RAPID CITY
REGIONAL AIRPORT

Master Plan Update

May 2004

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Airport Master Plan Update

for

Rapid City Regional Airport

Rapid City, South Dakota

prepared for

City of Rapid City

by

KADRMAS, LEE & JACKSON

Rapid City, South Dakota

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Rapid City Regional Airport
Master Plan Update

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Addendum A

INTRODUCTION

The Master Plan Update for Rapid City Regional Airport was completed in January 2000 to set forth a long-term vision and development plan for the Airport. While the Master Plan continues to guide future developments at the airport, several airfield planning elements need to be revised and updated to comply with Federal Aviation Administration (FAA) standards and recent changes taken place in airport operations. As an addendum to the Master Plan, this report discusses the Runway 14-32 length, precision approach upgrade on Runway 14, and Taxiway A relocation.

Rapid City Regional Airport

EXISTING AIRFIELD SYSTEM

Airport Reference Code

The current Airport Reference Code (ARC) at Rapid City Regional Airport is C-III, according to FAA specifications. This category represents the airport's ability to accommodate the largest aircraft currently operating at the airport, which is the DC-9. The future ARC category is anticipated to be upgraded to Group C-IV, pending the ability of the airfield system to handle larger aircraft serving the Airport. Typical airplanes in this category are military C-4 and C-130 and B757 in commercial service. Some of the military aircraft in this group presently operate at the airport.

Runway System

As discussed in the Master Plan, the airfield system at Rapid City Regional Airport consists of two intersecting runways and associated taxiways. The two runways are designated as 14-32 and 5-23, corresponding to the magnetic compass bearing of the runway strip. Runway 14-32 is the main runway handling most of the landings and take-offs at the airport. Crosswind Runway 5-23 is a short runway used mostly by general aviation operators.

Example of the C-130 aircraft

Taxiway System

The taxiway system provides direct access between the runways and terminal area. The main taxiways at the airport are parallel Taxiways A and B which facilitate aircraft operations on Runways 14-32 and 5-23, respectively. Additionally, several right-angle exit taxiways are located between Runway 14-32 and Taxiway A. Of particular importance is the separation of parallel Taxiway A and Runway 14-32, which has varying separation distances from the runway. The northern and southern sections are separated by 265 feet (centerline-to-centerline), while the mid-section is located at a distance of 560 feet from the runway. As discussed in the Master Plan (Sections 1.4.2 and 3.5), Taxiway A does not currently meet the minimum separation standard of 400 feet required for Aircraft Group C-III or C-IV.

RUNWAY 14-32 LENGTH

An analysis was conducted to assess the usability of Runway 14-32 considering current and forecast aircraft serving the airport. The analysis was conducted in accordance with guidelines contained in the *FAA Advisory Circular 150-5300-13* with latest changes. Main factors considered in the analysis were runway physical characteristics, critical aircraft performance, and markets served.

Elevation and temperature directly affect runway length and aircraft performance. Airports located at higher elevations, such as Rapid City Regional Airport, need a longer runway for aircraft take-offs than those located near sea level. This is particularly important during hot summer days when temperatures climb above normal levels. A review of the current Airport Layout Plan shows the airport is located 3,202 feet above Mean Sea Level (MSL) and the mean maximum temperature of the hottest month is registered at 86 degrees. These values were used as main elements in evaluating the required runway length.

Another key element to consider is the critical aircraft serving the airport. According to the Master Plan, the present critical aircraft is the DC-9 (Group III), requiring the longest runway length. Northwest Airlines, as the dominant air carrier, serves the airport using this type of aircraft. However, the airline is gradually acquiring new fleet to replace older aircraft. In particular, A320, B737, and B757 are considered logical replacements for the DC-9, depending upon the destinations served and expected traffic volume. The replacement aircraft are expected to have a better performance in terms of required runway length and stage length capability than DC-9. For example, the current length of Runway 14-32 would be sufficient to handle B737-500 for destinations flown up to 1,500 miles.

The DC-9 aircraft, flown by Northwest Airlines, is currently the critical aircraft at Rapid City Regional Airport.

