4%	85.9%	87.3%	93.7%
Night	95.1%	96.7%	93.7%	92.3%	94.6%	94.3%	94.8%	93.1%	90.8%	94.2%	93.4%	95.7%
24 Hours	94.1%	94.6%	88.6%	85.5%	87.1%	88.5%	92.8%	91.5%	88.1%	90.4%	91.1%	95.0%

Table 25 RNAV (GPS) Rwy 31 (VNAV) - Runway Effectiveness

LNAV/VNAV Runway 31 - Runway Effectiveness

250 ft - 1/2 mi

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	97.5%	100.0%	98.4%	98.1%	98.0%	97.3%	96.6%	94.2%	93.4%	97.9%	96.4%	95.5%
1:00	97.5%	99.8%	97.7%	98.8%	97.4%	94.9%	95.0%	92.8%	92.2%	97.2%	95.4%	97.0%
2:00	97.2%	99.8%	96.5%	97.2%	96.4%	96.5%	91.1%	88.2%	90.1%	98.2%	95.4%	96.7%
3:00	98.0%	99.2%	96.4%	97.4%	95.5%	90.5%	90.0%	84.9%	86.9%	97.8%	96.0%	97.3%
4:00	97.1%	98.9%	97.1%	97.0%	93.3%	89.9%	89.3%	83.0%	85.6%	97.3%	95.4%	96.5%
5:00	98.0%	98.4%	96.2%	96.5%	92.4%	89.2%	87.1%	81.9%	82.3%	98.0%	95.7%	96.7%
6:00	97.4%	97.4%	95.7%	96.5%	93.4%	93.6%	92.2%	80.0%	82.0%	96.6%	95.4%	96.7%
7:00	96.4%	96.2%	93.4%	96.0%	94.3%	94.8%	95.1%	89.0%	85.5%	94.5%	95.6%	96.8%
8:00	96.7%	97.9%	93.8%	96.7%	97.5%	95.4%	95.9%	92.8%	91.5%	96.5%	96.2%	96.4%
9:00	96.7%	97.7%	95.4%	97.2%	97.7%	98.4%	98.6%	96.3%	94.5%	97.0%	96.7%	95.4%
10:00	97.9%	99.2%	96.6%	97.4%	99.4%	99.6%	99.9%	98.0%	98.4%	97.9%	97.5%	97.1%
11:00	98.1%	98.6%	97.3%	99.1%	99.7%	100.0%	100.0%	99.3%	99.1%	98.2%	98.1%	98.0%
12:00	97.8%	98.4%	98.1%	98.4%	99.6%	99.7%	99.5%	99.5%	99.7%	99.3%	98.8%	97.9%
13:00	98.8%	99.0%	97.1%	99.0%	98.9%	100.0%	99.7%	100.0%	100.0%	99.0%	99.2%	97.4%
14:00	99.0%	97.9%	97.0%	99.2%	99.3%	99.9%	100.0%	100.0%	100.0%	99.4%	98.8%	98.3%
15:00	99.5%	99.2%	98.2%	99.8%	100.0%	100.0%	100.0%	100.0%	99.4%	99.9%	99.7%	98.3%
16:00	99.3%	99.1%	97.7%	99.8%	99.7%	100.0%	99.7%	100.0%	99.8%	99.7%	98.9%	98.6%
17:00	98.9%	99.7%	97.9%	99.3%	100.0%	100.0%	100.0%	99.7%	99.7%	99.6%	99.2%	97.8%
18:00	98.5%	99.9%	98.1%	98.9%	100.0%	99.6%	100.0%	99.7%	99.6%	99.8%	98.6%	97.7%
19:00	99.1%	99.8%	99.0%	99.1%	99.9%	100.0%	100.0%	99.9%	98.7%	99.6%	98.9%	98.2%
20:00	98.2%	99.9%	98.9%	99.9%	99.8%	100.0%	100.0%	99.8%	99.1%	99.2%	97.8%	97.8%
21:00	98.0%	99.1%	99.4%	99.6%	99.4%	99.6%	99.8%	99.8%	98.6%	98.9%	97.9%	97.5%
22:00	97.8%	99.9%	98.5%	99.5%	98.7%	98.5%	98.6%	98.1%	97.6%	98.7%	97.4%	97.2%
23:00	97.4%	99.8%	98.6%	99.0%	98.5%	97.8%	98.0%	95.3%	96.1%	97.9%	96.7%	97.4%
Day	98.2%	98.4%	96.7%	98.4%	98.5%	98.1%	98.0%	96.5%	97.3%	98.3%	97.8%	97.3%
Night	97.8%	99.4%	97.7%	98.2%	96.9%	95.6%	94.8%	92.5%	91.9%	98.2%	97.0%	97.2%
24 Hours	98.0%	98.9%	97.2%	98.3%	97.9%	97.3%	96.9%	94.7%	94.6%	98.2%	97.3%	97.3%

Table 26 RNAV (GPS) Rwy 31 (VNAV) - Overall Effectiveness

LNAV/VNAV Runway 13 - Overall Effectiveness

250 ft - 1/2 mi

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	94.7%	97.3%	93.8%	92.0%	95.3%	95.4%	96.1%	93.1%	90.1%	93.6%	93.0%	91.3%
1:00	94.3%	97.8%	94.7%	92.6%	95.1%	92.6%	93.2%	92.0%	89.1%	93.4%	92.1%	93.1%
2:00	94.9%	96.9%	92.4%	90.8%	93.4%	93.8%	90.5%	87.3%	88.2%	94.2%	92.0%	93.3%
3:00	94.6%	96.2%	91.2%	92.3%	92.9%	88.8%	89.1%	83.3%	84.7%	94.6%	90.4%	92.8%
4:00	94.5%	96.0%	92.5%	91.8%	90.8%	87.5%	88.2%	81.4%	83.8%	93.9%	92.1%	93.1%
5:00	94.5%	94.4%	91.5%	90.5%	90.2%	86.6%	86.3%	80.7%	79.9%	93.7%	91.7%	93.2%
6:00	94.4%	94.8%	91.1%	89.6%	90.7%	89.8%	91.5%	79.5%	79.6%	91.9%	91.5%	94.2%
7:00	92.7%	92.4%	87.7%	86.9%	88.8%	90.1%	92.6%	88.1%	83.1%	91.4%	91.1%	93.2%
8:00	94.5%	94.2%	85.0%	84.8%	89.2%	87.4%	92.1%	90.3%	87.6%	91.5%	89.5%	92.6%
9:00	92.0%	91.4%	85.0%	79.1%	82.3%	84.5%	94.4%	92.5%	86.5%	86.8%	86.9%	91.8%
10:00	92.2%	92.4%	82.2%	76.5%	79.1%	84.2%	91.4%	90.7%	86.3%	85.0%	86.7%	91.7%
11:00	91.5%	90.8%	80.1%	75.1%	76.1%	81.0%	88.7%	88.8%	82.4%	82.0%	83.8%	91.9%
12:00	90.2%	90.2%	78.9%	73.2%	71.7%	78.7%	89.0%	87.1%	80.4%	82.4%	84.4%	92.9%
13:00	90.8%	88.8%	76.4%	72.2%	74.0%	80.7%	87.2%	88.3%	81.8%	82.0%	84.3%	90.4%
14:00	90.2%	89.3%	80.1%	76.0%	76.2%	80.2%	87.2%	86.8%	79.1%	81.7%	84.9%	92.7%
15:00	90.8%	91.2%	79.5%	74.6%	76.6%	79.1%	89.4%	87.9%	81.3%	82.3%	87.0%	93.6%
16:00	92.9%	92.7%	81.8%	76.0%	77.0%	81.3%	90.3%	89.9%	84.4%	82.7%	92.0%	95.0%
17:00	92.9%	94.9%	87.3%	80.0%	79.9%	82.9%	91.8%	91.9%	87.3%	89.3%	92.7%	94.8%
18:00	93.7%	96.5%	89.7%	83.5%	82.9%	85.7%	94.4%	95.7%	92.3%	94.6%	92.4%	93.3%
19:00	93.4%	96.7%	91.9%	87.6%	90.8%	90.2%	96.4%	98.2%	93.5%	92.8%	91.7%	94.8%
20:00	94.0%	95.4%	91.2%	90.1%	92.1%	93.7%	98.0%	96.6%	92.5%	93.6%	93.2%	94.2%
21:00	93.5%	95.4%	92.6%	92.4%	92.9%	94.1%	97.6%	96.5%	93.7%	92.4%	92.3%	95.5%
22:00	94.3%	97.4%	93.3%	94.1%	93.5%	95.2%	96.5%	97.0%	92.7%	92.7%	92.6%	93.5%
23:00	94.1%	97.4%	94.1%	95.1%	95.8%	94.1%	96.8%	94.5%	91.9%	92.5%	91.3%	93.4%

Day	91.7%	91.7%	82.8%	78.2%	81.1%	84.8%	91.3%	89.0%	84.4%	85.2%	86.5%	92.2%
Night	94.0%	96.3%	92.5%	91.6%	93.2%	92.7%	93.5%	91.0%	88.3%	93.4%	92.1%	93.7%
24 Hours	93.2%	94.2%	87.7%	84.9%	86.1%	87.4%	92.0%	89.9%	86.3%	89.6%	90.0%	93.2%

Table 27 RNAV (GPS) Rwy 31 (LNAV) - Runway Effectiveness

LNAV Runway 31 - Runway Effectiveness

335 ft - 5/8 mi

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	96.0%	98.5%	97.7%	97.2%	97.1%	95.9%	93.6%	91.2%	90.5%	97.1%	94.4%	93.1%
1:00	96.3%	98.1%	96.8%	97.9%	96.7%	91.9%	92.2%	89.5%	88.5%	96.0%	93.9%	95.3%
2:00	95.6%	98.1%	95.6%	96.6%	94.8%	93.3%	86.8%	84.4%	88.5%	96.4%	94.3%	93.5%
3:00	95.9%	98.1%	95.0%	96.4%	92.4%	87.9%	87.0%	80.4%	84.3%	96.4%	94.0%	93.3%
4:00	95.5%	97.6%	95.1%	95.5%	90.9%	86.7%	86.1%	79.3%	81.1%	95.3%	94.3%	92.1%
5:00	94.4%	97.2%	95.0%	95.6%	89.9%	86.5%	83.7%	79.3%	78.6%	95.3%	94.6%	92.5%
6:00	94.0%	95.4%	94.8%	95.2%	92.9%	89.3%	91.1%	77.2%	79.4%	94.8%	93.9%	92.3%
7:00	94.0%	94.2%	91.4%	94.8%	92.9%	93.7%	93.8%	87.5%	83.4%	93.0%	94.6%	92.7%
8:00	93.2%	95.2%	92.4%	94.6%	95.8%	94.8%	95.3%	90.8%	89.5%	95.3%	93.9%	90.8%
9:00	93.9%	95.6%	93.8%	96.4%	97.1%	97.6%	98.2%	94.9%	92.9%	95.8%	94.1%	90.8%
10:00	96.0%	98.4%	93.9%	96.6%	99.1%	98.7%	99.7%	97.0%	96.5%	95.6%	96.5%	93.5%
11:00	96.8%	96.9%	95.9%	99.0%	99.1%	99.3%	100.0%	98.6%	98.2%	96.9%	96.6%	95.4%
12:00	97.1%	97.5%	97.3%	98.4%	99.6%	99.3%	99.5%	99.5%	99.0%	98.5%	97.6%	95.3%
13:00	98.0%	96.9%	96.6%	98.6%	98.4%	100.0%	99.7%	100.0%	99.9%	97.8%	98.4%	94.4%
14:00	98.2%	97.3%	96.6%	99.2%	99.3%	99.9%	100.0%	99.8%	99.7%	99.1%	97.2%	95.7%
15:00	98.5%	98.7%	97.3%	99.6%	99.6%	99.9%	100.0%	100.0%	98.8%	99.4%	98.3%	96.6%
16:00	98.7%	97.8%	97.4%	99.1%	99.7%	100.0%	99.7%	100.0%	99.4%	99.3%	97.7%	97.1%
17:00	98.3%	99.2%	97.5%	98.6%	100.0%	100.0%	100.0%	99.7%	99.4%	99.3%	98.6%	96.8%
18:00	97.7%	99.5%	97.7%	98.4%	100.0%	99.6%	100.0%	99.7%	99.0%	98.9%	98.1%	97.2%
19:00	98.0%	99.7%	98.3%	99.0%	99.7%	99.8%	100.0%	99.9%	98.0%	98.9%	97.3%	97.3%
20:00	96.3%	99.2%	98.7%	99.8%	99.6%	99.6%	100.0%	99.8%	97.7%	98.5%	96.8%	94.6%
21:00	96.3%	98.9%	99.1%	99.2%	99.0%	98.9%	99.6%	99.5%	97.2%	98.2%	96.1%	94.9%
22:00	95.5%	99.6%	98.1%	98.9%	97.1%	98.1%	97.6%	97.5%	95.5%	97.5%	96.1%	95.5%
23:00	95.4%	98.8%	97.4%	98.5%	97.7%	95.9%	97.3%	93.8%	94.0%	96.7%	95.3%	96.0%

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Day	96.7%	97.1%	95.7%	97.8%	98.1%	97.4%	97.5%	95.7%	96.3%	97.3%	96.4%	94.1%
Night	95.9%	98.4%	96.8%	97.5%	95.5%	93.6%	92.5%	90.4%	89.4%	96.9%	95.7%	94.6%
24 Hours	96.2%	97.8%	96.2%	97.6%	97.0%	96.1%	95.9%	93.3%	92.9%	97.1%	95.9%	94.4%

Table 28 RNAV (GPS) Rwy 31 (LNAV) - Overall Effectiveness

LNAV Runway 13 - Overall Effectiveness
335 ft - 5/8 mi

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	93.3%	95.8%	93.2%	91.2%	94.4%	94.0%	93.0%	90.1%	87.3%	92.9%	91.0%	89.1%
1:00	93.1%	96.1%	93.9%	91.7%	94.4%	89.7%	90.5%	88.6%	85.6%	92.2%	90.6%	91.5%
2:00	93.3%	95.3%	91.5%	90.2%	91.9%	90.6%	86.2%	83.6%	86.7%	92.5%	91.0%	90.2%
3:00	92.6%	95.2%	89.8%	91.4%	89.8%	86.2%	86.1%	79.0%	82.2%	93.3%	88.5%	89.0%
4:00	93.0%	94.8%	90.6%	90.5%	88.5%	84.4%	85.1%	77.7%	79.4%	92.0%	91.0%	88.9%
5:00	90.9%	93.3%	90.3%	89.7%	87.8%	84.1%	83.0%	78.1%	76.3%	91.1%	90.7%	89.2%
6:00	91.1%	92.9%	90.3%	88.4%	90.2%	85.6%	90.3%	76.6%	77.1%	90.3%	90.1%	89.9%
7:00	90.4%	90.5%	85.9%	85.9%	87.5%	89.0%	91.3%	86.5%	81.0%	89.9%	90.2%	89.3%
8:00	91.0%	91.6%	83.8%	83.0%	87.7%	86.9%	91.6%	88.5%	85.7%	90.3%	87.3%	87.2%
9:00	89.3%	89.5%	83.6%	78.4%	81.8%	83.8%	94.0%	91.1%	85.0%	85.8%	84.6%	87.3%
10:00	90.5%	91.7%	79.9%	75.8%	78.9%	83.4%	91.2%	89.7%	84.6%	83.0%	85.8%	88.3%
11:00	90.3%	89.2%	78.9%	75.1%	75.7%	80.4%	88.7%	88.2%	81.7%	80.9%	82.5%	89.4%
12:00	89.6%	89.4%	78.3%	73.2%	71.7%	78.5%	89.0%	87.1%	79.8%	81.8%	83.4%	90.5%
13:00	90.1%	86.9%	75.9%	72.0%	73.5%	80.7%	87.2%	88.3%	81.8%	81.1%	83.7%	87.6%
14:00	89.4%	88.8%	79.8%	76.0%	76.2%	80.2%	87.2%	86.7%	78.8%	81.4%	83.6%	90.3%
15:00	89.8%	90.7%	78.7%	74.4%	76.3%	79.0%	89.4%	87.9%	80.8%	81.8%	85.8%	92.0%
16:00	92.3%	91.4%	81.6%	75.4%	77.0%	81.3%	90.3%	89.9%	84.0%	82.4%	90.9%	93.5%
17:00	92.3%	94.4%	86.8%	79.5%	79.9%	82.9%	91.8%	91.9%	87.0%	89.1%	92.1%	93.7%
18:00	93.0%	96.2%	89.4%	83.0%	82.9%	85.7%	94.4%	95.7%	91.6%	93.8%	92.0%	92.8%
19:00	92.4%	96.6%	91.3%	87.5%	90.7%	90.0%	96.4%	98.2%	92.9%	92.2%	90.2%	93.9%
20:00	92.2%	94.8%	91.0%	90.0%	92.0%	93.4%	98.0%	96.6%	91.2%	92.9%	92.3%	91.2%
21:00	91.9%	95.2%	92.3%	92.0%	92.5%	93.4%	97.4%	96.2%	92.3%	91.7%	90.6%	93.0%
22:00	92.1%	97.1%	93.0%	93.6%	92.1%	94.8%	95.6%	96.4%	90.7%	91.6%	91.5%	91.8%
23:00	92.1%	96.5%	93.0%	94.6%	95.1%	92.2%	96.1%	93.0%	89.9%	91.3%	90.0%	92.1%
Day	90.3%	90.4%	81.9%	77.7%	80.7%	84.1%	90.9%	88.3%	83.5%	84.3%	85.2%	89.1%
Night	92.2%	95.4%	91.7%	90.9%	91.8%	90.7%	91.3%	88.9%	86.0%	92.1%	90.8%	91.2%
24 Hours	91.5%	93.1%	86.8%	84.3%	85.3%	86.3%	91.0%	88.6%	84.7%	88.6%	88.7%	90.5%

7.2.5.9 Airport Open to Operations

The following tables show the likelihood of airport availability, as a percentage, for combinations of the best available approaches to each runway end.

The current capability of the airport to remain open to operations is shown for ILS capable operations in Table 29 and for RNAV capable operations in Table 30. These tables reveal that the airport has a very high likelihood of enabling all aircraft to arrive at the desired time of operation regardless of which navigation mode they utilize.

There are two small groups of hours where the current approaches, and primary runway configuration, may lead to delays for scheduled aircraft arrivals.

The first group of hours occur in the early morning of August and September. These hours are limited by the lack of low visibility approach options which would require the installation of an ATCT followed by pursuit of CAT II minimums to improve. Due to the limited number of scheduled flight operations arriving into HIB at this time of day, there are no additional approach enhancements or new approaches that need to be explored to improve the overall ability of aircraft to arrive into HIB at this time.

The second group of hours occur in the month of April, close to 13:00 local time. In this time period, the airport experiences crosswinds, and gusting wind conditions, which exceed the current tolerances we established to determine a runway's capability to receive aircraft. This problem is not related to the capability of the approach procedures, or departure procedures, to match the anticipated weather minimums, but reflects a historical likelihood that strong weather patterns moving over HIB in March, April and May in the early afternoon frequently force aircraft to consider either attempting a high crosswind operation or delaying their flight to permit the wind conditions to improve.