Considering markets served, several airlines currently have non-stop scheduled service to Denver, Salt Lake City, and Minneapolis/St. Paul, according to the published schedule by *Official Airline Guides* (OAG). The longest distance flown is to Salt Lake City at 508 miles. Other potential cities to serve from the airport include Chicago and Detroit. While scheduled service is not anticipated beyond 1000 miles for this market, charter flights from the east or west coast should be considered given growing tourist industry and emergence of new industries in the region. The charter market, however, would be seasonal for mainly serving visitors to the region. ***Table 1*** summarizes city-pair destinations and distances flown from Rapid City.

The runway length requirement was computed for DC-9 series aircraft serving the airport. Factors considered for the critical aircraft included engine type, stage length, seating and cargo capacities, typical load factors, varying operating temperatures, airport elevation, and surface conditions (dry/wet). Wind conditions were assumed to be calm, while an airport elevation of 3,202 feet MSL and varying operating temperatures were used.

Table 1
City-Pair Destinations from Rapid City
RAPID CITY REGIONAL AIRPORT

CITY	STATE	TRAVEL DISTANCE[1]
Scheduled		
Denver	Colorado	300
Minneapolis/St. Paul	Minnesota	489
Salt Lake City	Utah	508
Chicago[2]	Illinois	794
Detroit[2]	Michigan	1015
Charter		
New York[2]	New York	1486
Los Angeles[2]	California	1250

1. In air miles
2. Not currently served directly from Rapid City Regional Airport

Source: Official Airlines Guide

An aircraft performance analysis was conducted for the runway length at 8,701 feet (existing length), 9,500 feet, 10,000 feet, and 10,500 feet considering DC-9 and other selected aircraft***. As Exhibits 1 through 3 and Tables 2 through 4*** illustrate, the critical aircraft could serve the existing markets with the current runway length. However, the aircraft performance would be significantly impacted for longer destinations such as Chicago and Detroit. As shown, the runway extension to 9,500 feet would still impose weight restrictions on departures for DC-9, particularly during warm weather. For example, a direct flight to Chicago at 75 degrees would have a 10 percent or 3,000 pound payload reduction. This would translate into reduction in both passenger and cargo to meet take-off requirements.

Extending the runway by 1,300 feet for a total length of 10,000 feet would increase the allowable payload where a DC-9 could takeoff at the maximum allowable weight for destinations of about 750 miles or less. Weight restrictions, however, would be imposed for destinations over 750 miles, such as direct flights to Detroit.

The required runway length at 10,500 feet would adequately serve current and potential future markets for DC-9 without significant weight restriction due to the runway length. This length could also support the majority of the fleet serving the airport, including B757 and Airbus 320 for long-haul destinations. As shown on ***Table 5***, the B737 and B757 would need 9,500 feet and 10,500 feet, respectively, for a 2,000 air miles flight. A detailed analysis of the performance for the B757 and B737 is presented in ***Appendix A***.

Exhibit 1
Rapid City Runway Length Analysis
DC-9-50 Take-off Performance
NWA-RAP to MSP