Table 29 Airport Open To Operations - ILS

Hour (Local)	Month											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	98.0%	99.6%	98.6%	97.0%	98.6%	98.2%	97.5%	94.7%	96.0%	97.8%	97.3%	96.9%
1:00	98.0%	99.5%	98.6%	97.7%	97.6%	97.3%	95.6%	94.6%	95.4%	97.6%	96.9%	98.2%
2:00	98.3%	99.1%	97.1%	95.1%	96.9%	97.8%	92.4%	92.3%	93.5%	98.0%	96.7%	97.4%
3:00	97.8%	99.2%	97.5%	96.5%	97.6%	93.9%	93.0%	89.6%	90.8%	98.4%	98.0%	96.8%
4:00	97.6%	98.5%	97.4%	96.3%	96.8%	93.2%	91.0%	87.8%	89.7%	97.7%	96.6%	97.8%
5:00	97.5%	98.3%	97.8%	96.4%	94.5%	91.4%	89.2%	87.1%	86.8%	97.8%	97.2%	97.7%
6:00	97.4%	98.5%	97.2%	96.3%	95.3%	95.7%	93.5%	83.9%	86.2%	97.0%	97.5%	97.3%
7:00	97.8%	97.1%	94.6%	94.1%	97.6%	97.5%	96.2%	91.7%	88.7%	96.0%	96.5%	98.0%
8:00	97.7%	97.7%	95.2%	96.6%	97.9%	98.1%	96.8%	96.3%	94.5%	97.1%	95.9%	97.7%
9:00	98.0%	97.1%	96.9%	94.6%	97.5%	98.3%	99.0%	98.8%	97.6%	96.9%	97.0%	95.9%
10:00	98.8%	97.5%	94.3%	92.5%	95.3%	97.0%	98.2%	97.4%	98.0%	95.4%	97.4%	97.8%
11:00	98.2%	96.5%	95.5%	92.4%	93.0%	96.1%	95.9%	96.4%	96.8%	94.9%	98.1%	96.5%
12:00	97.2%	95.8%	94.3%	91.6%	92.8%	96.0%	97.5%	95.5%	95.5%	95.2%	97.5%	97.5%
13:00	98.4%	95.5%	94.8%	90.7%	93.0%	95.9%	95.6%	96.5%	97.1%	95.7%	96.3%	96.8%
14:00	97.3%	95.1%	93.1%	91.3%	93.3%	94.2%	96.8%	97.3%	95.4%	95.2%	94.8%	98.1%
15:00	98.1%	96.2%	93.2%	93.0%	94.0%	95.2%	95.4%	96.1%	95.4%	95.5%	97.0%	97.3%
16:00	98.7%	97.2%	96.2%	93.0%	95.1%	95.9%	96.3%	98.4%	97.3%	96.4%	97.3%	99.4%
17:00	99.2%	98.5%	97.4%	95.0%	96.5%	97.4%	97.2%	98.4%	98.9%	97.3%	98.5%	98.8%
18:00	98.7%	99.4%	97.8%	97.1%	97.5%	98.3%	98.2%	99.3%	99.5%	98.9%	98.7%	98.8%
19:00	98.8%	99.3%	99.4%	97.6%	99.2%	98.6%	98.8%	99.5%	99.0%	98.9%	97.9%	99.3%
20:00	98.9%	98.4%	98.6%	98.1%	99.1%	99.7%	100.0%	99.0%	98.6%	99.3%	97.1%	99.4%
21:00	97.8%	98.5%	98.9%	98.8%	98.3%	99.2%	99.4%	99.5%	99.1%	98.2%	98.0%	99.2%
22:00	98.3%	99.2%	98.5%	98.4%	98.1%	99.2%	98.0%	98.9%	97.4%	97.9%	97.7%	98.6%
23:00	98.1%	99.3%	98.7%	97.9%	98.8%	98.6%	97.9%	96.4%	97.6%	96.7%	97.5%	98.2%
Day	98.1%	96.7%	95.3%	93.5%	95.6%	96.6%	96.5%	95.8%	96.2%	96.0%	96.7%	97.2%
Night	98.2%	99.0%	98.2%	97.2%	97.6%	97.2%	95.6%	94.5%	94.2%	98.0%	97.5%	98.2%
24 Hours	98.1%	98.0%	96.7%	95.3%	96.4%	96.8%	96.2%	95.2%	95.2%	97.1%	97.2%	97.9%

Table 30 Airport Open to Operations – RNAV (GPS) LPV or VNAV

		Month											
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Hour (Local)	0:00	97.1%	99.4%	98.2%	95.7%	98.0%	97.3%	96.4%	93.9%	93.6%	97.4%	96.5%	93.8%
	1:00	96.4%	99.0%	97.2%	96.9%	96.9%	95.0%	94.2%	92.4%	92.0%	96.5%	95.0%	95.6%
	2:00	96.7%	98.8%	95.5%	94.3%	95.8%	96.3%	90.6%	88.0%	90.0%	97.0%	94.5%	94.9%
	3:00	96.7%	98.3%	95.5%	95.8%	95.2%	90.5%	89.8%	84.7%	86.9%	97.4%	95.5%	95.3%
	4:00	96.2%	97.9%	95.6%	95.5%	93.2%	89.8%	88.8%	83.2%	85.9%	96.3%	94.2%	95.3%
	5:00	96.4%	97.3%	95.0%	95.0%	91.9%	88.9%	86.7%	82.1%	82.3%	96.9%	94.8%	95.3%
	6:00	96.4%	96.6%	94.5%	94.7%	92.7%	93.0%	92.0%	80.2%	81.9%	95.8%	95.1%	95.2%
	7:00	96.0%	95.2%	92.2%	93.5%	94.3%	94.3%	94.1%	88.8%	85.7%	93.8%	95.4%	95.5%
	8:00	96.5%	96.5%	92.6%	94.5%	96.3%	94.9%	94.8%	92.4%	90.5%	95.7%	95.4%	94.7%
	9:00	96.2%	96.3%	94.9%	93.3%	96.3%	96.9%	98.4%	96.3%	94.0%	95.8%	95.4%	93.6%
	10:00	97.4%	97.3%	93.1%	91.8%	94.8%	96.8%	98.2%	96.0%	96.8%	94.6%	95.4%	95.9%
	11:00	96.9%	96.0%	93.8%	91.7%	93.0%	96.1%	95.9%	96.2%	96.0%	93.9%	96.7%	95.3%
	12:00	96.0%	95.0%	93.7%	91.5%	92.5%	96.0%	97.5%	95.5%	95.2%	94.6%	96.5%	96.2%
	13:00	96.8%	95.0%	93.5%	90.1%	93.0%	95.9%	95.6%	96.5%	97.1%	95.1%	95.3%	95.3%
	14:00	96.5%	94.5%	92.7%	91.1%	93.3%	94.2%	96.8%	97.3%	95.4%	95.2%	94.3%	96.7%
	15:00	97.2%	96.0%	93.0%	92.8%	94.0%	95.2%	95.4%	96.1%	95.4%	95.3%	96.5%	96.3%
	16:00	98.1%	97.1%	95.6%	92.9%	95.1%	95.9%	96.3%	98.4%	97.2%	96.4%	97.0%	98.1%
	17:00	98.3%	98.5%	97.2%	94.6%	96.5%	97.4%	97.2%	98.4%	98.6%	97.2%	97.7%	96.7%
	18:00	98.2%	99.3%	97.2%	96.6%	97.5%	98.2%	98.2%	99.3%	98.8%	98.7%	98.0%	96.7%
	19:00	98.1%	99.0%	99.0%	97.4%	99.1%	98.6%	98.8%	99.5%	98.1%	98.5%	97.9%	97.6%
	20:00	98.0%	98.3%	98.2%	97.6%	99.0%	99.7%	100.0%	99.0%	98.3%	98.6%	96.3%	97.3%
	21:00	96.9%	98.0%	98.6%	98.3%	97.9%	99.2%	99.4%	99.5%	98.3%	97.7%	96.5%	97.2%
	22:00	96.9%	99.1%	97.8%	97.8%	97.1%	98.2%	97.8%	98.1%	96.6%	97.3%	96.6%	96.6%
	23:00	97.0%	99.2%	98.1%	97.3%	97.8%	97.9%	97.6%	95.3%	96.2%	95.8%	96.3%	96.2%

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Day	96.8%	96.1%	94.1%	92.9%	94.9%	95.8%	96.0%	94.7%	95.1%	95.2%	95.7%	95.5%
Night	97.0%	98.5%	97.0%	96.4%	96.3%	95.5%	94.3%	92.3%	91.7%	97.2%	96.1%	96.1%
24 Hours	97.0%	97.4%	95.5%	94.6%	95.5%	95.7%	95.4%	93.6%	93.4%	96.3%	96.0%	95.9%

The ILS and RNAV approach procedures both produce a similar capability for aircraft to arrive at the anticipated time. This means that during low temperature periods when certain aircraft might be unable to use the LNAV/VNAV approach, the ILS will provide the same capability. Conversely, during periods when the localizer or glideslope performance may be affected by snow, the LNAV/VNAV approach will be able to compensate.

7.2.6 Departures and Analysis of Departures

HIB does not currently have any instrument departures.

HIB does have an Obstacle Departure Procedure (ODP).

Fence 1134' from DER, 670' right of centerline, 2743' MSL.

HIBBING, MN
RANGE RGNL (HIB)
TAKEOFF MINIMUMS AND (OBSTACLE) DEPARTURE PROCEDURES
AMDT 6 05AUG04 (04218) (FAA)
DEPARTURE PROCEDURE:
Rwy 22, climb via heading 227° to 2200 before turning right.
Rwy 31, climb via heading 310° to 2200 before turning left.
TAKEOFF OBSTACLE NOTES:
Rwy 4, antenna on pole, 361' from DER, 409' right of centerline, 1377' MSL.
Rwy 13, obstacle light on pole, 1184' from DER, 636' left of centerline.
Numerous trees beginning 1291' from DER, 745' left of centerline up to 1419' MSL.
Trees 1497' from DER, 563' right of centerline, 1388' MSL.
Rwy 22, multiple trees beginning 368' from DER, 170' right of centerline, up to 1416' MSL.
Multiple trees beginning 413' from DER, 117' left of centerline, up to 1400' MSL.
Rwy 31, light standard, 865' from DER, 595' right of centerline, 1381' MSL.

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These obstacle departure procedures can be used by aircraft at any time with ½ mile visibility (similar to the existing ILS approach visibility) under ¼ mile visibility with adequate visual references. Because the ILS approach availability shows a very high likelihood of allowing arrivals across almost all hours and month, the lower visibility available for departures with adequate visual reference (1/4 mile) is assumed to allow aircraft to depart at any time or month without restriction.

7.2.7 Summary of Existing Procedures

The existing approaches published by the FAA are very effective, efficiently designed, and do not require significant changes.

The departure procedures at HIB are all operationally adequate. We find no procedure limitations that would influence aircraft operators to select departure runways in any way that might need additional consideration in the Monte Carlo modeling.

7.3 Instrument Procedures Following Possible Extension of Runway 13-31

7.3.1 Analysis of Approaches to Runway 13 Following a Possible Extension of Rwy 13-31

The possible extension of runway 13-31 to the southeast would only affect instrument approach procedures on runway 13 that utilize the I-JAE localizer. This is currently limited to the ILS or LOC/DME Rwy 13 approaches.

To evaluate a possible change to the ILS or LOC/DME Rwy 13 approach, we modeled the approach with the I-JAE localizer relocated to the position listed in Table 5. The procedure was rebuilt in GPD with no anticipated changes to the approach minimums, waypoints, or altitudes when compared to the existing approach.

7.3.2 Analysis of Approaches to Runway 31 Following a Possible Extension of Rwy 13-31

The ILS or LOC Rwy 31 and RNAV (GPS) Rwy 31 were both modeled for all possible threshold locations resulting an extension of runway 13-31 from its current length to values starting at 7,000ft up to and including 8,000ft in total length.

This included a relocation of the runway 31 glideslope, PAPI and MALSR to the position listed in Table 6.

Both the ILS or LOC and RNAV (GPS) procedure were found to be TERPS/PBN compliant at the new threshold location with no anticipated changes to approach minimums from those currently published by FAA.

The ILS or LOC approach will require either the outer marker to be relocated or a DME that is dedicated to the ILS to be installed. This will both ensure that the final approach fix can be established within the required navigational accuracy and would provide the opportunity for the approach procedure to be changed from a 2.90º glideslope to a 3.00º glideslope without changing the minimums.

In order to ensure that no changes in the minimums occur, the airport would need to remove all vegetative obstructions in a rectangular area beginning at the threshold of the runway (following the extension) extending to Tower Line Rd with a width of 800ft (400ft either side of centerline). In the event that the airport was unable to remove all vegetative obstructions, then trees currently located 3,000ft from the end of the current runway threshold would only need to be reduced by 8ft (for a 3.00º glideslope) or 12ft (for a 2.90º glideslope).

7.3.3 Analysis of Arrivals Following a Possible Extension of Rwy 13-31

The possible extension of runway 13-31 is not anticipated to create any new requirements for arrival procedures to support approach operations.

7.3.4 Analysis of Departures Following a Possible Extension of Rwy 13-31

The current obstacle departure procedure from both runways 13 and 31 were analyzed using GPD at each of the proposed runway extension locations to the southeast. Following the presumed obstacle clearance described in Section 6.2.3.1, there would be no requirement to introduce departure minimums that were higher than standard, or introduce any required climb gradients.

Because the current ODP would be relatively unchanged, there would also not be any requirement to develop published instrument departure procedures following the runway extension.

7.3.5 Summary of Procedures Following Runway 13-31 Extension

In the event that a runway extension is achieved, the analysis of existing instrument approaches and existing departure procedures finds that there would be no adverse impacts to the procedures caused by the relocation.

Installation of a DME specific to the I-HIB ILS will enable the FAA to be unconstrained by the use of the OM and would enable the GS to return to a 3.00 angle following the runway extension. Because OMs are becoming an obsolete technology, we strongly recommend coordinating with FAA SSC and OESG personnel regarding the addition of the DME to the I-HIB ILS even in the absence of any possible runway extension.

To preserve the current minimums, some vegetative obstruction removal would be required between the extended runway 31 threshold and Tower Line Rd. In the event that the trees could not be removed, then a tree topping could be performed to achieve the same effect.

8 Historical Weather Data

Performing a Monte Carlo analysis to determine runway length requires consideration of both terminal weather data to account for its influence on takeoff performance, and enroute weather to consider its effects on flight planning. This section describes the historical weather data that was collected, the overall properties of key weather data, and which historical weather data was used to create distributions as inputs to the overall runway length analysis.

8.1 Terminal Weather Data

Terminal weather data, like temperature, pressure, runway surface condition and wind direction & speed are required by regulations when operators determine takeoff and landing limits. For a specific flight operation this data is usually taken from METARs or D-ATIS information and is supplemented by pilot or air traffic controller observations. Additional information about the runway surface condition can be obtained by Field Condition NOTAMs (FICONs) which are published by the airport and indicate whether the runway is dry, wet or contaminated by snow/slush/ice. FICONs are divided into 1/3rds of the runway and updated by airport personnel and published during events when the runway is predicted, or discovered, to be less than dry.

When using terminal weather data to inform a forward-looking aircraft performance calculation, like runway length determination, it is important to balance the selection of weather-related inputs with statistically significant reliability. The goal of this selection is to ensure that a variable modeled as an input can be both a plausible expectation of future weather conditions and not an inadvertent statistical outlier that creates an unintentional bias in the results.

This section describes how terminal weather information was collected, which inputs were selected for use with takeoff performance computations and how the information was converted into distributions for use with the Monte Carlo modeling.

8.1.1 Source and Methods for Terminal Weather Data Processing

Terminal historical weather information was collected from the National Climactic Data Center (NCDC) Climate Data Online (CDO) servers for HIB over a 10-year historical period. The data collected was originally reported from the on airport ASOS in the form of METARs consisting of both routine, hourly, observations and special conditions, off hour, weather observations resulting from nearly 160,000 observations.

Historical FICON information was also provided by the airport to the team to compare runway surface conditions, measured and observed by airport personnel, to those which would have been predicted solely by the on field ASOS.

To express historical weather observations in a format usable either directly or indirectly as an input for a Monte Carlo analysis, a process of time weighting must be accomplished over the source data. Typically, weather observations are made on an hourly schedule. When a significant change in weather occurs for wind, ceiling or precipitation due to a storm or turbulent wind conditions, these observations may be made more frequently. The process of time weighting accounts for these "brief" weather observations that only occur during some portion of an hour, without exerting an excess influence relative to the typical hourly observations. The mathematical steps used to achieve time weighting are not expressed in this report but can be described in more detail from the project team upon request.

Increasing data fidelity to time increment of less than an hour has been found to yield no statistical difference to the results constructed over a one-hour increment. However, accounting for monthly variations in data are essential to ensure the accuracy of any normalization in a data distribution used as an input.

Once the time weighting process has been applied to the source data, all historical weather properties are available for direct application with aircraft performance calculations. From this dataset, the project team is able to decide whether to use either generalized distribution models or the discrete empirical inputs. These discrete selections do not permit additional modification of historical weather but do provide Monte Carlo level analysis to more accurately sample data from variables which could be difficult to accurately express through any regression analysis.

The choice of using a selected distribution (often achieved through curve fitting) for a particular variable can be used directly or modified to reflect future states at the airport. This method is typically limited only to temperature and pressure information.

For the purposes of this analysis, none of the terminal weather data inputs used in the Monte Carlo analysis were modified from the time weighted values derived over the previous 10-year period. This unmodified data was chosen in an attempt to align the results of this analysis with other accepted FAA methodologies regarding simplified applications of Average Daily Maximum values.

8.1.2 Temperature

The effect of temperature on aircraft performance is significant to engine thrust, lift, altitude correction and absolute operating limitations.

10-year historical temperature information for HIB, presented in Fahrenheit for the convenience of the reader, is presented in Table 31 and Table 32 for the 50% and 85% confidence intervals.

Table 31 10-Year Mean Historical Outside Air Temperature at HIB,

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	**7.3**	**8.7**	**23.5**	**32.0**	**43.0**	**53.1**	**57.0**	**55.9**	**50.0**	**37.0**	**27.0**	**14.2**
1:00	**6.8**	**8.1**	**22.4**	**30.8**	**42.1**	**52.2**	**55.9**	**55.0**	**48.3**	**37.0**	**26.1**	**14.4**
2:00	**7.0**	**6.1**	**21.0**	**30.0**	**39.9**	**52.0**	**55.9**	**55.0**	**48.1**	**36.0**	**26.0**	**14.0**
3:00	**6.8**	**6.1**	**21.0**	**30.0**	**39.0**	**51.1**	**55.0**	**54.0**	**48.0**	**36.0**	**25.0**	**14.0**
4:00	**6.8**	**5.0**	**21.0**	**29.1**	**39.0**	**50.0**	**54.3**	**53.7**	**47.5**	**36.0**	**25.0**	**14.0**
5:00	**7.0**	**5.0**	**21.0**	**28.9**	**39.0**	51.1	53.9	**53.1**	**46.9**	**35.1**	**25.0**	**13.7**
6:00	**6.5**	**4.5**	**19.9**	**28.9**	42.1	54.0	57.1	54.0	**46.9**	**35.1**	**25.0**	**14.0**
7:00	**6.2**	**6.1**	21.1	33.1	46.9	57.8	62.3	57.9	48.9	35.1	26.1	**13.9**
8:00	6.8	8.8	24.1	36.0	51.1	61.0	66.0	62.1	53.1	37.9	27.0	14.0
9:00	8.1	12.0	27.1	37.9	54.1	64.0	70.0	65.7	56.6	41.0	29.9	15.9
10:00	10.0	15.1	30.0	41.0	57.0	66.0	72.0	68.7	59.2	44.1	30.9	17.4
11:00	12.9	17.1	32.0	43.0	57.9	68.0	73.9	71.0	62.1	45.7	32.0	19.0
12:00	14.4	19.0	33.1	45.0	59.9	69.1	75.0	72.0	64.0	46.9	33.1	19.9
13:00	16.0	19.9	34.0	46.4	61.0	70.0	75.9	73.0	64.5	46.9	33.1	19.9
14:00	15.5	21.0	35.1	46.9	62.1	71.1	77.0	73.5	64.9	48.0	33.5	19.9
15:00	15.1	21.0	35.1	47.3	62.1	71.1	77.0	73.9	66.0	48.5	33.1	19.2
16:00	13.5	19.9	34.5	47.5	62.1	71.1	77.0	73.0	64.9	48.0	31.1	19.0
17:00	**12.7**	18.0	34.0	46.1	61.0	70.0	75.9	73.0	63.0	46.3	**30.0**	**17.1**
18:00	**11.0**	**15.3**	33.1	45.0	60.1	69.1	74.5	71.1	60.1	43.0	**28.9**	**16.3**
19:00	**10.9**	**14.0**	**30.0**	**42.1**	57.1	66.9	72.0	66.9	55.9	**41.0**	**28.1**	**16.0**
20:00	**9.0**	**12.4**	**28.9**	**37.9**	**53.1**	62.1	66.9	**63.0**	**53.1**	**39.9**	**28.0**	**15.4**
21:00	**8.1**	**12.0**	**27.0**	**36.0**	**48.9**	**57.9**	**62.8**	**60.1**	**52.0**	**39.0**	**27.0**	**15.1**
22:00	**8.3**	**10.9**	**25.5**	**34.0**	**47.5**	**55.9**	**60.7**	**57.9**	**51.1**	**37.9**	**27.0**	**14.5**
23:00	**8.9**	**10.0**	**24.1**	**33.1**	**45.0**	**55.0**	**59.0**	**57.0**	**50.0**	**37.0**	**26.9**	**14.8**
Day	12.5	17.2	31.1	42.9	56.7	65.1	70.4	68.3	60.3	44.3	31.0	18.3
Night	**8.2**	**8.9**	**23.8**	**32.7**	**43.6**	**53.4**	**57.6**	**56.5**	**49.3**	**37.3**	**26.8**	**14.8**
24 Hours	9.8	12.3	27.4	37.8	51.3	61.2	66.1	63.4	55.2	40.8	28.5	16.1

Table 32 10-Year 85% Confidence Interval Historical Outside Air Temperature at HIB

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	**23.0**	**24.1**	**35.1**	**41.0**	**54.0**	**60.1**	**65.1**	**64.3**	**59.0**	**48.0**	**36.0**	**28.9**
1:00	**23.0**	**24.1**	**34.0**	**39.2**	**53.1**	**59.1**	**64.9**	**64.0**	**58.2**	**46.9**	**36.0**	**28.9**
2:00	**23.0**	**24.1**	**33.5**	**39.0**	**52.5**	**59.0**	**64.2**	**63.0**	**57.9**	**46.1**	**35.9**	**28.7**
3:00	**23.0**	**23.0**	**33.1**	**39.0**	**51.2**	**58.5**	**63.2**	**62.5**	**57.9**	**46.0**	**35.1**	**28.0**
4:00	**23.0**	**23.0**	**33.1**	**38.0**	**51.1**	**57.9**	**63.9**	**62.2**	**57.9**	**46.0**	**35.1**	**28.0**
5:00	**23.0**	**21.9**	**32.5**	**37.9**	**51.4**	57.9	64.0	**62.1**	**57.0**	**46.0**	**35.1**	**28.0**
6:00	**22.8**	**21.9**	**32.6**	**37.9**	52.4	60.1	64.9	62.1	**57.0**	**45.0**	**34.3**	**27.0**
7:00	**22.8**	**21.9**	33.1	41.0	56.6	64.0	68.0	64.1	57.9	45.0	34.8	**27.0**
8:00	23.0	23.0	35.1	45.1	61.0	67.6	72.0	67.7	61.0	48.0	37.0	27.0
9:00	24.1	26.1	37.9	50.0	64.9	71.1	75.0	71.1	64.0	51.1	39.9	28.0
10:00	25.0	28.0	41.0	54.0	68.0	73.0	77.0	74.7	68.0	54.0	43.0	30.0
11:00	26.1	30.2	43.8	56.1	70.0	75.0	79.1	77.0	71.1	57.0	45.0	30.0
12:00	27.0	32.0	46.0	57.9	72.0	76.0	81.0	79.0	73.0	59.0	46.9	32.0
13:00	28.9	33.1	48.0	60.1	73.0	78.1	82.0	80.1	75.0	60.1	46.9	32.0
14:00	28.0	33.1	48.9	60.2	73.9	79.0	82.9	81.0	75.9	62.1	48.1	32.0
15:00	28.7	33.9	48.9	62.1	73.9	79.0	82.9	81.0	75.9	62.1	46.9	32.0
16:00	27.0	32.0	48.9	62.1	73.9	79.0	82.0	81.0	75.0	60.4	45.0	30.1
17:00	**26.1**	29.3	48.0	61.0	73.4	78.1	81.2	80.1	73.0	58.3	**42.1**	**30.0**
18:00	**25.2**	**28.0**	45.0	59.0	72.0	77.0	80.1	78.1	70.0	55.0	**39.9**	**29.7**
19:00	**25.0**	**27.0**	**41.0**	**54.0**	69.1	75.0	78.1	73.9	64.9	**52.0**	**37.9**	**28.9**
20:00	**25.0**	**26.5**	**39.0**	**48.0**	**63.0**	69.7	73.0	**70.0**	**63.0**	**51.1**	**37.0**	**28.9**
21:00	**24.1**	**26.9**	**37.9**	**46.0**	**60.1**	**65.4**	**70.0**	**68.0**	**61.0**	**50.0**	**36.0**	**28.9**
22:00	**24.1**	**25.3**	**37.0**	**43.0**	**57.0**	**64.0**	**68.0**	**66.0**	**60.4**	**48.9**	**36.0**	**28.9**
23:00	**24.1**	**24.6**	**35.1**	**42.9**	**55.9**	**62.1**	**66.9**	**65.7**	**59.0**	**48.0**	**35.4**	**28.9**
Day	26.4	30.1	43.7	55.7	68.1	72.5	76.5	75.0	69.6	56.0	43.4	30.4
Night	**23.8**	**24.4**	**35.3**	**42.2**	**54.9**	**60.8**	**65.8**	**64.8**	**58.9**	**47.8**	**36.5**	**28.6**
24 Hours	24.8	26.8	39.5	48.9	62.6	68.6	72.9	70.8	64.7	51.9	39.4	29.3

Cells in the tables are color coded to visualize which hours of the day, and months of the year, are expected to experience temperatures which may adversely impact aircraft (yellow). Green or white cells have negligible temperature effects on aircraft performance. This breakdown was determined by the project team based on typical thrust break temperatures for the aircraft selected and seeks to generally identify hours of the day when runway length results may be longer than those anticipated under standard day conditions.

The 85% confidence interval value represents a direct application of the standard deviation for the weather data calculated across the entire year (all 12 months, all hours) for a 2-sided normalized distribution. This application approximates the Average Daily Maximum and is a commonly used value by most airlines when considering payload forecasting for a market. For perspective, the highest observed temperature from the dataset was 92F, most recently from 14AUG2015 @ 16:53L and the coldest temperature was -40F from 31JAN2019 @ 07:53L.

From this analysis, while HIB does experience a wide range of temperatures throughout the year, it does not often experience adversely hot temperatures. None of the temperature observations over the past 10 years exceeded certificated operating limits which could have precluded takeoff or landing operations from occurring. Therefore, pseudo random sampling of all months and hours of temperature data can be considered for the aircraft performance analysis.

8.1.2.1 Temperature Application in the Monte Carlo Analysis

To implement the anticipated range of temperatures that would be most applicable to assess operational capabilities using the Monte Carlo analysis, the project team elected to utilize a normal distribution to represent the temperature for a given month across any hour of the day rather than a normal distribution spread across the entire year. This was selected in part, because a normal distribution model can be well adapted to match a specific month's worth of historical temperature information without needing to consider bi-modality or skew.

The decision to use monthly distributions was also chosen because the Monte Carlo analysis did not focus on either a single hour, or limited range of hours for possible operations. This means that the temperature used in the Monte Carlo analysis can be applicable to any hour in a given month as a starting point for a single permutation in the Monte Carlo process.

The result of creating 12 independent normal distributions of historical temperature means that the Monte Carlo outcomes run over all 12 months will not reveal a distribution of temperature values that reflects an annual normal distribution. This will ensure that the specific climate effects that HIB experiences will be accurately represented in the overall results.

8.1.3 Pressure

The local pressure at an airport is often different than the values anticipated under standard atmospheric conditions. These nonstandard conditions must be considered by flight crews to ensure that the pressure-based altimeter onboard the aircraft is accurately adjusted and that any non-standard aircraft performance effects are taken into consideration.

10-year historical pressure information for HIB, presented in QNH for inHg, is presented in Table 33 and Table 34 for the 15% and 50% confidence intervals.

Table 33 10-Year 50% Confidence Interval Historical Altimeter Setting (QNH inHg) at HIB

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	**29.96**	**30.03**	**30.04**	**29.98**	**29.95**	**29.91**	**29.97**	**29.97**	**30.00**	**29.95**	**29.97**	**29.99**
1:00	**29.96**	**30.03**	**30.04**	**29.98**	**29.96**	**29.91**	**29.96**	**29.97**	**29.99**	**29.95**	**29.97**	**29.98**
2:00	**29.97**	**30.02**	**30.04**	**29.98**	**29.95**	**29.91**	**29.96**	**29.97**	**29.99**	**29.95**	**29.98**	**29.98**
3:00	**29.96**	**30.01**	**30.03**	**29.97**	**29.95**	**29.91**	**29.96**	**29.97**	**29.98**	**29.94**	**29.98**	**29.98**
4:00	**29.96**	**30.01**	**30.03**	**29.98**	**29.96**	**29.91**	**29.96**	**29.97**	**29.99**	**29.95**	**29.98**	**29.98**
5:00	**29.96**	**30.02**	**30.03**	**29.98**	**29.96**	29.92	29.96	**29.97**	**30.00**	**29.94**	**29.98**	**29.98**
6:00	**29.96**	**30.01**	**30.04**	**29.99**	29.97	29.92	29.97	29.98	**30.00**	**29.95**	**29.98**	**29.98**
7:00	**29.96**	**30.02**	30.05	30.00	29.98	29.92	29.98	29.98	30.02	29.95	29.98	**29.99**
8:00	29.97	30.01	30.05	30.00	29.97	29.92	29.99	29.98	30.02	29.95	29.98	30.00
9:00	29.98	30.02	30.05	29.99	29.97	29.92	29.98	29.98	30.02	29.96	29.98	30.01
10:00	29.98	30.02	30.05	29.99	29.97	29.92	29.97	29.98	30.02	29.96	29.98	30.01
11:00	29.96	30.01	30.05	29.98	29.97	29.92	29.97	29.98	30.01	29.96	29.97	29.98
12:00	29.95	30.00	30.04	29.97	29.96	29.91	29.96	29.97	30.00	29.96	29.96	29.97
13:00	29.94	29.99	30.03	29.96	29.96	29.90	29.96	29.96	30.00	29.95	29.95	29.96
14:00	29.93	30.00	30.02	29.95	29.95	29.89	29.96	29.96	30.00	29.94	29.95	29.96
15:00	29.95	29.99	30.01	29.95	29.94	29.89	29.95	29.95	29.99	29.93	29.95	29.97
16:00	29.96	30.00	30.01	29.93	29.93	29.89	29.94	29.95	29.99	29.93	29.96	29.98
17:00	**29.96**	30.01	30.01	29.94	29.92	29.89	29.94	29.95	29.98	29.94	**29.97**	**29.99**
18:00	**29.97**	**30.01**	30.02	29.95	29.93	29.88	29.94	29.94	29.98	29.95	**29.98**	**29.99**
19:00	**29.97**	**30.02**	**30.03**	**29.96**	29.94	29.89	29.94	29.95	29.98	**29.95**	**29.99**	**29.99**
20:00	**29.97**	**30.02**	**30.03**	**29.97**	**29.94**	29.89	29.94	**29.95**	**29.99**	**29.94**	**29.99**	**29.99**
21:00	**29.97**	**30.03**	**30.04**	**29.98**	**29.95**	**29.90**	**29.96**	**29.96**	**30.00**	**29.95**	**29.99**	**29.99**
22:00	**29.97**	**30.03**	**30.03**	**29.98**	**29.96**	**29.91**	**29.96**	**29.96**	**30.01**	**29.95**	**29.99**	**29.99**
23:00	**29.97**	**30.03**	**30.04**	**29.98**	**29.95**	**29.91**	**29.96**	**29.97**	**30.00**	**29.94**	**29.98**	**29.99**

Day	29.96	30.01	30.03	29.97	29.95	29.90	29.96	29.97	30.00	29.95	29.96	29.98
Night	**29.96**	**30.02**	**30.04**	**29.98**	**29.95**	**29.91**	**29.96**	**29.96**	**30.00**	**29.95**	**29.98**	**29.99**
24 Hours	29.96	30.01	30.03	29.97	29.95	29.91	29.96	29.97	30.00	29.95	29.97	29.98

Table 34 10-Year 15% Confidence Interval Historical Altimeter Setting (QNH inHg) at HIB

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	29.67	29.70	29.77	29.73	29.75	29.75	29.82	29.82	29.80	29.69	29.70	29.71
1:00	29.67	29.70	29.76	29.73	29.75	29.75	29.81	29.82	29.80	29.70	29.70	29.70
2:00	29.67	29.70	29.75	29.71	29.74	29.74	29.81	29.82	29.80	29.70	29.71	29.71
3:00	29.66	29.70	29.73	29.72	29.74	29.73	29.81	29.82	29.80	29.69	29.71	29.71
4:00	29.65	29.70	29.74	29.71	29.74	29.72	29.81	29.82	29.79	29.67	29.72	29.70
5:00	29.66	29.71	29.74	29.71	29.74	29.73	29.81	29.82	29.80	29.67	29.71	29.70
6:00	29.66	29.71	29.74	29.72	29.75	29.74	29.81	29.83	29.80	29.67	29.71	29.70
7:00	29.66	29.71	29.73	29.73	29.76	29.74	29.82	29.83	29.81	29.66	29.71	29.71
8:00	29.67	29.72	29.74	29.73	29.75	29.74	29.82	29.83	29.80	29.67	29.71	29.71
9:00	29.67	29.71	29.75	29.73	29.74	29.73	29.83	29.82	29.80	29.67	29.72	29.72
10:00	29.67	29.72	29.76	29.72	29.74	29.73	29.82	29.83	29.80	29.68	29.72	29.73
11:00	29.66	29.72	29.76	29.73	29.75	29.72	29.82	29.83	29.79	29.67	29.70	29.72
12:00	29.65	29.71	29.74	29.73	29.75	29.72	29.83	29.81	29.79	29.68	29.70	29.71
13:00	29.65	29.69	29.75	29.71	29.74	29.73	29.82	29.81	29.78	29.67	29.68	29.70
14:00	29.64	29.68	29.73	29.71	29.74	29.74	29.81	29.81	29.78	29.66	29.68	29.70
15:00	29.66	29.69	29.72	29.71	29.74	29.74	29.80	29.80	29.77	29.67	29.68	29.71
16:00	29.67	29.69	29.72	29.71	29.74	29.74	29.81	29.81	29.78	29.68	29.68	29.72
17:00	29.68	29.70	29.73	29.71	29.74	29.73	29.80	29.80	29.78	29.69	29.70	29.72
18:00	29.68	29.70	29.74	29.72	29.73	29.73	29.80	29.80	29.79	29.69	29.71	29.71
19:00	29.70	29.69	29.75	29.72	29.73	29.73	29.80	29.80	29.80	29.69	29.71	29.72
20:00	29.70	29.70	29.75	29.74	29.74	29.74	29.80	29.81	29.81	29.70	29.70	29.73
21:00	29.70	29.71	29.76	29.73	29.75	29.75	29.81	29.81	29.81	29.71	29.70	29.72
22:00	29.69	29.70	29.75	29.74	29.76	29.75	29.81	29.82	29.81	29.70	29.70	29.72
23:00	29.68	29.70	29.75	29.73	29.76	29.74	29.81	29.82	29.81	29.69	29.70	29.72

Day	29.66	29.70	29.74	29.72	29.74	29.73	29.81	29.82	29.79	29.67	29.70	29.71
Night	**29.67**	**29.70**	**29.75**	**29.72**	**29.75**	**29.74**	**29.81**	**29.82**	**29.80**	**29.69**	**29.71**	**29.71**
24 Hours	29.67	29.70	29.74	29.72	29.74	29.74	29.81	29.82	29.80	29.68	29.70	29.71

Cells in the table are color coded to help visualize which hours of the day, and months of the year, are expected to experience pressure conditions which are beneficial to aircraft performance (green), adverse to aircraft performance (yellow) or neutral (white). This breakdown was determined by the project team based on sensitivity to non-standard pressure conditions for the aircraft selected and seeks to generally identify hours of the day when runway length results may be longer than those anticipated under standard day conditions.

The 15% confidence interval value represents a direct application of the standard deviation for the weather data calculated across the entire year (all 12 months, all hours) for a 2-sided normalized distribution. This application approximates is a commonly used value by many airlines when considering whether non-standard pressure conditions should be considered in payload forecasting for a market.

From the results shown in Table 33, the average pressure measurements experienced at HIB are nominal to aircraft performance conditions. Furthermore, any non-standard pressure conditions are relatively minor and thus have little effect on aircraft performance and subsequent runway length determinations.

8.1.3.1 Pressure Application in the Monte Carlo Analysis

Due to the limited periods of time when non-standard pressure application is expected to influence aircraft performance at HIB, the project team elected not to apply non-standard pressure to any of the Monte Carlo analysis.

8.1.4 Runway Condition

In the current aircraft operating environment, flight crews are presented with varying runway conditions that must be considered for both takeoff and landing. This includes information about whether the runway surface is dry, wet or contaminated by other temporary conditions like ice, snow, standing water and slush. Any non-dry runway will create a takeoff and landing performance impact on an aircraft's ability to remain centered on the runway and bring the aircraft to a complete stop within the available accelerate-stop distance or landing distance due to a decrease in friction between airplane tires and the runway surface. For conditions worse than just wet, a contaminated runway will further degrade takeoff performance as the aircraft must push through the contaminant during acceleration for takeoff.

Runway condition information at HIB is currently reported to flight crews via FICON NOTAMs for pilots to consider during the arrival and approach to land. Planning and dispatch offices rely on METAR, TAF and other in-house forecasting technologies to estimate runway conditions, along with the information contained in the FICONs. These observations are supplemented by flight crew experiences (PIREPs) as the anticipated hour of operation nears.

The project team utilized active precipitation (rain, snow, sleet), fog and precipitation during the previous period data from the METAR to approximate the likelihood that the runway surface would be wet (RCC – 5) for a given month or hour.

The historical FICON information provided to the team presented two important pieces of information. The first is that the ASOS observations, and predicted wet runway surface observations, matched very closely with RCC 5 and less than 5. This means that the ASOS based predictions for the likelihood of a wet runway can be used for Monte Carlo modeling without the need to create a separate FICON based distribution.

The second insight gleaned from FICON information is the high likelihood that FICONS below 5 are present at HIB during winter periods, especially on runway 4-22. The overall trend of information suggested that the airport is performing exceptional runway snow removal and de-icing procedures on runway 13-31, often at the expense of runway 4-22. For the purposes of predicting runway length, only dry and wet runway conditions need to be considered. However, there are times, especially during hours when the airport operations team is not present (00:00 – 04:00) where runway surface conditions of less than 5 were identified. This can have an adverse effect on landing performance during those hours and will require separate consideration for runway length necessary to support inbound operations.

10-year historical wet runway conditions information is shown in Table 35 expressed as a percentage likelihood of occurrence for a given hour/month.

Table 35 10-Year Historical Likelihood of Operating on a Wet Runway Surface

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	7.6%	5.6%	4.7%	6.6%	6.1%	6.4%	7.5%	11.1%	9.1%	6.5%	9.1%	11.8%
1:00	7.1%	5.2%	5.3%	5.3%	8.1%	9.3%	7.9%	12.4%	9.8%	6.9%	10.5%	9.6%
2:00	8.0%	4.8%	6.0%	8.1%	9.2%	8.3%	11.6%	14.8%	10.2%	6.8%	9.8%	8.6%
3:00	8.1%	6.5%	6.7%	6.8%	7.3%	10.7%	10.0%	18.1%	12.5%	5.9%	7.8%	11.8%
4:00	11.0%	6.4%	6.6%	7.6%	10.0%	13.0%	14.3%	16.6%	15.0%	7.4%	9.8%	9.2%
5:00	9.5%	8.3%	6.4%	7.1%	9.0%	11.9%	16.3%	15.7%	16.5%	7.6%	9.4%	12.4%
6:00	10.9%	8.1%	4.9%	7.6%	8.1%	6.7%	6.9%	18.0%	15.9%	7.4%	8.2%	10.7%
7:00	11.8%	9.6%	8.0%	9.8%	5.6%	4.3%	5.2%	8.3%	12.7%	7.7%	8.2%	10.3%
8:00	12.9%	13.6%	9.1%	8.2%	4.2%	3.3%	3.1%	4.9%	5.8%	6.6%	12.0%	15.6%
9:00	15.1%	17.3%	10.3%	9.7%	4.4%	4.1%	3.4%	2.7%	3.0%	6.0%	9.7%	15.0%
10:00	13.9%	14.9%	9.6%	9.7%	5.8%	4.9%	3.7%	1.7%	5.4%	7.8%	13.6%	16.6%
11:00	13.8%	17.8%	12.0%	8.2%	6.1%	6.3%	2.8%	2.6%	4.1%	6.3%	13.3%	16.0%
12:00	15.4%	15.4%	9.5%	8.0%	7.6%	5.6%	3.6%	3.6%	4.1%	7.8%	12.1%	17.5%
13:00	14.8%	16.4%	8.9%	7.7%	8.7%	8.2%	3.8%	5.5%	5.6%	7.0%	10.3%	13.4%
14:00	14.1%	14.1%	7.9%	9.0%	6.6%	7.1%	2.5%	2.9%	4.1%	9.0%	11.3%	13.3%
15:00	12.9%	12.1%	11.0%	6.2%	6.8%	6.9%	3.6%	3.1%	4.5%	7.0%	9.4%	10.6%
16:00	10.2%	11.9%	7.5%	7.5%	7.1%	6.3%	3.7%	3.6%	4.3%	6.8%	11.9%	9.8%
17:00	11.1%	8.6%	5.5%	6.4%	5.3%	5.2%	5.0%	4.4%	5.2%	7.7%	9.7%	9.8%
18:00	12.1%	9.0%	5.8%	7.9%	4.1%	6.5%	3.5%	3.6%	5.0%	8.0%	8.7%	9.5%
19:00	9.1%	6.8%	4.4%	6.5%	5.1%	5.4%	2.2%	4.3%	4.7%	6.1%	8.1%	9.9%
20:00	9.1%	5.6%	4.4%	6.4%	5.5%	5.0%	3.4%	3.6%	4.2%	7.6%	8.3%	10.9%
21:00	8.4%	6.7%	4.5%	6.9%	7.6%	5.3%	3.0%	4.1%	5.6%	6.8%	6.6%	9.2%
22:00	6.9%	5.5%	5.8%	7.4%	6.3%	5.9%	3.7%	5.9%	7.9%	7.8%	8.6%	9.8%
23:00	5.3%	6.7%	5.6%	5.7%	5.1%	7.5%	5.7%	8.4%	6.5%	6.7%	9.1%	10.8%
Day	13.7%	14.2%	8.8%	8.2%	6.1%	6.1%	4.5%	4.9%	5.3%	7.3%	11.2%	14.2%
Night	9.1%	6.8%	5.4%	6.8%	7.4%	8.3%	8.0%	11.1%	10.3%	6.9%	8.8%	10.3%
24 Hours	10.8%	9.9%	7.1%	7.5%	6.7%	6.8%	5.7%	7.5%	7.6%	7.1%	9.8%	11.7%

The cells in this table are color coded to reflect airline decision making about periods when a runway is expected to be wet (yellow) or dry (green) from the perspective of payload forecasting only.

From this chart it becomes apparent that wet runway conditions can be expected year-round at HIB, with a much higher likelihood during the winter months, and during overnight hours year-round.