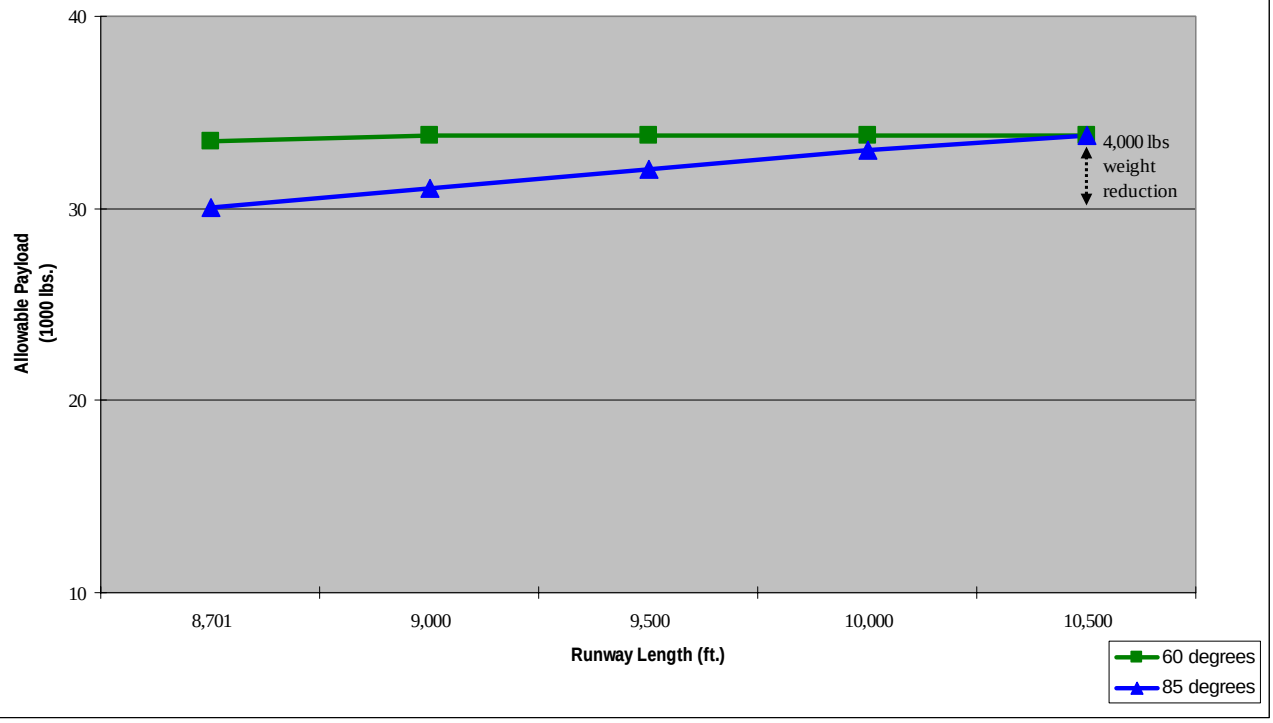


Exhibit 2
Rapid City Runway Length Analysis
DC-9-50 Take-off Performance
NWA-RAP to ORD