8.1.4.1 Runway Surface Application in the Monte Carlo Analysis

To accurately reflect the likelihood that an aircraft may need to depart on a wet runway (RCC 5) the project team decided to incorporate empirical discrete pseudo random sampling on a monthly basis. This results in 12 independent months where the possibility of a runway length calculation utilizing wet runway data reflects historical observation, without any normalization of the inputs.

The decision to use empirical discrete selection of values ensures that the impacts of wet runway on takeoff performance are not inadvertently over-represented. Such over-representation can occur across a statistically significant sample of Monte Carlo runs. Using the discrete data results in an average likelihood of a performance computation using a wet runway condition of roughly 8% for a 12-month period, with individual monthly rates tracking closely to those values shown in Table 35.

Landing runway length requirements, where the RCC could be less than 5, will be analyzed outside of a Monte Carlo process due to the lack of 10 years' worth of information to build any meaningful probabilistic distributions.

8.1.5 Icing

Aircraft operating in icing conditions can have an impact on both takeoff and landing performance due to the use of anti-ice engine bleeds which may degrade available engine thrust.

Icing conditions are considered to occur when the outside air temperature is at or below 10 degrees C (50 F) and visible moisture is present. While there are no direct sources available to flight crews that report the rate, amount or likelihood of icing, most flight crews and airlines consider the need to apply anti-icing performance information taken from METARs and onboard aircraft sensors.

For the purposes of modeling aircraft performance, the combination of wet or contaminated runway surface conditions (which includes the likelihood of visible moisture close to the runway), low visibility and ceilings (which indicate additional possible sources of visible moisture in the form of clouds) and outside air temperature forms that basis of evaluating the likelihood of an aircraft operating needing to apply anti-ice engine bleeds.

10-year historical icing condition information is shown in Table 36, expressed as a percentage likelihood of occurrence for a given hour/month.

Table 36 10-Year Historical Likelihood of Operating in Icing Conditions

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	8.6%	7.5%	5.0%	8.2%	4.2%	1.8%	1.5%	4.1%	7.3%	5.9%	10.1%	12.3%
1:00	8.7%	6.5%	6.0%	7.6%	5.8%	3.4%	2.9%	4.3%	6.9%	7.0%	12.6%	12.0%
2:00	9.1%	6.1%	7.1%	10.6%	7.0%	3.7%	3.4%	6.5%	7.3%	6.5%	11.2%	10.1%
3:00	9.1%	7.9%	7.8%	7.5%	5.3%	6.4%	6.1%	7.8%	10.5%	5.5%	9.4%	13.3%
4:00	11.8%	7.0%	7.1%	8.7%	9.3%	7.7%	5.7%	9.5%	11.8%	7.9%	11.7%	10.2%
5:00	11.0%	9.9%	7.7%	8.4%	8.5%	6.5%	9.1%	8.5%	12.7%	8.0%	10.9%	13.1%
6:00	12.7%	9.3%	6.8%	8.5%	7.3%	1.1%	1.9%	7.4%	13.8%	8.5%	9.8%	12.5%
7:00	14.1%	12.5%	10.3%	10.9%	4.9%	0.1%	0.4%	1.8%	8.5%	8.7%	10.3%	12.4%
8:00	14.7%	16.3%	11.0%	9.6%	3.3%	0.2%	0.3%	0.0%	2.7%	7.0%	13.8%	18.9%
9:00	18.2%	18.6%	11.7%	10.0%	2.7%	0.7%	0.0%	0.0%	1.3%	6.5%	11.6%	18.8%
10:00	16.0%	16.1%	11.2%	9.5%	3.2%	0.4%	0.0%	0.0%	3.0%	7.4%	14.9%	19.2%
11:00	16.2%	19.2%	12.7%	8.5%	4.2%	0.1%	0.0%	0.0%	1.6%	6.0%	14.3%	17.7%
12:00	16.8%	16.1%	10.0%	7.4%	4.1%	0.1%	0.0%	0.0%	2.6%	7.5%	13.3%	19.1%
13:00	16.3%	17.3%	9.5%	8.0%	4.3%	0.2%	0.0%	0.0%	3.2%	6.6%	11.6%	16.2%
14:00	15.4%	15.3%	8.5%	8.5%	4.0%	0.7%	0.0%	0.0%	1.9%	7.1%	12.3%	15.3%
15:00	13.8%	12.6%	11.2%	6.6%	3.0%	0.1%	0.0%	0.0%	0.5%	6.2%	10.8%	13.4%
16:00	11.3%	12.5%	8.0%	7.2%	3.5%	0.3%	0.0%	0.0%	0.6%	5.4%	13.4%	11.0%
17:00	12.2%	10.0%	5.9%	5.9%	2.9%	0.0%	0.0%	0.0%	1.2%	6.5%	11.5%	11.4%
18:00	12.7%	9.4%	6.4%	7.2%	2.1%	0.3%	0.0%	0.0%	1.6%	6.3%	10.0%	11.7%
19:00	9.7%	7.6%	5.1%	5.6%	2.7%	0.3%	0.0%	0.0%	0.8%	5.2%	9.1%	11.7%
20:00	10.0%	6.2%	4.5%	6.8%	2.8%	0.3%	0.0%	0.0%	1.5%	7.4%	9.5%	12.7%
21:00	9.0%	7.2%	5.0%	7.2%	3.9%	0.0%	0.0%	0.0%	2.3%	6.4%	8.4%	10.1%
22:00	8.1%	7.2%	6.3%	8.1%	4.2%	0.8%	0.3%	1.1%	3.5%	7.1%	10.0%	11.5%
23:00	5.9%	8.5%	5.9%	6.4%	3.9%	1.6%	0.3%	3.0%	4.4%	6.5%	9.5%	12.9%

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Day	15.4%	15.1%	9.7%	8.3%	3.7%	0.3%	0.2%	0.1%	2.4%	6.6%	12.8%	16.1%
Night	10.2%	7.7%	6.2%	7.8%	5.5%	3.2%	2.9%	4.4%	6.9%	6.9%	10.2%	11.9%
24 Hours	12.1%	11.1%	7.9%	8.0%	4.5%	1.5%	1.3%	2.2%	4.6%	6.8%	11.3%	13.6%

In Table 36, cells which have been shaded in green are periods where an operator would not base a payload forecast on anti-ice aircraft performance considerations, whereas the white and yellow cells represent hours and months where the likelihood of considering aircraft performance impacts from icing increase.

From this figure the likelihood of experiencing icing conditions matches reasonable operational expectations that icing conditions would likely occur throughout the early spring, late autumn, and winter months and aside from overnight hours, would not be expected during the summer period. In summer, warmer temperatures prevent the formation of ice on aircraft surfaces. For the rest of the year, both precipitation and cloud formation at or below the 50 degrees F threshold is more likely.

8.1.5.1 Icing Application in the Monte Carlo Analysis

To accurately reflect the likelihood that an aircraft may need to consider anti-icing usage the project team decided to incorporate empirical discrete pseudo random sampling on a monthly basis. This results in 12 independent months where the possibility of a runway length calculation utilizing wet runway data reflects historical observation, without any normalization of the inputs.

The decision to use empirical discrete selection of values ensures that the impacts of wet runway on takeoff performance are not inadvertently over-represented. Such over-representation can occur across a statistically significant sample of Monte Carlo runs. Using the discrete data results in an average likelihood of a performance computation using engine anti-ice of roughly 8% for a 12-month period, with individual monthly rates tracking closely to those values shown in Table 36.

While there are periods of the year at HIB where aircraft anti-ice application may occur, the project team decided not to consider the effects of icing in the Monte Carlo analysis due to the low prevalence during anticipated flight operations hours.

8.1.6 Winds and Runway Usage

Runway selection is a critical variable in the determination of overall runway length requirements, especially when comparing existing or proposed runways to other runways that may be advantageously oriented in such a way to enhance overall wind coverage. A runway, or more specifically a runway direction, is preferred for operational use when that direction experiences no tailwind and has limited crosswind. For a typical airport with multiple runways covering a large portion of possible wind directions, the preferred threshold for winds is for a runway to have 0 knots of tailwind and less than 20 knots of crosswind.

The analysis of which runway direction that might be used the project team considered historical wind direction and intensity modeled together using the same METAR information as the previous weather elements.

Table 37 and Table 38 show the historical likelihood that Runways 13 and 31 would have been preferred for use based on these wind criteria. Ceiling and visibility are not considered in this discussion.

Table 37 10-Year Historical Likelihood of Rwy 13 Being Preferred for Operation Based on Wind Data

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	49.6%	48.4%	60.8%	62.9%	69.3%	75.7%	76.5%	72.7%	72.6%	62.5%	58.1%	49.2%
1:00	50.5%	50.6%	61.2%	61.6%	68.0%	75.8%	71.2%	73.3%	67.4%	64.9%	58.5%	53.1%
2:00	53.2%	47.7%	59.8%	61.8%	68.3%	79.1%	75.8%	70.8%	69.1%	59.4%	57.2%	50.9%
3:00	48.0%	53.0%	62.6%	61.7%	70.9%	77.8%	75.4%	74.0%	68.9%	64.4%	59.0%	51.6%
4:00	49.7%	51.4%	61.7%	61.7%	71.8%	74.5%	73.3%	76.1%	69.7%	60.8%	58.0%	52.1%
5:00	53.0%	51.6%	63.2%	63.3%	71.2%	78.1%	76.1%	74.2%	71.0%	57.9%	55.8%	49.8%
6:00	51.2%	51.6%	61.2%	61.9%	70.2%	76.8%	77.1%	73.6%	69.5%	61.9%	60.0%	51.3%
7:00	49.6%	52.0%	63.5%	61.4%	65.6%	66.1%	60.6%	66.6%	68.3%	59.3%	62.3%	48.6%
8:00	51.0%	47.2%	58.0%	55.0%	52.6%	60.2%	48.9%	55.0%	65.2%	58.9%	56.2%	51.7%
9:00	45.2%	42.6%	55.2%	49.9%	51.3%	54.5%	42.0%	49.0%	53.1%	51.1%	50.5%	46.5%
10:00	44.2%	35.4%	47.8%	45.6%	44.1%	48.9%	40.9%	40.2%	49.9%	44.6%	45.5%	46.0%
11:00	36.8%	31.2%	44.7%	40.6%	44.9%	47.1%	32.6%	38.1%	39.4%	43.0%	46.0%	40.8%
12:00	36.6%	29.2%	41.1%	41.3%	45.2%	45.6%	33.4%	35.8%	42.2%	36.3%	39.2%	38.5%
13:00	35.3%	29.5%	44.9%	38.9%	41.0%	45.8%	33.9%	35.0%	39.3%	41.0%	39.5%	40.0%
14:00	31.6%	29.7%	42.4%	36.9%	39.9%	41.3%	25.9%	37.5%	39.6%	38.4%	41.9%	40.9%
15:00	35.0%	28.0%	38.6%	38.4%	38.3%	45.2%	29.1%	33.9%	38.5%	40.8%	44.5%	39.9%
16:00	41.3%	33.0%	42.4%	39.2%	42.5%	43.3%	28.9%	36.9%	42.6%	41.1%	48.9%	49.5%
17:00	47.4%	42.1%	45.3%	41.5%	44.8%	45.5%	31.9%	37.1%	47.5%	45.2%	52.0%	50.8%
18:00	46.1%	45.3%	49.8%	43.9%	47.4%	46.4%	35.4%	43.0%	60.2%	52.0%	57.3%	52.7%
19:00	49.3%	46.8%	59.9%	52.3%	55.2%	55.2%	47.1%	58.2%	64.6%	55.2%	59.6%	50.7%
20:00	46.3%	45.2%	61.2%	59.3%	65.6%	65.8%	61.6%	69.9%	70.5%	57.8%	58.2%	53.1%
21:00	47.6%	46.4%	59.7%	63.2%	64.0%	70.1%	69.9%	68.2%	69.4%	58.7%	58.3%	51.2%
22:00	45.6%	47.8%	63.2%	58.8%	67.8%	73.0%	73.3%	70.9%	67.5%	61.4%	57.8%	51.4%
23:00	48.9%	49.8%	61.9%	59.4%	68.0%	75.7%	72.9%	72.1%	71.3%	58.1%	59.2%	51.8%
Day	39.7%	34.8%	47.8%	44.4%	48.8%	54.1%	44.1%	45.7%	50.0%	46.0%	47.4%	43.8%
Night	49.0%	49.1%	61.4%	60.7%	68.5%	75.2%	73.5%	72.2%	69.7%	60.3%	57.8%	51.2%
24 Hours	45.5%	43.1%	54.6%	52.5%	57.0%	61.1%	53.9%	56.8%	59.1%	53.1%	53.5%	48.4%

Table 38 10-Year Historical Likelihood of Rwy 31 Being Preferred for Operation Based on Wind Data

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	76.7%	78.7%	70.3%	68.4%	71.1%	71.2%	81.1%	79.6%	75.2%	72.5%	71.2%	74.2%
1:00	76.5%	76.9%	69.3%	70.1%	74.9%	72.4%	85.1%	80.5%	75.4%	71.7%	71.7%	71.5%
2:00	75.6%	79.2%	72.0%	69.2%	75.6%	72.9%	82.8%	82.6%	78.8%	72.0%	72.2%	76.0%
3:00	77.5%	80.1%	71.0%	70.2%	75.1%	77.5%	81.4%	82.7%	78.8%	72.7%	73.4%	74.7%
4:00	78.0%	80.3%	71.9%	71.8%	72.6%	71.9%	84.9%	80.7%	77.7%	73.1%	70.9%	73.0%
5:00	75.3%	81.2%	71.6%	72.4%	76.1%	73.3%	85.4%	82.0%	74.7%	73.0%	72.8%	71.3%
6:00	76.7%	79.2%	70.9%	69.8%	72.0%	68.1%	85.5%	85.1%	75.8%	72.2%	74.0%	72.2%
7:00	77.4%	78.0%	71.5%	65.1%	59.8%	57.8%	75.1%	79.4%	75.9%	72.3%	70.9%	76.2%
8:00	75.3%	77.0%	65.9%	56.4%	59.2%	54.0%	70.1%	71.8%	65.0%	70.1%	66.0%	70.5%
9:00	74.8%	73.0%	57.8%	54.8%	53.2%	54.6%	71.1%	67.4%	60.4%	62.8%	61.0%	70.7%
10:00	67.1%	70.8%	57.9%	53.9%	55.1%	55.9%	68.5%	67.3%	56.6%	62.0%	62.1%	65.0%
11:00	70.5%	71.9%	57.9%	56.0%	52.3%	56.1%	70.5%	67.4%	62.7%	58.8%	60.7%	66.4%
12:00	69.0%	71.6%	59.1%	55.0%	50.9%	57.2%	73.5%	66.7%	57.9%	63.7%	63.3%	66.5%
13:00	68.4%	71.1%	58.9%	57.5%	56.5%	55.2%	69.6%	66.5%	61.8%	60.2%	63.2%	64.6%
14:00	71.4%	72.2%	60.1%	56.9%	57.4%	57.6%	74.7%	67.1%	59.3%	61.5%	59.0%	66.1%
15:00	69.4%	73.5%	61.3%	57.5%	59.3%	54.7%	71.2%	67.2%	62.4%	61.2%	61.7%	69.4%
16:00	71.0%	73.4%	61.5%	56.7%	57.6%	59.0%	73.8%	67.7%	60.0%	62.7%	63.7%	70.7%
17:00	72.0%	72.6%	64.9%	58.8%	55.4%	57.6%	72.3%	68.9%	61.3%	64.7%	66.3%	70.5%
18:00	75.9%	73.5%	61.7%	57.7%	55.9%	57.9%	72.6%	66.5%	61.6%	64.4%	65.1%	71.6%
19:00	70.6%	73.0%	63.0%	57.5%	54.2%	56.2%	72.2%	69.9%	62.0%	65.2%	67.0%	72.9%
20:00	75.8%	71.3%	62.5%	57.8%	56.2%	60.9%	69.9%	66.6%	62.0%	64.7%	66.2%	71.9%
21:00	75.3%	72.9%	61.9%	55.4%	61.1%	63.7%	73.1%	70.0%	65.3%	66.1%	66.9%	74.0%
22:00	76.2%	75.8%	60.8%	63.5%	61.4%	63.3%	74.0%	71.0%	68.8%	67.3%	69.1%	73.0%
23:00	75.9%	76.0%	66.7%	67.8%	65.8%	64.8%	76.0%	76.0%	71.5%	70.6%	69.8%	71.3%
Day	70.8%	72.7%	61.5%	57.2%	57.1%	58.5%	73.5%	69.9%	62.1%	63.7%	63.2%	67.8%
Night	75.7%	76.9%	67.7%	66.2%	69.0%	69.7%	79.8%	77.2%	73.1%	70.1%	69.8%	73.0%
24 Hours	73.9%	75.1%	64.6%	61.7%	62.0%	62.2%	75.6%	73.0%	67.1%	66.9%	67.0%	71.0%

Hours and months containing values in green indicate periods when the runway would be preferred for use by an aircraft operator (assuming no other terrain, convective activity, or ATC restrictions). Hours in white represent an hour and month when the runway use is neutral, while hours and months in yellow represent periods when the runway is less likely to be used.

Similar to runway preference, the wind data was also examined to assess whether a runway could be used. A runway is considered to be capable of supporting operations up to a much higher tailwind and crosswind limit compared to the previous analysis of runway preference. In the case of HIB, no more than a 10-knot tailwind and a crosswind of up to 20 knots. Comparing both the likelihood of runway preference and runway capability provides a more complete picture regarding whether there are hours of months when a runway is rarely considered for usage or whether there are conditions when crosswinds or adverse wind conditions are so severe a runway (or runways) become unsuitable for aircraft operations, up to and including the entire airport.

Table 39 and Table 40 represent the runway capability analysis based on 10 years of historical wind data for Runways 13 and 31 respectively. As before, ceiling and visibility are not considered in this segment of the analysis.

Table 39 10-Year Historical Likelihood of Rwy 13 Being Capable of Supporting Operations Based on Wind Data

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	82.9%	81.5%	87.3%	88.1%	93.5%	94.9%	97.6%	97.1%	92.9%	87.8%	83.6%	83.5%
1:00	81.8%	88.4%	88.6%	88.2%	94.4%	95.1%	96.9%	97.1%	94.2%	88.6%	83.1%	84.4%
2:00	82.7%	84.6%	89.5%	87.4%	93.3%	96.0%	97.2%	95.2%	93.8%	85.8%	86.8%	84.4%
3:00	83.1%	85.9%	88.5%	89.3%	93.4%	95.6%	97.4%	96.9%	92.4%	90.0%	83.6%	81.4%
4:00	80.8%	84.8%	88.9%	88.4%	93.7%	96.1%	97.6%	95.9%	93.9%	89.6%	82.5%	84.5%
5:00	81.9%	85.0%	90.5%	87.9%	94.4%	96.7%	96.1%	96.9%	93.9%	85.1%	85.7%	84.3%
6:00	80.9%	84.5%	88.1%	85.8%	91.5%	94.7%	96.2%	96.2%	93.1%	87.5%	83.7%	83.6%
7:00	82.5%	85.4%	88.5%	83.6%	88.8%	92.2%	91.8%	94.4%	91.9%	88.5%	84.5%	85.2%
8:00	81.7%	81.5%	85.8%	80.8%	86.1%	89.0%	89.3%	92.3%	89.5%	85.9%	81.4%	83.0%
9:00	76.9%	79.0%	83.4%	77.4%	81.0%	84.0%	84.4%	88.2%	84.7%	79.7%	77.6%	82.5%
10:00	75.4%	74.3%	79.3%	75.2%	76.1%	80.4%	81.9%	80.9%	81.7%	73.9%	73.2%	78.6%
11:00	71.6%	73.4%	78.5%	66.0%	71.5%	76.0%	74.0%	79.0%	75.9%	73.0%	76.7%	79.8%
12:00	71.5%	72.4%	74.7%	67.4%	68.8%	74.1%	75.4%	76.3%	74.3%	70.0%	71.8%	79.2%
13:00	69.3%	69.1%	73.2%	64.1%	69.4%	74.1%	72.2%	76.3%	73.9%	68.9%	71.4%	79.7%
14:00	68.8%	66.7%	72.6%	62.5%	69.1%	72.5%	72.2%	77.2%	72.8%	71.5%	71.1%	81.4%
15:00	72.5%	67.5%	71.0%	65.6%	66.7%	72.0%	69.9%	76.2%	75.9%	72.0%	75.7%	83.9%
16:00	78.6%	71.0%	73.2%	66.4%	72.4%	74.6%	73.5%	78.7%	78.6%	72.8%	80.9%	89.2%
17:00	78.9%	80.9%	78.9%	68.6%	75.0%	78.1%	75.5%	83.1%	83.9%	78.0%	80.4%	87.9%
18:00	78.9%	82.6%	83.5%	77.5%	76.9%	82.5%	84.6%	88.7%	91.9%	85.5%	82.2%	83.6%
19:00	79.7%	83.5%	85.8%	84.6%	86.3%	88.1%	90.9%	95.2%	92.4%	86.7%	81.7%	86.5%
20:00	78.4%	81.4%	86.0%	87.5%	93.1%	97.0%	96.8%	96.2%	93.0%	86.7%	83.2%	84.4%
21:00	81.3%	83.7%	85.6%	90.5%	91.8%	97.1%	96.6%	96.6%	92.7%	87.0%	81.9%	84.2%
22:00	80.6%	81.8%	86.8%	89.5%	92.6%	96.4%	96.9%	97.2%	93.2%	85.6%	80.9%	86.9%
23:00	79.7%	85.1%	87.5%	88.7%	93.0%	96.5%	97.3%	97.2%	92.3%	86.3%	81.4%	84.6%
Day	74.0%	73.6%	78.6%	71.3%	77.1%	82.9%	82.8%	84.5%	82.1%	76.6%	76.5%	81.9%
Night	80.9%	84.2%	87.7%	88.0%	93.3%	96.0%	97.2%	96.6%	93.2%	87.2%	82.9%	84.6%
24 Hours	78.3%	79.7%	83.2%	79.6%	83.9%	87.2%	87.6%	89.6%	87.2%	81.9%	80.2%	83.6%