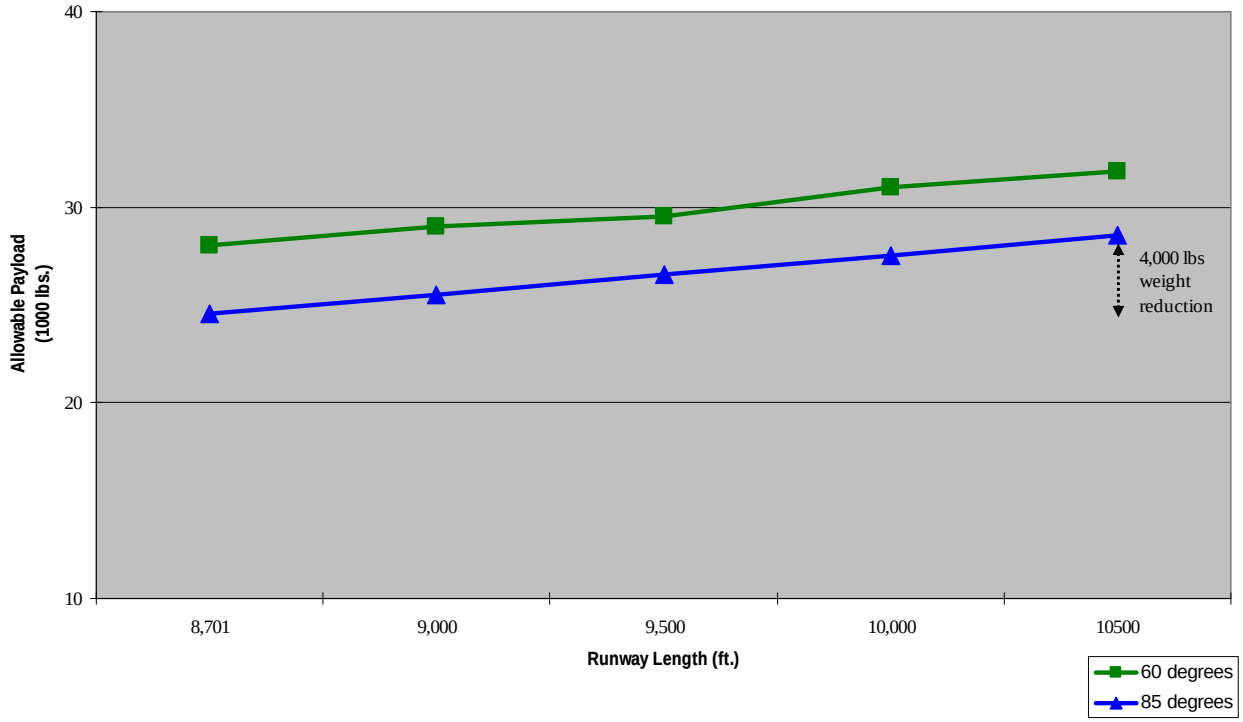
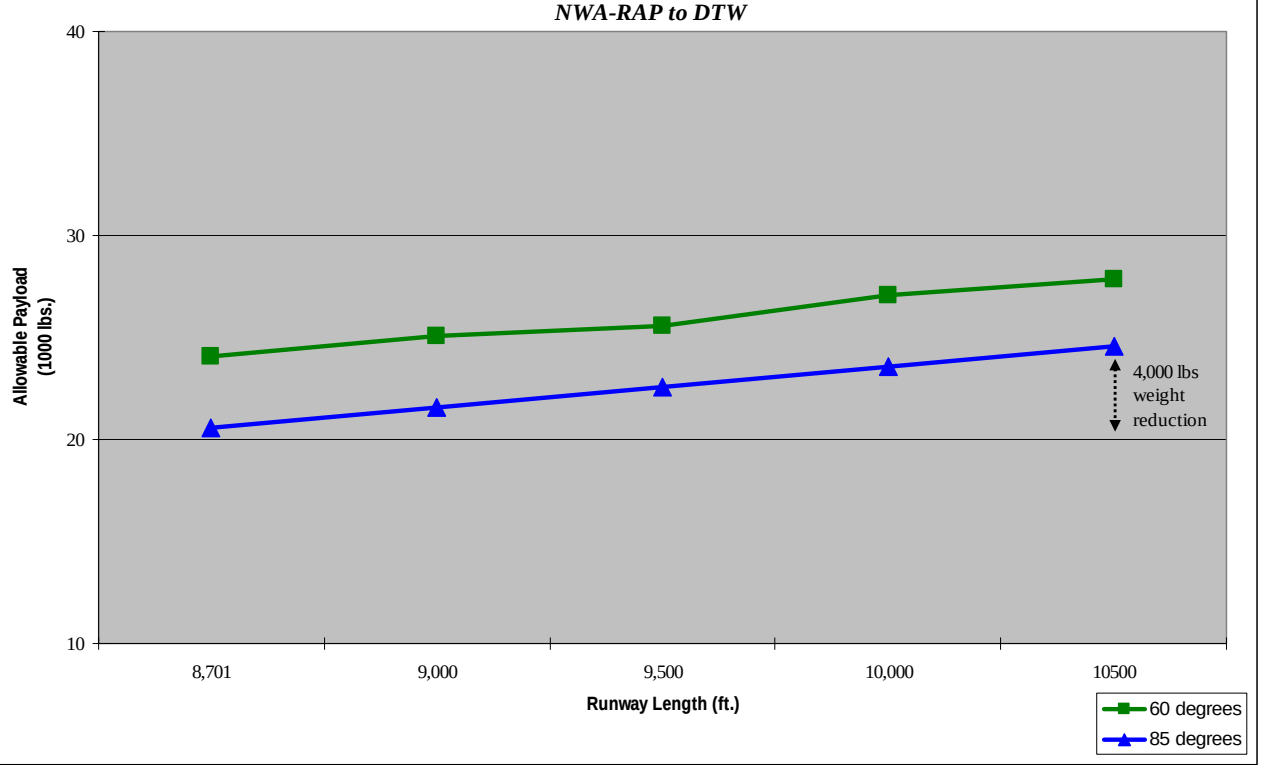


Exhibit 3
Rapid City Runway Length Analysis
DC-9-50 Take-off Performance
NWA-RAP to DTW



Airport: Rapid City Regional Airport
Aircraft: Boeing DC-9-51
Engine: JT8D-17
Typical Airline: Northwest Airlines
Itinerary: RAP – MSP
Distance: 489 Miles
Runway: 14-32
Fuel Burn: 18 lbs/nm
Seating Capacity: 125
Cargo Capacity: 1174 ft3

Table 2
DC-9 Aircraft Performance
Rapid City to Minneapolis
RAPID CITY REGIONAL AIRPORT

			Runway at 8,701 feet²				*Runway at 9,500 feet²*				*Runway at 10,000 feet²*				*Runway at 10,500 feet²*			
TEMP	MAX STRUCTURAL TAKE-OFF WEIGHT[1]	OPERATING EMPTY WEIGHT	ALLOWABLE TAKE-OFF WEIGHT	MAX ALLOWABLE PAYLOAD[2]	NO. OF PAX	CARGO[3]	ALLOWABLE TAKE-OFF WEIGHT	MAX. ALLOWABLE PAYLOAD[2]	NO. OF PAX	CARGO[3]	ALLOWABLE TAKE-OFF WEIGHT	MAX. ALLOWABLE PAYLOAD[2]	NO. OF PAX	CARGO[3]	ALLOWABLE TAKE-OFF WEIGHT	MAX. ALLOWABLE PAYLOAD[2]	NO. OF PAX	CARGO
(°F)	(000 lbs)		(000 lbs)			(000lbs)	(000 lbs)				(000 lbs)			(000 lbs)	(000 lbs)			(000 lbs)
32°	121.0	65	116.0	34	125	6	117.5	34	125	6	119.0	34	125	6	119.8	34	125	6
50°	121.0	65	116.0	34	125	6	117.5	34	125	6	119.0	34	125	6	119.8	34	125	6
60°	121.0	65	116.0	34	125	6	117.5	34	125	6	119.0	34	125	6	119.8	34	125	6
70°	121.0	65	116.0	34	125	6	117.5	34	125	6	119.0	34	125	6	119.8	34	125	6
75°	121.0	65	112.5	30	125	3	114.5	32	125	5	115.5	33	125	6	116.5	34	125	6
80°	121.0	65	112.5	30	125	3	114.5	32	125	5	115.5	33	125	6	116.5	34	125	6
85°	121.0	65	112.5	30	125	3	114.5	32	125	5	115.5	33	125	6	116.5	34	125	6
90°	121.0	65	112.5	30	125	3	114.5	32	125	5	115.5	33	125	6	116.5	34	125	6
95°	121.0	65	112.5	30	125	3	114.5	32	125	5	115.5	33	125	6	116.5	34	125	6
97°	121.0	65	112.5	30	125	3	114.5	32	125	5	115.5	33	125	6	116.5	34	125	6
100°	121.0	65	112.5	30	125	3	114.5	32	125	5	115.5	33	125	6	116.5	34	125	6

1. Maximum structural take-off weight is at standard temperature and pressure
2. Maximum Structural Payload: 33,825 lbs
3. Maximum Cargo Payload: 9,392 lbs
No wind or runway obstructions
Runway Gradient: 0.0%
Airport Elevation: 3202.4 feet
Max mean Temp.: 86 degrees
Assume 200 NM ALT plus 45 minutes airtime for fuel reserve.
Source: Boeing Airplane Characteristics for DC-9 series and Kadrmas, Lee & Jackson analysis

Airport: Rapid City Regional Airport
Aircraft: Boeing DC-9-51
Engine: JT8D-17
Typical Airline: Northwest Airlines
Itinerary: RAP – ORD
Distance: 794 Miles
Runway: 14-32
Fuel Burn: 18 lbs/nm
Seating Capacity: 125
Cargo Capacity: 1174 ft3

Table 3
DC-9 Aircraft Performance
Rapid City to Chicago
RAPID CITY REGIONAL AIRPORT