Table 40 10-Year Historical Likelihood of Rwy 31 Being Capable of Supporting Operations Based on Wind Data

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0:00	97.2%	97.3%	95.4%	93.8%	97.2%	98.1%	99.4%	98.8%	96.4%	95.6%	96.4%	95.6%
1:00	96.7%	98.0%	97.0%	93.7%	97.6%	97.6%	98.1%	99.1%	96.7%	96.1%	96.5%	96.0%
2:00	97.6%	97.1%	95.7%	93.4%	96.9%	97.2%	99.4%	99.0%	97.9%	95.9%	96.4%	96.4%
3:00	96.5%	97.0%	94.5%	94.8%	97.2%	98.1%	99.0%	98.2%	97.6%	96.7%	94.2%	95.4%
4:00	97.4%	97.1%	95.3%	94.7%	97.3%	97.3%	98.8%	98.0%	97.9%	96.6%	96.5%	96.5%
5:00	96.4%	95.9%	95.1%	93.8%	97.6%	97.1%	99.1%	98.5%	97.1%	95.6%	95.9%	96.4%
6:00	96.9%	97.3%	95.2%	92.9%	97.1%	95.9%	99.2%	99.4%	97.1%	95.2%	95.9%	97.4%
7:00	96.1%	96.0%	93.9%	90.6%	94.2%	95.0%	97.4%	99.0%	97.1%	96.7%	95.3%	96.3%
8:00	97.7%	96.2%	90.6%	87.7%	91.5%	91.6%	96.0%	97.4%	95.6%	94.8%	93.0%	96.0%
9:00	95.2%	93.6%	89.1%	81.4%	84.3%	85.9%	95.7%	96.1%	91.6%	89.6%	89.9%	96.2%
10:00	94.2%	93.2%	85.1%	78.5%	79.6%	84.5%	91.6%	92.5%	87.7%	86.8%	88.9%	94.4%
11:00	93.3%	92.1%	82.2%	75.8%	76.4%	81.0%	88.7%	89.4%	83.2%	83.5%	85.5%	93.7%
12:00	92.3%	91.7%	80.5%	74.4%	72.0%	79.0%	89.4%	87.5%	80.6%	83.0%	85.5%	94.9%
13:00	91.9%	89.7%	78.6%	73.0%	74.7%	80.7%	87.4%	88.3%	81.8%	82.9%	85.0%	92.8%
14:00	91.1%	91.3%	82.6%	76.6%	76.8%	80.3%	87.2%	86.8%	79.1%	82.2%	85.9%	94.4%
15:00	91.2%	91.9%	80.9%	74.7%	76.6%	79.1%	89.4%	87.9%	81.8%	82.4%	87.2%	95.3%
16:00	93.5%	93.5%	83.8%	76.1%	77.3%	81.3%	90.5%	89.9%	84.5%	83.0%	93.1%	96.4%
17:00	93.9%	95.2%	89.1%	80.6%	79.9%	82.9%	91.8%	92.2%	87.6%	89.7%	93.4%	96.8%
18:00	95.2%	96.6%	91.5%	84.4%	82.9%	86.1%	94.4%	96.0%	92.6%	94.8%	93.7%	95.5%
19:00	94.3%	96.9%	92.8%	88.3%	90.9%	90.2%	96.4%	98.2%	94.7%	93.2%	92.7%	96.5%
20:00	95.7%	95.5%	92.2%	90.2%	92.3%	93.7%	98.0%	96.7%	93.3%	94.3%	95.4%	96.3%
21:00	95.5%	96.2%	93.2%	92.7%	93.5%	94.5%	97.8%	96.7%	95.0%	93.5%	94.3%	98.0%
22:00	96.4%	97.5%	94.7%	94.6%	94.8%	96.7%	97.9%	98.8%	95.0%	94.0%	95.2%	96.2%
23:00	96.6%	97.6%	95.5%	96.0%	97.3%	96.2%	98.8%	99.1%	95.6%	94.5%	94.5%	95.9%
Day	93.4%	92.8%	85.7%	79.5%	82.4%	86.5%	93.3%	92.9%	87.5%	87.4%	88.9%	94.9%
Night	96.2%	96.9%	94.7%	93.2%	96.2%	97.0%	98.7%	98.3%	96.3%	95.1%	95.1%	96.4%
24 Hours	95.1%	95.2%	90.2%	86.4%	88.2%	90.0%	95.1%	95.1%	91.6%	91.3%	92.5%	95.8%

The color selection in the cells for the runway capable likelihoods are the same used for the runway preference likelihoods.

This analysis shows that both runway directions are capable of supporting operations from a wind perspective. Consequently, the runway preference tables may yield a more accurate picture of likely runway selection. These tables suggest that operations in the runway 31 direction are preferable to the runway 13 direction.

8.1.6.1 Wind and Runway Usage Limitations

There are three limitations from this type of wind and runway usage analysis that should be noted. The first is that when comparing a specific likelihood value for a particular hour and month across all the runways, the sum of likelihoods will most likely yield a value over 100%. This is primarily because calm wind conditions will be treated as allowing each runway to be equally likely of usage.

The second limitation to note is that wind gusts were considered as steady state wind conditions without any further manipulation (e.g. multiplying gusts by 1.5). This can result in time periods where the likelihood of a runway direction is neither preferred nor capable. Because gusting wind conditions typically do not last for long periods of time, the application of time weighting minimizes the overall impact of high gusting wind conditions over a given period. However, gust application against the established crosswind and tailwind limitations can limit the overall usability of a runway.

The third limitation is that this level of runway usage analysis is not based on any historical air traffic utilization information. While this information is valuable in verifying that the historical weather analysis is a close match to commonly experienced airfield conditions, the project team has verified these findings with the airport and found them to be generally consistent with historical aircraft operations.

8.1.6.2 Wind Application in the Monte Carlo Analysis

The project team has chosen to use calm wind conditions for the Monte Carlo analysis.

The analysis described to this point has focused on using thresholds of tailwinds and crosswinds to identify when a runway may be preferred or capable of supporting aircraft operations.

However, part 121 aircraft performance calculations require consideration of tailwinds on takeoff analysis, which can penalize aircraft performance. For the purposes of the Monte Carlo Analysis, the adverse effect of tailwind is mitigated by assuming that an operator would choose not to takeoff or land with a known tailwind condition, thus avoiding a potential performance degradation that could increase the required runway length.

Headwind is not considered for this analysis because most operators do not take advantage of beneficial headwind in takeoff performance computations except under unusual situations as a matter of company policy.

Some aircraft can experience performance limitations resulting from crosswinds. This is not uncommon for approach and landing operations but should not result in any increased runway length requirements for runway 13-31. For takeoff purposes a crosswind can create a performance limitation under contaminated runway conditions are worse than wet (RCC < 5). In these situations, operators may need to restrict the flap settings, thrust values or increase control speeds of the aircraft to protect against the possibility of drifting off of the runway centerline. These limitations are generally only applicable to Part 25 aircraft on runways less than 148ft wide. Since runway 13-31 is 150ft wide, these effects are not considered.

8.1.6.3 Runway Usage Application in the Monte Carlo Analysis

Based on the results of the runway capability analysis revealing a significant preference for operating on runway 31, the runway preference analysis was selected as an empirical discrete basis for the selection of which runway direction to use for a particular Monte Carlo iteration based on all historical observations in a given month. This means that for an annual time period, with no specific hour or group of hours, the likelihood of a particular runway direction will be randomly selected for the target month based on a pseudo random selection from time weighted runway preference results.

The decision to use an empirical discrete selection is further strengthened by the project team's decision to limit the Monte Carlo analysis to only consider one runway (two runway directions) at a time. This means that when analyzing runway 13-31, the likelihood of selecting a runway direction in a given Monte Carlo run can only result in the selection of either runway 13 or runway 31. Across a 12-month period this resulted in an average selection of Runway 31 across 65% - 70% of all runs.

8.2 Enroute Weather Data

Enroute weather information is used to determine the time, distance and fuel necessary for a given payload to be carried between city-pairs. Traditional enroute weather conditions that are considered include winds, temperature, and icing. Less common considerations such as ozone concentrations, ionospheric interruption, turbulence, convective activity and volcanic activity are not considered in this analysis. For the purposes of ensuring accurate runway length determinations in a Monte Carlo model, several enroute weather variables can be simplified through other flight operational assumptions like route efficiency metrics (see section 9.3). Therefore, this section will only describe the consideration made by the project team regarding enroute winds, temperatures and icing conditions.

8.2.1 Enroute Temperature

Historical enroute temperature data was taken from Boeing's PCWindTemp application covering the previous 30-year period from 1989 – 2019. The temperature information is calculated along two known points on earth for any altitude and direction of flight. The temperature has been normalized by Boeing and is provided to the user based on a selected confidence interval outcome for a given time period.

8.2.2 Application of Enroute Temperature to Monte Carlo Analysis

Enroute temperature variations were not considered by the project team for Monte Carlo analysis. This is because most modern aircraft do not experience significant changes to high-speed performance characteristics unless the upper atmosphere temperatures exceed ISA+15. While this condition can occur, it is uncommon for aircraft operating on the routes being analyzed from HIB and will therefore be disregarded from the Monte Carlo analysis as a random variable. All temperatures will therefore follow ISA+0.

8.2.3 Enroute Icing

Historical enroute icing data is not a widely available information set, is notoriously difficult to obtain from publicly available weather sources and is difficult to accurately apply across generalized routes of flight over long distances. Thus, most airlines do not consider historical icing application when making payload range forecasts in favor of taking icing performance impacts into consideration during real-time flight planning.

8.2.4 Application of Enroute Icing to Monte Carlo Analysis

Enroute icing variations were not considered by the project team for Monte Carlo analysis.

8.2.5 Enroute Winds

Historical enroute wind data was taken from Boeing's PCWindTemp application covering the previous 30-year period from 1989 – 2019. The wind information is calculated along two known points on earth for any altitude and direction of flight. The steady state wind values have been normalized by Boeing and are provided to the user based on a selected confidence interval outcome for a given time period.

Enroute wind data for flights originating from HIB follows a general trend across all 12 months whereby:

- Flights departing to destinations located to the west of HIB encounter headwinds
- Flights departing to destinations located to the south, southeast, and east of HIB encounter tailwinds

8.2.6 Application of Enroute Winds to Monte Carlo Analysis

Enroute winds were used to pre-calculate flight planning fuel requirements for each month using the 5%, 15%, 50%, 85% and 95% confidence interval wind values from PCWindTemp. The flight planning performance calculation module used for this analysis, PACELAB Mission, directly interfaces with PCWindTemp enabling varying flight level consideration of the historical wind results based on the direction of flight and step climbs iterations. This ensures that instead of a single wind value being applied across the entire route, several historical wind levels (consistent with the selected confidence interval) would be considered.

Historical wind values were modified for the initial climb and final descent portions using a fixed ratio of 85% of the last utilized flight level.

The pseudo-random selection of wind adjusted flight performance was achieved by considering a standard normal distribution allowing interpolation between the 5 pre-determined confidence intervals. However, no extrapolation was permitted to cover historical enroute wind situations that exceeded the 5% and 95% selections. This has the effect of reducing extreme flight conditions that might have resulted in unusual flight planning decisions and, consequently, unusual runway length requirements.

8.3 Summary

Historical weather data was used as the basis for modeling anticipated weather conditions for consideration with takeoff, landing and flight planning aircraft performance calculations. 10 years' worth of historical data was used for terminal weather information while 30 years of historical weather data was used for enroute weather information.

While the terminal weather source data was formatted to enable monthly and hourly analysis, the calculations used by the project team resulted in monthly data distributions that were compiled across the Monte Carlo runs to present runway length analysis applicable to annual operations.

The following values were used for terminal weather inputs:

- Temperature
- Runway Usage (based on Wind Preference)
- Runway Surface Condition (Dry or Wet)
- Anti-Ice Usage

Enroute weather inputs only considered historical wind information.

Based on a review of the historical weather data, the project team anticipates a limited range of temperature related impacts on aircraft performance with a preference towards the usage of Runway 31.

9 Flight Operations

9.1 Aircraft

A variety of aircraft currently operate at HIB on domestic, non-oceanic routes including business jets, regional jets and narrowbody airliners. At the time that this analysis was conducted, the largest scheduled aircraft operation was conducted by Sun Country Airlines operating charter flights to LAS, IFP and PHX.

The following section describes the aircraft that were selected for analysis, the parameters and methods used to calculate both the low speed (takeoff) and high speed (flight planning) performance and which portions of this information were made available throughout the Monte Carlo simulations.

9.1.1 Selection of Aircraft

The following are a list of aircraft that were originally considered by the project team for analysis in the Monte Carlo Runway Length analysis:

Aircraft:

- CRJ-200
- CRJ-701
- CRJ-901
- ERJ-170
- ERJ-175
- 737-800
- 737-MAX8
- 737-900
- A319
- A320
- A320NEO
- A220
- 560XLS
- 800XP

This comprehensive list of aircraft was reduced to a representative group that had the following characteristics:

1. Aircraft that were likely to be operated by airlines that would serve HIB on a regular, 12 month per year, basis
2. Aircraft that were likely to be operated on all, or most, of the target routes being analyzed through the Monte Carlo process
3. Aircraft that the project team had access to for high fidelity takeoff and flight planning performance calculations

When considering these three factors, the comprehensive list was reduced to the following six aircraft types:

- 560XLS
- CR2
- CR9
- E175
- 737-800
- A320

A notable exception to this list is the A220 airplane. The A220 has operating and performance characteristics such that the current state of the HIB runway poses no payload or range restrictions.

9.2 Aircraft Configuration

Just as runway length and historical weather values can influence the takeoff and flight planning performance of an aircraft, so to can properties related to the configuration of an aircraft. Of particular interest to this exercise are factors that influence the amount of fuel that can be carried and used, factors that influence payload capacity, and operator decisions that influence the overall weight of the aircraft.

These variables require careful examination for their impacts on overall runway length requirements and include structural weight limitations, engine types, seating configuration, passenger weight, baggage weight, cargo, load factor and aircraft empty weight.

9.2.1 Aircraft Structural Weight and Engine Types Used in Monte Carlo Analysis

The following section describes the aircraft that were considered, and the fixed values selected, across multiple configurations in operations today. Each aircraft contains a description of the following aircraft characteristics:

- Powerplant: The engines that were assumed to be installed and analyzed for takeoff and flight planning performance.
- MRMP: The certified maximum ramp weight, which is the heaviest that an aircraft can be at any time during the ground operation (e.g. taxiing).
- MTOW: The certified maximum takeoff weight, which is the heaviest that an aircraft can be at the beginning of the takeoff roll. This may be further limited by operational requirements (e.g. field length).
- MLW: The certified maximum landing weight, which is the heaviest that an aircraft can be at the point where a landing will be attempted under normal (non-emergency) operating circumstances. This may be further limited by operational requirements (e.g. field length).

- MZFW: The certified maximum zero fuel weight, which is the heaviest that an aircraft can be without any fuel onboard.
- Fuel Capacity: The usable fuel capacity, measured in liters. The density of fuel considered in this analysis was fixed at 6.76 lbs./gal.
- OEW: The operating empty weight of the aircraft to include seating, catering, flight crew and other service items that will be onboard the aircraft during the flight. A nominal value is used for this analysis. Considerable variation can occur due to operator preferences and aircraft weighing programs.

9.2.1.1 Cessna Citation 560XLS

- Powerplant: PW545B
- MRMP: 20,400 lbs.
- MTOW: 20,200 lbs.
- MLW: 18,700 lbs.
- MZFW: 15,100 lbs.
- Fuel Capacity: 1,013 gal
- OEW: 12,220 lbs.

Figure 19 Cessna Citation 560XLS

9.2.1.2 CRJ-200LR

- Powerplant: CF34-3C1
- MRMP: 53,250 lbs.
- MTOW: 53,000 lbs.
- MLW: 47,000 lbs.
- MZFW: 44,000 lbs.
- Fuel Capacity: 2,135 gal
- OEW: 30,500 lbs.

Figure 20 Bombardier CRJ-200LR

9.2.1.3 CRJ-901

- Powerplant: CF34-8C5A1
- MRMP: 85,000 lbs.
- MTOW: 84,500 lbs.

Figure 21 Bombardier CRJ-901

- MLW: 75,100 lbs.
- MZFW: 70,750 lbs.
- Fuel Capacity: 2,903 gal
- OEW: 47,750 lbs.

9.2.1.4 E175LR

- Powerplant: CF34-8E5A1
- MRMP: 85,870 lbs.
- MTOW: 85,517 lbs.
- MLW: 74,957 lbs.
- MZFW: 69,886 lbs.
- Fuel Capacity: 3,071 gal
- OEW: 48,000 lbs.

Figure 22 Embraer ERJ-175LR

9.2.1.5 B737-800

- Powerplant: CFM56-7B26
- MRMP: 174,900 lbs.
- MTOW: 174,200 lbs.
- MLW: 146,300 lbs.
- MZFW: 138,300 lbs.
- Fuel Capacity: 6,874 gal
- OEW: 91,300 lbs.

Figure 23 Boeing 737-800W

9.2.1.6 A320

- Powerplant: CFM56-5B4/P
- MRMP: 170,638 lbs.
- MTOW: 169,756 lbs.
- MLW: 145,505 lbs.
- MZFW: 142,198 lbs.
- Fuel Capacity: 6,302 gal

Figure 24 Airbus A320-200 CEO

- OEW: 93,000 lbs.

9.2.2 Fixed Aircraft Configuration Values in the Monte Carlo Analysis

Airlines that operate identical aircraft types will frequently use different passenger seating configurations to match their brand, passenger experience and revenue management strategy.

To ensure that the Monte Carlo runway length analysis represents both realistic operational results and broadly applicable results, the project team utilized a unique strategy for selecting fixed aircraft seating and load factor characteristics.

The first part of the strategy was to set a fixed target for load factor on the aircraft that represents the broadest possible success factors for airline operations as follows:

- Target Passenger Load Factor for All Aircraft: 100%
- Target Cargo Load Factor: 0%

As will be discussed in later sections, a successful Monte Carlo run is one that could support 100% of the target passengers (and their baggage) but where the target cargo load factors were permitted to decrease from an ideal starting level (sometimes as high as 20%) down to a value of 0% or no additional cargo beyond the passengers' bags.

For this analysis, the target cargo level identified is 0% meaning that the only items intended to be placed into the cargo hold would be those items directly related to ticketed passengers boarding the aircraft.

The second part of the strategy was to select a single seating configuration for each aircraft type independent of individual operator variations.

The project team examined current aircraft and operator-specific seating configurations across the target aircraft, focusing on significant airlines that might consider starting service to HIB following the runway extension. Unless specified, the capacities shown in Table 41 are nominal across several operators.

Table 41 Comparison of Q2 2021 Seating Capacities by Aircraft Type

Airplane Model	A320 (Allegiant)	186
	737-800 (Sun Country)	183
	CRJ-200	50
	CRJ-900	76
	ERJ-175	76
	Citation 560XLS (NetJets)	7

Aircraft seating configurations were selected to closely match anticipated aircraft/airline operators that might serve HIB. Seating configurations were chosen to generalize a number of seats greater than most other configurations currently in operation, but not necessarily with more seats than all configurations.

In cases where a seating configuration was known to operate in the market and had a greater number of seats than the value selected by the project team, that particular value was used and is highlighted in Table 41 using a bold font.

9.2.3 Variable Payload Values in the Monte Carlo Analysis

Even though our analysis considers a single passenger seating configuration for each airplane type, with target load factors, variations in the weight of passengers and their baggage are considered throughout the Monte Carlo analysis. By considering variations in the weight of passengers and bags, the overall takeoff and flight planning performance calculations reflect a range of different methodologies used to estimate the weight of non-tare payload on their aircraft.

9.2.3.1 Average Passenger Weight Variation in the Monte Carlo Analysis

The average passenger weight considered in this analysis accounts for the weight of the person, their clothing and any personal items and carry-on items they may bring onboard the airplane. The value also takes into consideration a statistical blend of gender and age. Most airlines use an average passenger weight in daily operations.

For the past several years, the average passenger weight used by US air carriers is 190 lbs. in the summer and 195 lbs. in the winter. Regional operators, with a restricted carry-on baggage program, use 184 lbs. and 189 lbs., respectively.

Variations in passenger weight is a critical consideration. New guidance from the FAA (Advisory Circular 120-27F) directs airlines to continuously survey passenger weights. This is anticipated to potentially increase average passenger weights by 5 to 10 lbs.