			Runway at 8,701 feet²				*Runway at 9,500 feet²*				*Runway at 10,000 feet²*				*Runway at 10,500 feet²*			
TEMP	MAX STRUCTURAL TAKE-OFF WEIGHT[1]	OPERATING EMPTY WEIGHT	ALLOWABLE TAKE-OFF WEIGHT	MAX ALLOWABLE PAYLOAD[2]	NO. OF PAX	CARGO[3]	ALLOWABLE TAKE-OFF WEIGHT	MAX. ALLOWABLE PAYLOAD[2]	NO. OF PAX	CARGO[3]	ALLOWABLE TAKE-OFF WEIGHT	MAX. ALLOWABLE PAYLOAD[2]	NO. OF PAX	CARGO[3]	ALLOWABLE TAKE-OFF WEIGHT	MAX. ALLOWABLE PAYLOAD[2]	NO. OF PAX	CARGO
(°F)	(000 lbs)		(000 lbs)			(000lbs)	(000 lbs)				(000 lbs)			(000 lbs)	(000 lbs)			(000 lbs)
32°	121.0	65	116.0	28	125	1	117.5	30	125	2	119.0	31	125	4	119.8	32	125	4
50°	121.0	65	116.0	28	125	1	117.5	30	125	2	119.0	31	125	4	119.8	32	125	4
60°	121.0	65	116.0	28	125	1	117.5	30	125	2	119.0	31	125	4	119.8	32	125	4
70°	121.0	65	116.0	28	125	1	117.5	30	125	2	119.0	31	125	4	119.8	32	125	4
75°	121.0	65	112.5	25	112	0	114.5	27	121	0	115.5	28	125	0	116.5	29	125	1
80°	121.0	65	112.5	25	112	0	114.5	27	121	0	115.5	28	125	0	116.5	29	125	1
85°	121.0	65	112.5	25	112	0	114.5	27	121	0	115.5	28	125	0	116.5	29	125	1
90°	121.0	65	112.5	25	112	0	114.5	27	121	0	115.5	28	125	0	116.5	29	125	1
95°	121.0	65	112.5	25	112	0	114.5	27	121	0	115.5	28	125	0	116.5	29	125	1
97°	121.0	65	112.5	25	112	0	114.5	27	121	0	115.5	28	125	0	116.5	29	125	1
100°	121.0	65	112.5	25	112	0	114.5	27	121	0	115.5	28	125	0	116.5	29	125	1

1. Maximum structural take-off weight is at standard temperature and pressure
2. Maximum Structural Payload: 33,825 lbs
3. Maximum Cargo Payload: 9,392 lbs
No wind or runway obstructions
Runway Gradient: 0.0%
Airport Elevation: 3202.4 feet
Max mean Temp.: 86 degrees
Assume 200 NM ALT plus 45 minutes airtime for fuel reserve.
Source: Boeing Airplane Characteristics for DC-9 series and Kadrmas, Lee & Jackson analysis

Airport: Rapid City Regional Airport
Aircraft: Boeing DC-9-51
Engine: JT8D-17
Typical Airline: Northwest Airlines
Itinerary: RAP – DTW
Distance: 1,015 Miles
Runway: 14-32
Fuel Burn: 18 lbs/nm
Seating Capacity: 125
Cargo Capacity: 1174 ft3

Table 4
DC-9 Aircraft Performance
Rapid City to Detroit
RAPID CITY REGIONAL AIRPORT

			Runway at 8,701 feet²				*Runway at 9,500 feet²*				*Runway at 10,000 feet²*				*Runway at 10,500 feet²*			
TEMP	MAX STRUCTURAL TAKE-OFF WEIGHT[1]	OPERATING EMPTY WEIGHT	ALLOWABLE TAKE-OFF WEIGHT	MAX ALLOWABLE PAYLOAD[2]	NO. OF PAX	CARGO[3]	ALLOWABLE TAKE-OFF WEIGHT	MAX. ALLOWABLE PAYLOAD[2]	NO. OF PAX	CARGO[3]	ALLOWABLE TAKE-OFF WEIGHT	MAX. ALLOWABLE PAYLOAD[2]	NO. OF PAX	CARGO[3]	ALLOWABLE TAKE-OFF WEIGHT	MAX. ALLOWABLE PAYLOAD[2]	NO. OF PAX	CARGO
(°F)	(000 lbs)		(000 lbs)				(000 lbs)				(000 lbs)			(000 lbs)	(000 lbs)			(000 lbs)
32°	121.0	65	116.0	24	109	0	117.5	26	116	0	119.0	27	123	0	119.8	28	125	0
50°	121.0	65	116.0	24	109	0	117.5	26	116	0	119.0	27	123	0	119.8	28	125	0
60°	121.0	65	116.0	24	109	0	117.5	26	116	0	119.0	27	123	0	119.8	28	125	0
70°	121.0	65	116.0	24	109	0	117.5	26	116	0	119.0	27	123	0	119.8	28	125	0
75°	121.0	65	112.5	21	93	0	114.5	23	103	0	115.5	24	107	0	116.5	25	112	0
80°	121.0	65	112.5	21	93	0	114.5	23	103	0	115.5	24	107	0	116.5	25	112	0
85°	121.0	65	112.5	21	93	0	114.5	23	103	0	115.5	24	107	0	116.5	25	112	0
90°	121.0	65	112.5	21	93	0	114.5	23	103	0	115.5	24	107	0	116.5	25	112	0
95°	121.0	65	112.5	21	93	0	114.5	23	103	0	115.5	24	107	0	116.5	25	112	0
97°	121.0	65	112.5	21	93	0	114.5	23	103	0	115.5	24	107	0	116.5	25	112	0
100°	121.0	65	112.5	21	93	0	114.5	23	103	0	115.5	24	107	0	116.5	25	112	0