With these considerations in place, the Monte Carlo analysis considers passenger weights ranging from 195lbs to 205 lbs. The passenger weight selected by pseudo random methods, with equal probability, between 195 and 205 lbs., at a 5-lb. increment. The selected passenger weight is then be multiplied by the total number of seats and becomes a required portion of the total payload considered as part of the takeoff weight for the route of flight being analyzed.

9.2.3.2 Average Baggage Weight Variation in the Monte Carlo Analysis

The average baggage weight considered in this analysis is the predicted weight of baggage that each passenger will check for under-floor carriage. Airlines will typically determine a market-dependent (domestic & international) weight for each piece, and a number of pieces per passenger. For example, each checked domestic (say, HIB-ORD) bag is assumed to weigh 30 pounds, with a quantity of .75 bags/pax, while each international bag (say, HIB-ORD-CDG) is assumed to weigh 40 pounds with a quantity of 1.2 bags/pax.

Similar to variable passenger weight, variable baggage weight is also significant to the Monte Carlo analysis. For the purposes of this analysis, the average baggage weight per person varies from 30 lbs. up to 40 lbs. The bag weight selected by pseudo random methods with equal probability of weights between 30 and 40 lbs., at a 5-lb. increment, is then multiplied by the total number of seats and included as part of the aggregate payload that must be considered as part of the takeoff weight for the route of flight being analyzed. In addition, the total baggage weight was subtracted from the total cargo carrying capacity of the aircraft ensuring that any supplemental cargo request did not inadvertently create an overload situation in the cargo section of the aircraft.

9.3 Destinations and Routes of Flight

Using a Monte Carlo analysis to determine the effectiveness of a given runway length is dependent upon the destinations that are likely to be targeted by air carriers flying to or from HIB. While the purpose of this analysis is not to suggest the economic feasibility or desirability of any specific city pair, several potential destinations were taken from the Master Plan Analysis to determine distances representing plausible markets not currently served by air carriers at HIB.

9.3.1 Routes and Time of Departure

Based on information provided by the project team, the target routes identified for potential air service are as follows:

- LAS
- PHX
- DEN
- MSP
- ORD
- DTW
- MCO

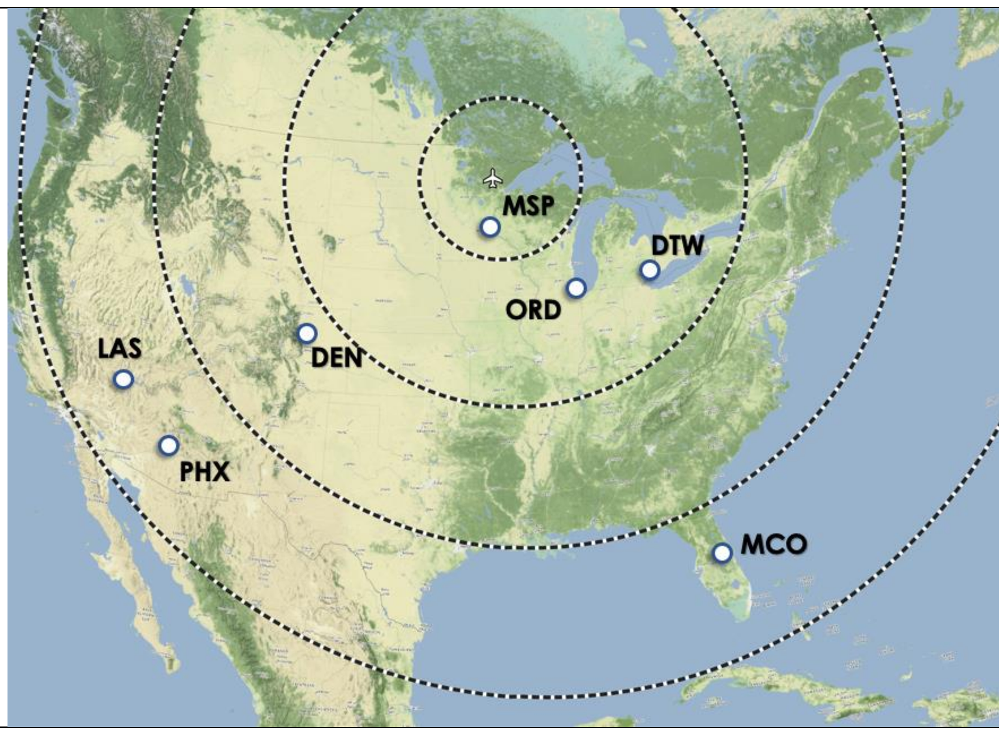


Figure 25 Range Ring Depiction for Departures Originating from HIB (Adapted from Airport Master Plan Report)

Of these destinations, several were selected as representative of the distances, and directions of flight, that were both capable of being operated at 100% load factor from HIB and which could serve as data points to assess overall aircraft performance capabilities. These destinations are indicated in Figure 25 as white dots spread across range rings depicting rings of equal flight time (each ring is 1 hour in still air) away from HIB (white airplane).

To increase the accuracy of high-speed aircraft performance calculations along the route of flight, it was necessary to adjust the great circle distance between HIB and the destination to reflect increased distances resulting from "route efficiency."

Route efficiency is a percentage increase in distance that the aircraft is expected to travel on top of the great circle distance resulting in a new airway distance using the formula:

Airway Distance = (1 + Route Efficiency) * Great Circle Distance

The route efficiency is used to account for the difference between the great circle distance and required airway distances; this is similar to "as the crow flies" versus street distance. Route efficiency is also used to account for variations in enroute weather conditions not considered elsewhere in the Monte Carlo process like non-standard wind patterns and turbulence/weather avoidance. The project team selected values of route efficiency which matched the historical flight plan filings as observed from ForeFlight to be considered along each route from HIB to the destination. In situations where historical flight plans had not recently been filed, the project team created routes that enabled a minimum of 3% route efficiency, with maximum values as high as 20% on shorter flights (less than 1 hour). The route efficiencies are summarized below in Table 42.

Table 42 List of Destinations and Airway Destinations Considered in The Monte Carlo Analysis

Destination (IATA)	Destination (City)	Great Circle Distance (NMi)	Airway Distance 1 (NMi) | (Likelihood)		Airway Distance 2 (NMi) | (Likelihood)		Airway Distance 3 (NMi) | (Likelihood)		Airway Distance 4 (NMi) | (Likelihood)	
MSP	Minneapolis, MN	151	163	50%	183	25%	195	20%	155	5%
ORD	Chicago, IL	387	395	50%	427	25%	589	20%	485	5%
DTW	Detroit, MI	510	535	50%	545	20%	589	20%	602	20%
DEN	Denver, CO	684	697	35%	743	30%	710	30%	819	5%
LAS	Las Vegas, NV	1203	1217	50%	1290	35%	1225	10%	1491	5%
PHX	Phoenix, AZ	1207	1255	25%	1279	25%	1304	25%	1328	25%
MCO	Orlando, FL	1258	1268	30%	1311	30%	1279	30%	1351	10%

Each of the route efficiencies listed above are not considered equally likely to occur either in the real world or in the Monte Carlo simulation. While the likelihood of each route varies significantly, the overall likelihood of each route being considered in the Monte Carlo Analysis is listed as a percentage value immediately to the right of the Airway Distance Values shown above.

There are no, known or anticipated, destinations identified for current and future service at HIB that require ETOPS or non-FAA flight planning considerations.

This analysis does not account for any specific time-of-day departure influences. We assume equal likelihood of a flight operating in any of the 12 months of a year, at any time of day. The team believes this is reasonable given the relative lack of performance-impacting hot temperatures at HIB.

9.3.2 Route and Time of Departure Inputs to Monte Carlo Analysis

Each destination identified in Table 42 was used as the basis for an independent Monte Carlo series of runs for the target aircraft.

For each destination, the airway distances identified in Table 42 were used to pre-calculate flight planning performance results that had a likelihood of selection specified in the table. As an example, for the route from HIB – ORD, there was a 50% chance that the airway distance from takeoff to touchdown to be analyzed was 395 Nmi, a 25% chance that the route was 427 Nmi, a 20% chance that the route was 445 Nmi and a 5% chance that the route selected was 485 Nmi. These likelihoods were applied across each of the 12 months independent from any other historical weather parameters.

9.4 Flight Planning

The role of flight planning calculations in the Monte Carlo analysis focused on exploring the effectiveness of an existing runway length is to determine an accurate aircraft takeoff weight and significantly, the fuel load for each operation. Each calculation considers the month of operation, the payload being carried, the aircraft, the route of flight and the enroute weather conditions specific to operations to and from HIB.

Each flight planning calculation utilizes regulatory-compliant methods particular to the host country and the airline operator to determine the amount of fuel required to plan for contingencies encountered while enroute to the destination or an alternate airport. A specialized set of high-speed aircraft performance data, supplied by aircraft manufacturers and refined by operator experience with the aircraft, is used with flight planning calculation engines to determine a mission-specific takeoff weight which can then be compared against the maximum possible takeoff weight available for a given runway length.

By directly calculating flight planning aircraft performance results using monthly enroute weather conditions along specific routes of flight, the accuracy of the overall Monte Carlo results is increased to ensure that the runway extension results have the highest likelihood of being sufficient for flight operations following a potential extension.

This section describes the flight planning data and methods used to calculate the planned takeoff weights for an aircraft, route and payload. This section also describes which aspects of the flight planning performance calculation are carried forward into the Monte Carlo analysis and provides some initial insight on the overall flight planning performance results.

9.4.1 Flight Planning Performance Data

Each flight planning performance calculation requires several different sets of high-speed aircraft performance information. This includes climb, cruise, descent, approach, missed approach and holding performance information.

The high-speed performance data used in this analysis is created through a combination of high-speed performance data taken from aircraft manufacturer provided data and tools. These data were imported and applied to routes using PACELab Mission software (PLMS).

In situations where the project team does not have manufacturer's high-speed aircraft performance information for the precise aircraft model (like the CR9 and E175), the team utilized the ForeFlight Dispatch capability to model their publicly available aircraft performance models.

9.4.2 Flight Planning Methods Used

The project team utilized the PLMS toolset to calculate flight plan aircraft performance results with the goal of preserving the target passenger load factor first, followed by the cargo load factor second for any takeoff weight up to the structural limited value.

Fuel calculations were calculated by applying 14 CFR Part 121 domestic flight planning regulations and the following conditions:

EN-ROUTE

- ENGINE START: 2 min
- TAXI: 9 min
- TAKEOFF AND CLIMB TO 1,500 FT AGL, distance not credited
- CLIMB TO OPTIMUM ALTITUDE: Main Speed Schedule defined by OEM
- STEP CRUISE: Main Speed Schedule defined by OEM, No minimum cruise length
- DESCENT TO LANDING: Main Speed Schedule defined by OEM
- APPROACH AND LANDING FROM 1,500 FT AGL: distance not credited
- TAXI: 5 min, taken from reserve

DIVERSION (starts after approach)

- OVERSHOOT TO 1,500 FT AGL: 80 % T/O-performance
- CLIMB TO 35,000 FT: Diversion Speed Schedule defined in Aircraft

- STEP CRUISE: Diversion Speed Schedule defined in Aircraft
- DESCENT TO LANDING: Diversion Speed Schedule defined in Aircraft
- APPROACH AND LANDING FROM 1,500 FT AGL: distance not credited

CONTINGENCY fuel is defined as:

- Continued Cruise: 0.75 hr.
- Burnt before diversion

Reserve is defined as the sum of:

- Diversion fuel
- Contingency fuel

Alternate airports were considered to be located between 50 - 100 nmi away from the destination airport.

All aircraft were assumed to operate at Long Range Cruise (LRC) speed. LRC is unique to each aircraft and represents an operational speed which favors minimizing fuel over flight time. This will have the effect of reducing the overall runway length required for a route of flight compared to faster speeds that may be used by airlines. LRC also represents a standard operational speed that can be consistently applied to all aircraft.

No takeoff or landing weight limitations were applied to PLMS flight planning performance analysis beyond the certified limitations. This enables each of the flight planning performance permutations to reflect the required takeoff weight which can then be compared to the takeoff weight available for each runway length/obstacle combination.

9.4.2.1 Insight from Flight Planning Results

All PLMS and ForeFlight Flight Planning performance runs were performed "in advance" of the Monte Carlo pseudo random selection methods, enabling the project team to review the overall characteristics of gross takeoff weight and load factors that were expected to meet the criteria.

All target aircraft were used to generate flight planning results; however, the CRJ-900 aircraft was unable to operate under most payload carrying conditions on routes beyond 3.5 hours.

9.4.2.2 When Flight Planning Results Did Not Succeed

There is one situation in which PLMS and/or ForeFlight was known to fail to generate a takeoff weight for use with the overall Monte Carlo Analysis.

The situation arises when the aircraft fuel capacity was insufficient to perform the route under the historical wind conditions and airway distance. In this situation, PLMS or ForeFlight would return an error indicating that the combination of inputs could not succeed given the requirement to carry a minimum payload of 100% passenger capacity.

9.4.3 Flight Planning Inputs to Monte Carlo Analysis

PLMS studies were utilized to generate thousands of different flight plan aircraft performance results that included independent inputs for the following combinations:

- Every month (x12)
- Each aircraft (x6)
- Each route (departing HIB to the destination)
- Each passenger weight (x3)
- Each baggage weight (x3)
- Each airway distance (x4)
- The 5 primary historical wind likelihoods (x5)

Each flight planning performance calculation was stored with data indexes created to enable rapid referencing of the inputs used - whether the flight plan succeeded for the inputs, the load factors achieved, and the takeoff weight required by the analysis.

9.4.4 Distribution of Flight Planning Performance for Monte Carlo Analysis

An individual flight planning calculation was performed for each aircraft, route, weather condition, airway distance and range of payload targets. This resulted in flight planning performance results that related the target takeoff weight required for the route of flight to the intended month of operation from HIB.

There are two important limitations to identify related to the distribution of takeoff weights used in the Monte Carlo Analysis.

The first limitation to note is that no flight planning performance was calculated for routes beyond the destinations identified in Section 9.3. This means that in cases where an operator may consider destinations from HIB beyond Phoenix or Orlando, additional calculations would be required to assess required takeoff weights. This is particularly important as aircraft operating over increasingly longer ranges eventually will need to reduce payload in order to carry enough fuel for a given route. This fuel capacity limitation can lead to failure cases for aircraft unable to achieve 100% Load Factor.

The second limitation to note is that the calculated distribution of flight planning performance results is based only on the destinations listed in Table 42. This is not expected to have a significant impact on the overall Monte Carlo results because the target takeoff weight determined by the flight planning performance is used as a direct input into the runway length calculation. No interpolation of results from the flight planning performance is required to enable the next phase of the Monte Carlo runway length analysis.

9.5 Takeoff Performance

9.5.1 Takeoff Performance Methods Used

Parts 25 and 121 require consideration of the following factors when determining the limiting takeoff weight for a runway length, obstacle definition and other environmental inputs:

- One-Engine Inoperative (OEI) Accelerate Go (25.113)
- One-Engine Inoperative Accelerate Stop (25.109)
- All-Engines Operating (AEO) Accelerate Go (25.113)
- All-Engines Operating Accelerate Stop (25.109)
- Brake Energy Limitations (25.735)
- Tire Speed Limitations (25.733)
- One Engine Inoperative Climb Limitations (25.121)
- One Engine Inoperative Obstacle Clearance Limitations (121.189)
- Temperature and Pressure Altitude Limitations (121.189)
- Gust, Crosswind and Other Runway Surface Limitations (Identified by the OEM during certification)

These limiting factors determined using the FAA Approved Airplane Flight Manual (AFM) for each airplane type. Operationally, each OEM provides aircraft performance calculation software that optimizes variations with airplane configuration, takeoff safety speeds, climb speeds and other parameters to achieve the greatest possible takeoff weight in compliance with all regulatory limitations.

The primary mechanism for optimizing a takeoff performance calculation is to ensure that the minimum amount of runway, or declared distances, is utilized by the aircraft under normal conditions (all engines operating) and during an emergency loss of one engine at the most safety critical point on the runway. In Figure 26, the three primary calculations are depicted showing a normal takeoff (Accelerate Go (AEO), a normal or abnormal aborted takeoff (Accelerate Stop (AEO or OEI)) and an abnormal takeoff (Accelerate Go (OEI)).

Under each of these scenarios the aircraft is required to begin the takeoff roll with all engines operating. For the OEI scenarios, an engine failure occurs only at the most critical point of the takeoff. At that point the all OEI requirements must be met whether the takeoff is aborted or continued.

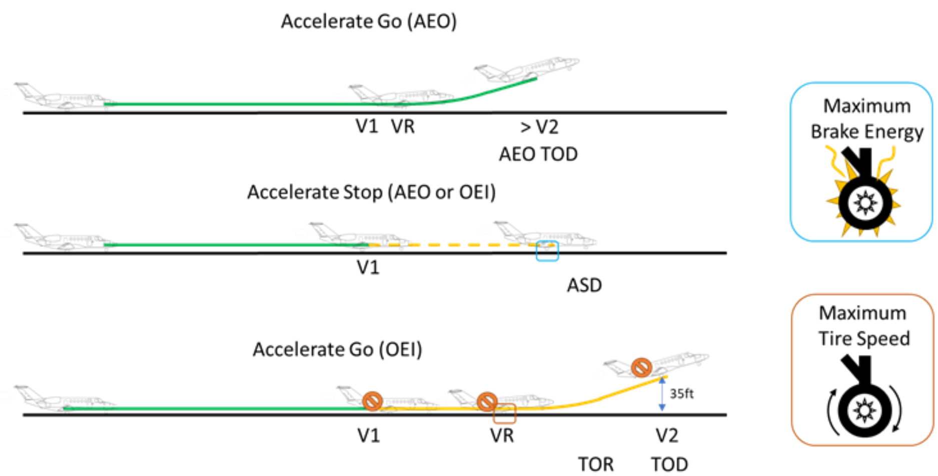


Figure 26 Primary Takeoff Performance Calculation Considerations for FAR 25/121 Operations

In each situation depicted, the performance calculation methods attempt to optimize the aircraft within the distances available so that the aircraft:

1. Reaches 35 ft. above the end of the runway (15 ft. under wet and or contaminated conditions)
2. Comes to a complete stop prior to reaching the end of the ASDA

Scenario 1. must be accomplished within the reported Takeoff Distance Available (TODA) and scenario 2 must be accomplished within the reported accelerate stop distance available (ASDA) both of which are part of the declared distances for a runway direction. The last of the three takeoff declared distances, Takeoff Run Available (TORA), is typically the published runway length. Most commonly, but not necessarily, these three distances are equal.

The performance calculation will optimize the use of the available distances attain the greatest weight possible.

The ability of the performance calculation to optimize takeoff distances also directly relates to the obstacles clearance requirements that the aircraft must also consider during the OEI takeoff maneuver.

Takeoff obstacle clearance requirements stipulate that the aircraft to continue the climb from the 35 ft. point (15 ft. under wet or contaminated conditions) and clear all remaining obstacles identified in the One Engine Inoperative OAA (described in Section 9.5.2) by both 35 ft. and an increasing margin based on distance to each obstacle. The margin is 0.8% of distance for 2-engine aircraft (25.115).

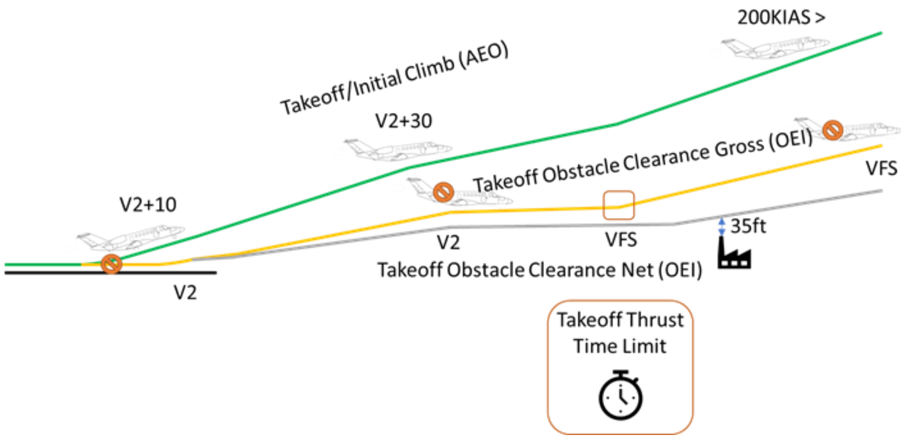


Figure 27 Overall Depiction of All Engines Operating and One Engine Inoperative Obstacle Clearance Considerations for FAR 25/121

The extent to which a takeoff weight is limited by obstacle clearance depends on three things:

1. Position of obstacles relative to the start of the takeoff
2. Length and slope of the runway
3. Climb capability

Position of obstacles may be an obvious consideration when determining an obstacle limited takeoff weight, but even a small obstacle close to the end of a runway may be enough to change the overall takeoff performance optimization, consequently rendering portions of the runway effectively unusable.

The second elements related to the length and slope of the runway is also important, especially on runways with a downhill (negative) slope. These runways may appear to have many objects that will be required for obstacle clearance, but takeoff performance computations are aware of the starting point of the aircraft as it begins the takeoff roll. Therefore, optimized takeoff performance may enable an aircraft to become airborne prior to the end of the runway, essentially increasing distance to clear any obstacles.

The final element, climb capability, is directly tied to the weather conditions and the regulatory requirement of an aircraft to maintain a generic climb capability following the loss of thrust in one engine. This is influenced by the pressure altitude, outside air temperature, flap selection, and initial climb speed. While climb capability can be an issue at high-temperature and/or high-altitude airports, climb capability at HIB is not considered to be a significant limitation.

9.5.2 Obstacle Accountability Areas

Part 135, 121 and 125 aircraft operators are required to consider one engine inoperative obstacle clearance for any objects, or terrain, detected inside an Obstacle Accountability Area (OAA).

Aircraft operators in the US utilize an OAA based methods specified within FAA Advisory Circular 120-91A. This AC defines two methods based on whether an operator chooses either to use navigational methods to narrow the OAA, or to rely on a more generic Area Analysis method.

The OAA defined in the AC expands as a function of distance from the end of the runway. The initial width begins at 300 ft. on either side of the centerline (approximately 90m). This width is fixed until 4,800 ft. from the end of the runway. At that point, each outer boundary of the OAA grows at a rate of 16:1 until the maximum OEA half width of 2,000 ft. is reached (3000 ft. for turning departures).

While US operators can choose to use AC 120-91A methods, some operators may use a more conservative OAA a result of an operator's policy decision or due to regulatory requirements (non-US operators).

AC 120-91A allows US operators to use a narrower initial OAA half-width of 200 ft. "within the airport boundaries". However, this method of analysis was not modeled in the Monte Carlo analysis.

For HIB, the project team focused its aircraft performance calculations only on AC 120-91A OAA methods.

9.5.3 Takeoff Performance Inputs to Monte Carlo

The primary goal of incorporating takeoff performance into the Monte Carlo analysis is to be able to determine whether the airport has sufficient runway length to achieve current and future payload range capabilities for target aircraft. Since all takeoff performance computations are calculated for a single runway direction, and obstacle profile, to determine a limiting takeoff weight, then is of paramount importance to calculate all limiting takeoff weights for each runway direction and obstacle combination that could be reasonably considered.

Pre-calculated takeoff performance results must therefore be divided into those with fixed inputs, either as inputs, outputs or both, and those which will be fed into pseudo random distributions based on historical weather inputs identified in Section 8.1.

9.5.3.1 Fixed Values for Takeoff Performance Calculations

All takeoff performance calculations were permitted to achieve optimized results using the following methods:

- Optimized decision speed (determination of V1 and application of declared distance considerations)

- Optimized takeoff safety speed (varying V2 for minimum climb or obstacle clearance)

All takeoff performance calculations considered the following values as established inputs that would not vary

- One obstacle definition per runway direction and length
- 10-minute engine inoperative takeoff thrust time limitations
- Thrust reversers were not considered for any performance calculations
- No headwind, tailwind or crosswind values were considered
- Only dry or wet runway surface conditions were considered
- Anti-Ice bleeds were set to off or Engine Only
- No inoperative, MEL or CDL items were considered
- No thrust degradation was applied beyond the values already considered for certification of takeoff performance
  - No fixed derated thrust application
  - No assumed temperature thrust reduction

Flap and slat configurations were each run independently using the parameters identified above to determine the greatest possible weights for each condition to carry forward into the Monte Carlo Analysis. In other words, if a given aircraft type has three takeoff configurations, the takeoff performance results would be run for all three settings; the configuration resulting in the greatest weight from the three would be selected for the Monte Carlo analysis, and the other results would be set aside. This means that for any combination of inputs, including temperature, runway, obstacle, a different flap setting may be considered.

All optimization techniques, flap settings, and other fixed inputs align with known operational practices of the airlines and aircraft identified in this analysis.

9.5.3.2 Distributions for Takeoff Performance Calculations in the Monte Carlo Analysis

An individual takeoff performance calculation was performed for each runway, obstacle definition, weather condition and flap/slat setting. These takeoff performance results relate the maximum takeoff weight permitted by the runway and environmental conditions to a runway length.

The current limitation of this analysis is that no takeoff performance was calculated for a runway length in excess of 8,000 ft. This means that in cases where a takeoff weight required a length greater than 8,000 ft. to complete a mission with no loss of passenger load factor, the Monte Carlo sample run will only indicate that insufficient weight was generated and it will not attempt to extrapolate runway length results beyond 8,000 ft.

9.6 Landing Performance

Contemporary landing performance now consists of two complementary requirements, a traditional time-of-dispatch determination, and a newer time-of-arrival determination.

9.6.1 Certificated Landing

As with takeoff, dispatch landing performance is driven by 14CFR Parts 25 & 121 as part of the required flight planning process by Part 121 dispatchers.

- Required Landing Distance (25.125)
- All-Engines Operating Climb Limitations (25.119)
- Engine Inoperative Climb Limitations (25.121)
- Temperature and Pressure Altitude Limitations (121.195)
- Gust, Crosswind and Other Runway Surface Limitations (Identified by the OEM during certification)

Notably, certificated landing data does not account for either temperature or runway slope, however the flight-test verified distances are conservatively factored to account for those conditions and other factors that may occur in typical operations. Unlike takeoff, there is no capability to determine landing performance on contaminated runways, only dry or wet conditions are considered.

These limiting factors are determined using the FAA Approved Airplane Flight Manual (AFM) for each airplane type. Operationally, each OEM provides aircraft performance calculation software that optimizes variations with airplane configuration, approach and landing speeds, missed approach and go-around climb speeds and other parameters to achieve the greatest possible landing weight in compliance with all regulatory limitations.

9.6.2 Operational Landing

Operational landing assessments are intended to be done by flight crews closer to actual time of arrival with the understanding that conditions may have changed since time of dispatch. These determinations are driven by a 2005 runway excursion that resulted in FAA Safety Alert for Operators (SAFO) 06012, now superseded by SAFO 19001. While these assessments do not currently fall within the Code of Federal Regulations, FAA Certificate Management Offices do expect operators to adhere to the SAFO recommendations.

Operational landing does take into account more specific information regarding ambient conditions. Runway braking action due to contaminants, and the use of auto-braking systems, are considered for operational landing. Temperature and slope effects are also considered, all differing from the current regulatory requirements

The intent of operational landing assessments is to inform flight crew decision-making in line operations. However, some operators also use this information as part of dispatch process in addition to the normal dispatch flight planning requirement in order to provide some accountability for runway conditions. This can result in over-conservative results, including weight restrictions and flight cancellation.

As this information is not regulatory, it does not reside in the FAA Approved AFM. This data is provided to operators by the OEM in their Flight Crew Operating Manual (FCOM) or various software packages.

Landing performance, and runway length required to accommodate landing, was not explicitly considered as a part of the Monte Carlo Runway Effectiveness analysis.

9.6.3 Landing Performance Analysis

Landing performance, and runway length required to accommodate landing, was not explicitly considered as a part of the Monte Carlo Runway Effectiveness analysis. Instead, the team analyzed the Certified and Operational landing performance capabilities for all of the aircraft considered in the Monte Carlo Analysis on an individual basis.

Each aircraft was evaluated for the payload that would be available for an aircraft to arrive into HIB with FAR 121 Domestic flight planning 45-minute fuel reserves + enough fuel to travel to an alternate and execute a full stop landing.

The landing performance evaluated dry, wet and contaminated runway conditions expressed by FICON RCC values of 6 (Dry), 5 (wet) and 3.

From this analysis, all aircraft types examined, except two, are capable of landing at HIB on either runway 13 or 31 with the current runway length.

The CRJ-701 and CRJ-901 aircraft encounters payload limitations under wet and contaminated conditions under the certified landing performance computation. The results can be summarized as follows:

Table 43 Summary of CRJ-901 Certified Landing Performance for Existing Runway

Rwy	LDA	Condition	PAX Carried	Lbs. below MLW
13-31	6,758	Dry	76	0
		RCC 5	76	1,353
		RCC 3	3	22,602

Table 44 Summary of CRJ-701 Certified Landing Performance for Existing Runway

Rwy	LDA	Condition	PAX Carried	Lbs. below MLW
13-31	6,758	Dry	69	0
		RCC 5	69	0
		RCC 3	0	N/A

From this analysis, an operator of a CRJ-901 aircraft would not be able to dispatch a flight to HIB during a period when the runway could be contaminated by snow, slush or ice.

However, there are certain US operators of the CRJ-901 who have been compelled by the FAA to utilize the certified landing performance as the basis for the operational landing distance assessment (8900.1 Vol 4 Chapter 3 Table 4-11). For these operators (some of whom operate into HIB on a regular basis) then the flight would have to hold/divert until the runway conditions returned to wet. This is especially impactful during periods where the airport might be preparing to close for or when the ASOS reporting becomes unreliable, leading to an increased likelihood of delays and diversions for this particular aircraft type.

To avoid these kinds of limitations for current and future CRJ-901 aircraft (or similar aircraft that were certificated prior to the adoption of Part 25 Amendment 92, such as the ERJ-135/145) an analysis was performed to identify the ideal landing distance available to enable full payload landings without delay or diversion. This resulted in the following values for the CRJ-901:

- LDA at HIB for CRJ-901 to achieve maximum PAX Dry: 5,570 ft
- LDA at HIB for CRJ-901 to achieve maximum PAX Wet: 6,405 ft
- LDA at HIB for CRJ-901 to achieve maximum PAX RCC 3: 8,355 ft

The following values are particular to the CRJ-701

- LDA at HIB for CRJ-701 to achieve maximum PAX Dry: 5,040 ft
- LDA at HIB for CRJ-701 to achieve maximum PAX Wet: 5,795 ft
- LDA at HIB for CRJ-701 to achieve maximum PAX RCC 3: 7,335 ft

The only way to achieve this increase in LDA necessary to support landing operations under common wintery conditions would be to extend the runway 13-31 length to a length between 7,400ft and 8,400ft in total length.

Because a runway extension of up to 8,000ft is being considered to accommodate takeoff performance payload-range requirements, the following table summarizes the inbound passenger counts would likely be achieved under dry, wet and RCC 3.

Table 45 Summary of CRJ-901 Certified Landing Performance for Runway 13-31 Extended to 8,000ft

Rwy	LDA	Condition	PAX Carried	Lbs. below MLW
		Dry	76	0
13-31	8,000	RCC 5	76	0
		RCC 3	61	9,761

Table 46 Summary of CRJ-701 Certified Landing Performance for Runway 13-31 Extended to 8,000ft

Rwy	LDA	Condition	PAX Carried	Lbs. below MLW
13-31	8,000	Dry	69	0
		RCC 5	69	0
		RCC 3	69	0

The PAX counts for the CRJ-701 at 8,000 ft would no longer be affected by RCC 3 conditions and the CRJ-901 would still be able to operate, albeit with some passenger/baggage restrictions. In these situations, regional jet operators with access to both the CRJ-901 and CRJ-701 could make the decision to send the CRJ-701 to HIB under these anticipated conditions, whereas they currently could not send either aircraft.

9.7 Summary

The project team selected aircraft, seating configurations, flight operations policies, and takeoff performance methods based on existing operations under FAR domestic regulations and guidelines.

Aircraft selected for this analysis are anticipated to be in service for at least the next 5 – 20-year period at HIB and utilize passenger seating configurations which match existing layouts from airlines that serve HIB or are likely to serve HIB in the future.

Based on preliminary flight planning performance and takeoff performance results, calculated for use with the Monte Carlo Runway Effectiveness Analysis, there are two important observations:

The current length of runway 13-31 is adequate to enable short range flight operations for regional jets, and some larger narrowbody aircraft, to fly to destinations within 2.5 hours of the airport. However, a longer runway length will be required to support larger aircraft flying to additional destinations of interest to the airport and the residents in the vicinity of HIB.

The landing length of the runway should ideally be increased to 8,400ft to prevent CRJ-901 aircraft from taking significant payload restrictions when encountering wintery conditions at time of arrival. In the event that a lesser length must be considered, then we recommend the airport target a runway length resulting in an LDA of between 7,400ft and 8,000ft.

10 Determining Ideal Runway Length for HIB

This section describes the methods used to determine the effectiveness of the current runway length resulting from a Markov Chain Monte Carlo methodology.

10.1 Monte Carlo Modeling Methodology

The project team used a simplified Markov Chain Monte Carlo methodology utilizing pseudo-random selections of predetermined variable distributions with two decision steps relating the flight planning takeoff weight, required to operate the aircraft on the desired route, to the takeoff weight resulting from the aircraft choosing to use a runway and obstacle definition.

Figure 28 illustrates the Markov Chain steps taken during each sample iteration enroute to achieving a Monte Carlo sampled distribution expressing the cumulative likelihood of an aircraft operating on a specific route for varying directions of the target runway.

A single aircraft and route served as the starting point for an independent Monte Carlo simulation resulting in a sample set that was specific to both. Thus, an independent Monte Carlo simulation was performed for each of the six aircraft across each of the target routes.

The first group of pseudo-random selection occurred to inform the Flight Planning, or "High Speed Performance" blue box described in Section 9.4. The selected inputs from the payload, enroute weather and flight planning considerations were used to identify the pre-calculated flight planning performance set for further evaluation.

In the event that the randomly selected flight planning performance run was unable to converge, meaning that it was unsuccessful for the aircraft to operate the route regardless of runway availability at HIB, then the result was considered to be a failure and the sample run was documented as such with information about where the failure occurred and for what reason. The sample run then restarted with another series of randomly selected input variables from the flight planning performance process generating a new gross takeoff weight necessary to operate with the target payload.

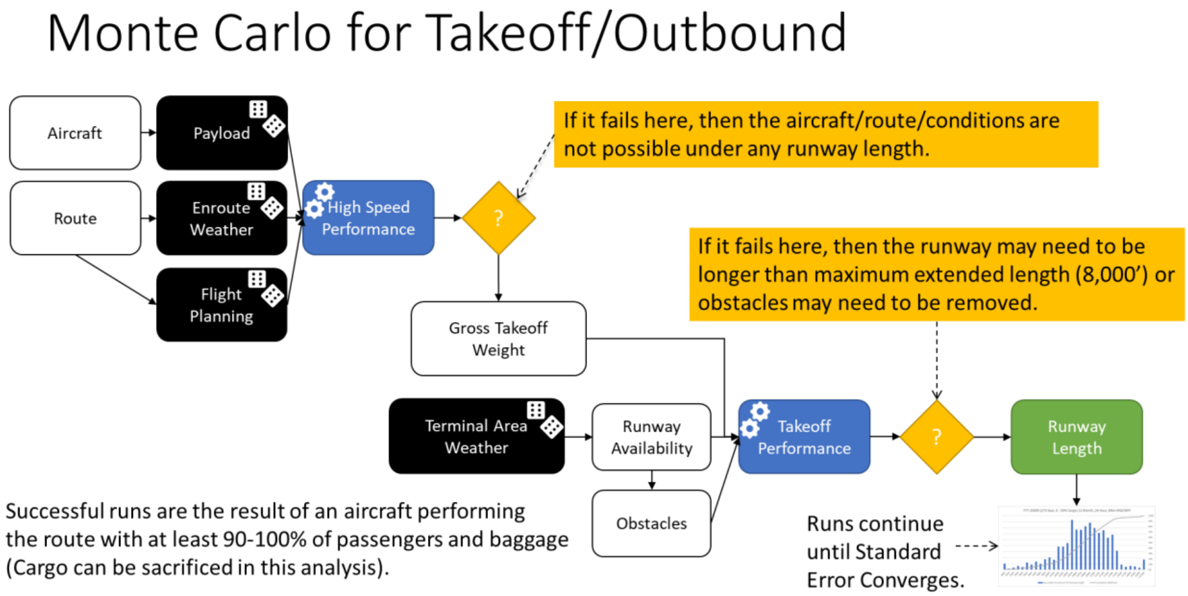


Figure 28 Flowchart Depicting Simplified Markov Chain Based Monte Carlo Analysis Process

The month and aircraft considered form the flight planning calculation were carried forward to the takeoff performance calculation process, ensuring that the pseudo-random selection of terminal weather inputs matched the time period used for the flight planning calculation. At this juncture, a pseudo-random selection of weather-related inputs was generated revealing the most likely direction of runway in use. The inputs were then fed into the takeoff performance generation tool.

In the situation where the flight planning takeoff weight matched a takeoff weight supported by an existing, or extended, runway length (and obstacle set) then this runway length value was carried forward as a successful sample run and the process repeated itself.

In the scenario where the takeoff weight identified by the flight planning performance calculation was less than a value available for the existing runway length on the runway, then the Monte Carlo sample run was assumed to be successful at the existing runway length.

If the target takeoff weight identified by the flight planning process was greater than the takeoff weight calculated using the randomly selected terminal weather inputs, then the sample run is considered to have failed due to not having enough runway length available. In this specific analysis, because no takeoff weights were generated for a runway extension that would result in runway 13-31 being longer than 8,000 ft., then it was known that a longer runway was still required and the sample run was recorded as needing more than 8,000 ft. without providing a specific answer on the exact amount.

The Monte Carlo process is repeated to build up a statistically significant sample set for each aircraft and route. The process produced samples until either 2,000 runs were calculated (including both successful and failed runs from the payload comparison steps), or until such time that the standard error of the 95% cumulative likelihood converged.

The resulting sample set for each aircraft and a route was then expressed in terms of the cumulative likelihood of operations, or cumulative distribution function, for consideration by the project team.

10.2 Cumulative Likelihood and Airline Operations

The tendency for an airline to operate scheduled, seasonal or charter service can be expressed in terms of the cumulative likelihood calculated from the Monte Carlo process described in the preceding section.

The concept of using cumulative likelihood approximates the operational decision making and payload forecasting techniques demonstrated by airlines operating on domestic and international operations to and from US airports over the past 20 years.

Runway lengths that support operations near the 100% cumulative likelihood values are likely to operate every day, at any time, without the need to alter the payload or significantly alter the time of flight. To put it another way, no delays would be expected and no denied passenger boardings would be anticipated as a result of challenges to takeoff performance.

Airports serving as hubs to major carriers frequently have one or more runways that achieve this 100% cumulative likelihood for all aircraft and routes. At the other extreme, airports in challenging environments may experience cumulative likelihoods for a runway that may be near 50% for any time throughout a year. In these situations, operators may still choose to fly the route, with the aircraft, from the runway in question. To mitigate the operational risks, an operator may limit the number of operations or limit the time of operation to one that results in a different cumulative likelihood (specific to the hour of operation) rather than one based on an annual analysis.

This information has been synthesized by the Project Team and can be categorized into the following ranges of likelihood and the kinds of operations that can be expected for a year-round operation from HIB, with no pre-determined time of departure:

95% - 100% Likelihood:

- Annual scheduled service
- No payload restrictions or
- No delays waiting for environmental conditions to improve

90% - 95% Likelihood:

- Annual scheduled service

- No payload restrictions
- Either an occasional delay or reduction in cargo

85% - 90% Likelihood:

- Annual scheduled service
- Some payload restrictions
- Targeted times of operation or potential seasonal service

50% - 85% Likelihood:

- Seasonal or charter service only
- Possibility of payload restrictions

<50% Likelihood:

- The route will not likely be attempted except under extraordinary circumstances

The cumulative likelihood values expressed above are specific to the strategy selected by the project team to utilize a 100% passenger load factor. This is an important distinction because a runway length that supports a 90 – 95% cumulative likelihood result will still result in the eventual outcome that a flight operation will not have enough runway length to operate without some takeoff performance related impact.

By choosing to start with a very high load factor any impacts experienced by an air carrier from the extended runway will not likely result in unfavorable operational decisions that would cause the airline/aircraft to either cease operations or incur significant commercial duress.

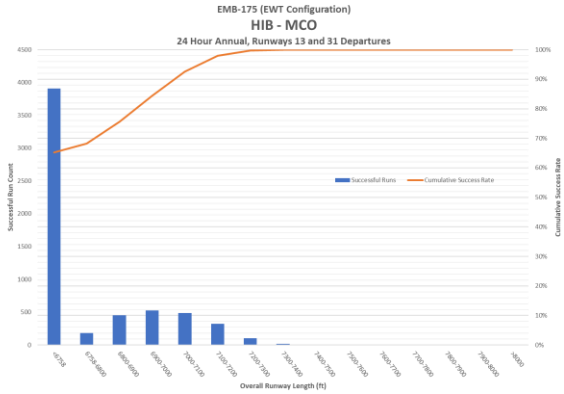
Cumulative likelihood does not relate to the financial decision-making process that each airline will undertake to consider additional factors like aircraft availability, crew or fuel costs, and ticket prices. Therefore, an airport/runway that provides 100% cumulative likelihood is not a guarantee of commercial service.

10.3 Aircraft Specific Results on Selected Routes

The Monte Carlo analysis revealed the cumulative likelihood of scheduled operations for each aircraft, on each route, expressed against ultimate length of Runway 13-31 extended to the south to a length greater than its existing 6,758 ft.

The following figures show a selection of aircraft cumulative likelihoods across runway length extensions for service from HIB to Orlando (MCO) and Las Vegas (LAS). Additional tables can be made available upon request via the airport to the project team.

10.3.1 HIB-MCO Results



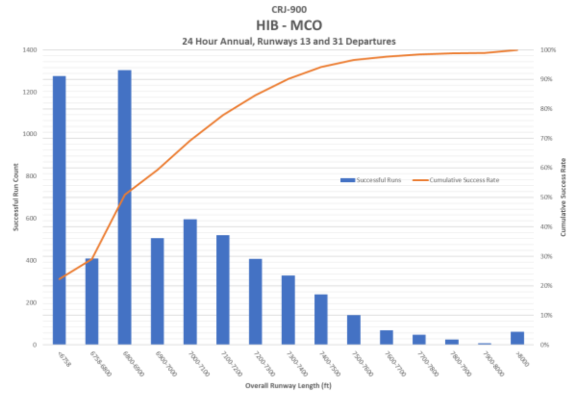
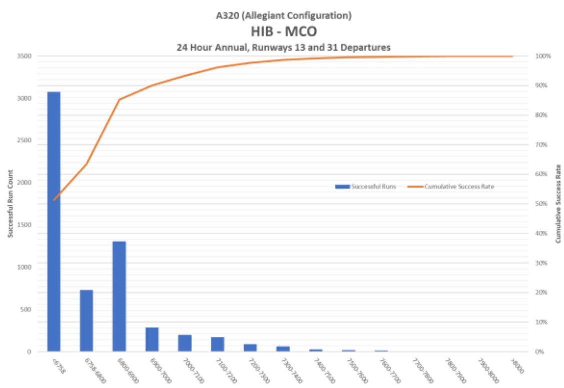


Figure 29 HIB - MCO EMB-175LR - Left

Figure 30 HIB - MCO CRJ-900LR - Right



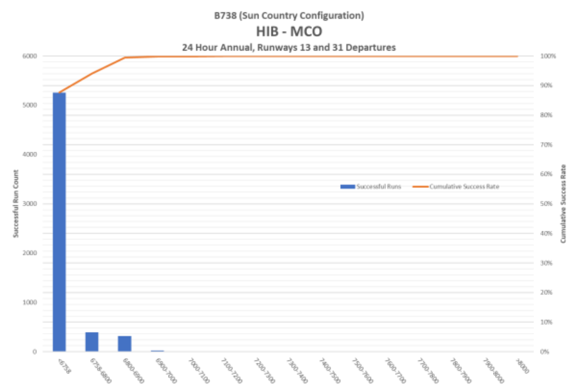


Figure 31 HIB - MCO A320 (ULCC)- Left

Figure 32 HIB - MCO 737-800 (ULCC) - Right

The figures depicted above present the ultimate runway length of Runway 13-31 extended to a length of 6,758 ft. up to 8,000 ft. The bar plots represent the total number of successful runs for the runway length identified, using the vertical axis on the left hand side of the diagram as a count of the successful runs.

The orange line running across each of the figures represents the cumulative likelihood for the aircraft and route and references the vertical axis on the right hand side of the graphic.

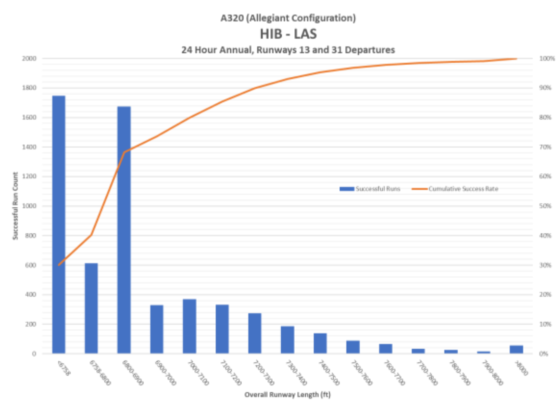
The results from these figures reveal that the distribution of runway lengths matches the overall expectations from fixed and variable inputs described in the previous sections.

In Figure 29 through Figure 32, four different aircraft results are presented for flights originating in HIB, departing to MCO. Each of the 4 aircraft results indicate that the current runway is not completely sufficient to ensure the highest cumulative likelihood for service to occur at any month, or time of day.

The 737-800 in Figure 32, configured as a ULCC, has the highest likelihood of success using the current runway length at the airport. This matches with real world observations because one such operator of this aircraft/configuration, has successfully operated this route from HIB in the past. The few residual results beyond 6,758ft of runway indicate the likelihood that adverse terminal weather conditions, passenger weights, and route efficiency variations may lead to situations where some payload may need to be sacrificed to operate the route from the current runway length.

The other three aircraft types all indicate that additional runway length would be necessary for an operator to successfully operate the route from HIB – MCO without any payload restrictions. The most significant impacts are observed on the CRJ-900 (Figure 30) which shows two peaks of successful runs and many results that would require more runway length than what is currently available. Many of the CRJ-900 results are related to the limited payload range capability of the aircraft on stage lengths that approach, and exceed, 2.5 hours. Flights of this length require a high gross takeoff weight, which is difficult to achieve from the current and future runway/obstacle configuration at HIB.

10.3.2 HIB-LAS Results



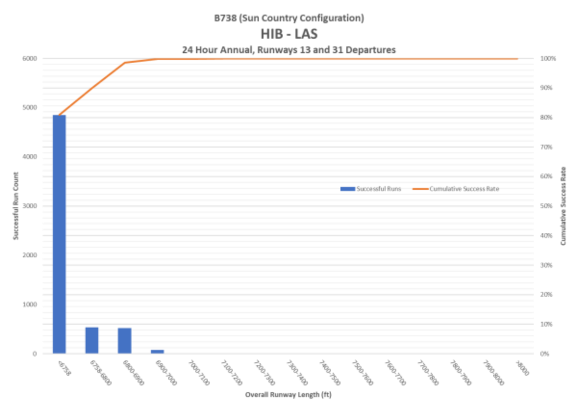


Figure 33 HIB - LAS A320 (ULCC) - Left

Figure 34 HIB - LAS 737-800 (ULCC) - Right

In Figure 33 and Figure 34, two different aircraft results are presented for flights originating in HIB, departing to LAS.

The 737-800 in Figure 34, configured as a ULCC, has the highest likelihood of success using the current runway length at the airport. This again matches with real world observations because one such operator of this aircraft/configuration has successfully operated this route from HIB in the past. The few residual results beyond 6,758ft of runway indicate the likelihood that adverse terminal weather conditions, passenger weights, and route efficiency variations may lead to situations where some payload may need to be sacrificed to operate the route from the current runway length.

The A320 aircraft type indicates that significant additional runway length would be necessary for an operator to successfully operate the route from HIB – LAS without any payload restrictions. The longer runway lengths required for the A320, when compared to the 737-800, are directly related to the OEMs one engine certified takeoff performance requirements for obstacle accountability. In this situation, the A320 is encountering obstacles when departing both runways which are not currently planned for mitigation resulting in reduced takeoff weights. The introduction of additional runway length enables reduced flap settings and V-Speed optimization to achieve the target weight by enhancing the initial climb angle.

10.4 Determining Ideal Runway Length

Once each of the aircraft/route level analysis had been generated by the Monte Carlo processes, the project team then selected two cumulative likelihood values which were believed to most closely match the operational requirements for future air service at HIB: the 90% and 95% values.

Each of the individual route and aircraft results at 90% (shown in Figure 35) and 95% (shown in Figure 36) were then combined into a single chart depicting runway length vs block time for each of the aircraft types. The addition of block time is intended to help the project team relate runway length requirement results for destinations which may not have been analyzed and/or to generate a plottable order for the destinations against their required runway lengths.

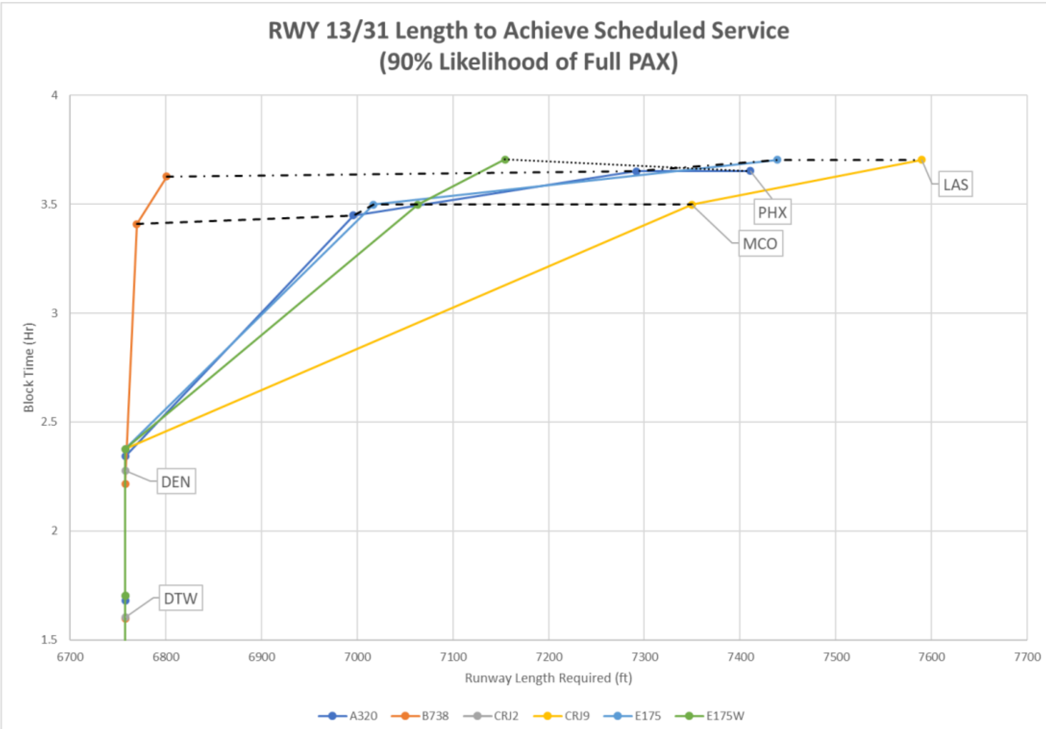


Figure 35 Runway 13/31 Length to Achieve Scheduled Service (90% Cumulative Likelihood)

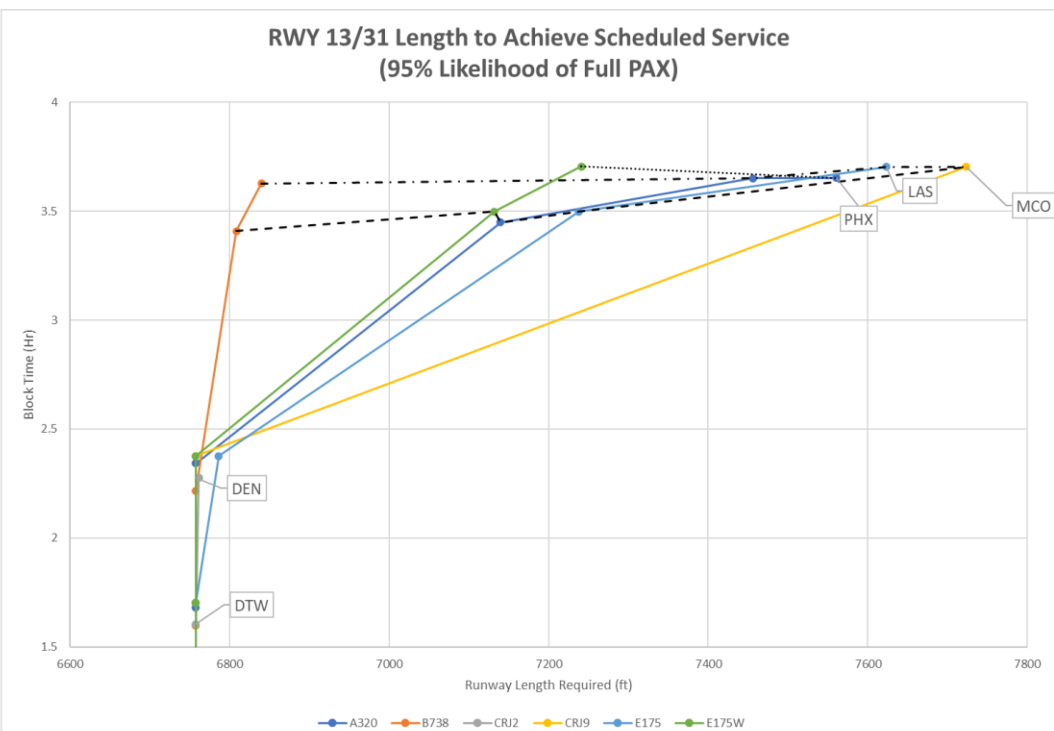


Figure 36 Runway 13/31 Length to Achieve Scheduled Service (95% Cumulative Likelihood)

Most scheduled operations occurring on a 7 day per week basis require the runway lengths associated with 95% cumulative likelihood to minimize passenger and flight operations disruptions. This would be most applicable to hub destinations like MSP, ORD, DTW, and DEN. Figure 35 and Figure 36 only show destinations/block times associated with DTW and DEN because all routes less than 1.5 hours block time were found to be successful on the existing runway length at a 95% cumulative likelihood. There is a small exception for the A320 operating in a ULCC configuration and flying to DEN. The recommended runway length for this particular aircraft type is more likely to focus on seasonal service, or limited day of week service.

For seasonal service, or limited day of week service, the 90% cumulative likelihood is a more accurate reflection of an air carrier's willingness to perform the route on the runway length identified. This is related to the ability of the air carrier to exercise some flexibility in the time of departure (non-hub/spoke model) or to select times of day for a given month that are likely to create more favorable departure performance outcomes.

The two aircraft of particular interest for seasonal service, or limited day of week service, are the 737-800 and A320. In addition, the consideration of an E175LR and CR9 is a possibility and is included in the following summary Table 47.

Table 47 Runway Length to Achieve/Retain Annual Service (90% Cumulative Likelihood)

Runway Length To Achieve/Retain Annual Service (90% Cummulative Likelihood)

HIB ->	MSP	ORD	DTW	DEN	MCO	LAS	PHX
737-800 (ULCC)	6,758	6,758	6,758	6,758	**6,770**	**6,801**	**6,800**
A320-200 (ULCC)	6,758	6,758	6,758	6,758	**6,996**	**7,292**	**7,410**
E175LR	6,758	6,758	6,758	6,758	**7,063**	**7,438**	**7,154**
CRJ-900	6,758	6,758	6,758	6,758	**7,340**	**7,589**	NA
CRJ-200	6,758	6,758	6,758	6,758	NA	NA	NA

From this table (excluding the CRJ-900 and ERJ-175LR), the length of runway 13-31 would need to be extended to 7,000ft for MCO operations, 7,300ft for LAS operations and 7,400ft for PHX operations.

No results are shown for the Cessna Citation 560XLS as it was found to be capable of operating to all destinations listed in this analysis under the current runway length at a 95% cumulative likelihood.

11 Summary

This report analyzed the effectiveness of the current runway, NAVAIDs and instrument procedures to retain and allow for current and future scheduled flight operations. This was achieved through a detailed examination of takeoff performance, landing performance, payload range carrying capabilities and instrument procedure effectiveness. The analysis also considered a potential extension of runway 13-31 to the southeast to mitigate existing landing performance challenges and increased payload range carrying capabilities to seasonal and day of week operators.

11.1 Summary of Takeoff Performance and Payload Range

The Monte Carlo analysis determined that the existing length, orientation, slope of runway 13-31 is sufficient to enable current scheduled aircraft to fly with full passengers and baggage to destinations up to 1.5 hours away from HIB. This includes most major US Airline hubs with HIB service like Minneapolis, Chicago, Detroit and Denver.

The analysis also revealed that departures beyond 1.5 hours will require runway 13-31 to be extended to a longer length to accommodate both current and future operations to seasonal and day of week destinations, frequently targeted by ULCC and Vacation Charter operators like Sun Country and Allegiant. The lengths identified in the Monte Carlo based analysis range from 7,000ft up to 7,400ft in total length, achieved through an extension of the runway to the southeast.

Equally important to runway length, this analysis revealed that the current PCN of runway 13-31 is lower than the value necessary to allow larger narrowbody aircraft to operate at the gross takeoff weight values necessary to achieve the routes identified in the Monte Carlo analysis. We recommend that the airport consider runway rehabilitation activities to increase the PCN, and potentially the subgrade, to enable current and future aircraft operators from restricting their payload range considerations and/or possibly damaging the runway.

11.2 Summary of Landing Performance

The landing performance studied in this report confirmed that most aircraft operating into HIB can safely plan and execute a landing into the airport under wet and dry conditions.

The significant exception is from older regional jets that either do not have high fidelity contaminated landing performance information or are being required by the FAA to consider extraordinarily conservative contaminated landing distance margins of safety. This results in the CRJ-900/901 (and several other regional jets certified in the late 90s/early 2000s) substantial performance reductions due to the existing runway length when conditions at the airport are forecast to be anything less than an RCC 5. This condition was analyzed and found to occur with some regularity in the winter periods, and with increasing probability for flights that might arrive after the airport operations team left and is no longer updating FICONs.

The solution to this problem is to extend the runway length of 13-31 and relocate the runway 31 threshold to the new starting point of the extended runway. The length to achieve full passenger loads on existing regional jets landing under contaminated conditions is approximately 8,400ft. For those operators who have the ability to choose between 69 and 76 seat regional jets, the required runway length could be reduced to between 7,400ft and 8,000ft to achieve similar benefits.

11.3 Summary of Existing Instrument Procedures

The current instrument approach and departure procedures were analyzed both in terms of their current FAA design and their overall effectiveness in enabling aircraft to arrive into HIB at the scheduled (preferred) time.

Nearly all existing instrument approaches were found to be designed to current FAA design standards. The exception is the RNAV (GPS) Rwy 13 LNAV/VNAV navigation method. This approach is currently penetrated by vegetative obstructions northwest of the airport. We presented three options for the airport, and FAA, to update the instrument procedure. Our recommendation is to reduce the tree heights as soon as possible and coordinate with the FAA to make the appropriate updates in the OAS/AIRNAV system before the FAA increases the approach minimums.

The ILS and RNAV approaches to both runways are highly effective at enabling aircraft to arrive on time during low IFR conditions. NAVAID enhancements to the ILS approaches were identified in both directions. Enhancements to the runway 13 glideslope critical area (or the upgrade of the glideslope) should be considered. Installing ILS-specific DMEs on one or both ILS with the goal of increasing procedure design capabilities and eliminating the need to use the outdated runway 31 outer marker.

11.4 Summary of Instrument Procedures Following Runway Extension

The existing instrument approaches were analyzed for possible runway extensions to the southeast, including lighting and NAVAID relocation. All instrument procedures retained their current TERPS/PBN design criteria and approach minimums. The ILS or LOC Rwy 31 approach will require the outer marker to be relocated, or replaced by the installation of a DME specific to the ILS. In either scenario, the FAA and airport would have the opportunity to consider adjusting the glideslope angle from the current value of 2.90º to the standard 3.00º, creating a potentially higher performing approach under snow conditions.

11.5 Ownership and Operation of NAVAIDS and Approach Lighting

The analysis of the instrument approach procedures, and the supporting NAVAIDs, reveals that the ILS and RNAV (GPS) approaches are both capable of allowing aircraft to arrive at the scheduled hour/month of operation. We believe that it is important for the FAA and airport to retain both ILS systems, and approach light systems, to ensure that aircraft can safely continue to arrive into HIB at the planned time of arrival for two reasons.

First, most scheduled aircraft operating into HIB do not have LPV navigation capabilities. This means that the only low IFR approach options for these aircraft are provided by the ILS and/or the LNAV/VNAV approaches. The overall effectiveness of each individual ILS approach to the airport's ability to allow aircraft arrivals at the preferred hour reveals that neither individual ILS will provide a high enough effectiveness for aircraft to routinely arrive into the airport. An ILS approach must be available to both runway ends based on historical wind and low IFR conditions.

Further complicating the instrument approach effectiveness are the temperature limitations imposed on the LNAV/VNAV approaches. Most scheduled aircraft operating at HIB do not, and will not have a non-barometric means of achieving VNAV. This means that the RNAV (GPS) Rwy 13 and 31 approaches will be temperature limited resulting in periods where a VNAV capable aircraft will be required to discontinue the use of the approach and revert to the ILS which does not have temperature limitations.

The MALSRs on both ends of runway 13-31 also serve an important capability to achieve the lowest possible approach visibility (1/2 mile) that enables the ILS and RNAV (GPS) approaches to be successful at allowing aircraft to land at the scheduled hour/month.

For these reasons, we recommend the airport take the necessary steps to ensure that the FAA retains ownership of the ILS on runway 31 and that the airport take the necessary steps to ensure that MnDOT retains the ILS on runway 13 or transfers its ownership/operation to FAA or an alternate 3rd party in accordance with the FAA Non-Federal NAVAID program in the future.

11.6 Recommended Improvements

1. Eliminate or lower the vegetative obstructions northwest of the runway 13 approach end and coordinate with FAA to apply changes to obstacles in AIRNAV/OAS
2. Improve the weight bearing capability of runway 13-31.
3. Consider a runway length extension, to the south to achieve a physical length of 8,000ft
4. Relocate the runway 31 landing threshold to the beginning of the new runway extension.
5. Consider resolving the runway 13 glideslope equipment/critical area terrain deficiency
6. Consider the addition of a DME to runway 31 followed by decommissioning of the corresponding Outer Marker