1. Maximum structural take-off weight is at standard temperature and pressure
2. Maximum Structural Payload: 33,825 lbs
3. Maximum Cargo Payload: 9,392 lbs
No wind or runway obstructions
Runway Gradient: 0.0%
Airport Elevation: 3202.4 feet
Max mean Temp.: 86 degrees
Assume 200 NM ALT plus 45 minutes airtime for fuel reserve.
Northwest Airlines current DC-90-50 type may be limited to a maximum of 750 mile stage length.
Source: Boeing Airplane Characteristics for DC-9 series and Kadrmas, Lee & Jackson analysis

Table 5
Runway Length Requirements
RAPID CITY REGIONAL AIRPORT

AIRCRAFT	DESIGN GROUP	ENGINE	MAX GROSS TAKE-OFF WEIGHT	MAX TAKE-OFF LENGTH	*Take-off Length at RAP/Stage Length*					*Landing Length*	
					300 nm	500 nm	750 nm	1000 nm	2000 nm	DRY RWY	WET RWY
			lbs (000)	(feet)						Flaps at 30 degrees (feet)	
DC-9-30[1, 2]	C-III	JT8D-7	108	9,800	<8,701	8,701	9,000	9,500	N/A	5,600	6,450
DC-9-50[1]	C-III	JT8D-17	121	10,500	<8,701	8,701	10,000	10,500[2]	N/A	5,300	6,100
A320-200	C-III	CFM56-5A1	162	7,665	—[3]	—[3]	—[3]	—[3]	—[3]	4,823	5,546
B737-500	C-III	CFM56-3B-1	134	10,000	<8,701	8,701	8,701	8,701	9,500	5,200	6,000
CRJs	C-II	CF34-3A1	53	5,265[4]	*	*	*	*	*	4,725	5,435
RJ85	C-III	LF-507	93	5,130[4]	*	*	*	*	*	3,920	4,500
B757-300	C-IV	PW2040	270	11,500	N/A	N/A	8,701	8,701	10,500	5,100	5,800

1. Landing flaps set at 40 degrees.
2. Restrictions on passenger and cargo due to weight limited to 103,000 lbs for high altitude.
3. Not calculated.
4. At sea level and standard temperature.

Airport Elevation: 3,202 feet AGL
Mean High Airport Temp.: 86 degrees
Runway Take-off Length based on Standard Day +15 degrees.

Source: Aircraft manufacturers' airport planning manuals, Janes All the World Aircraft, & Kadrmas, Lee & Jackson analysis

In addition, ***Table 6*** illustrates a comparative analysis of selected airports in the upper Midwest with similar climatic and elevation elements. In general, the runway length for airports located between 1,000 and 3,000 feet in elevation range from 8,800 feet to 10,300 feet. Airports with elevation over 3,000 feet typically have a runway length in excess of 10,000 feet.

Table 6
Runway Length Comparison
SELECTED MIDWEST COMMERCIAL AIRPORTS

AIRPORT	STATE	ELEVATION	RWY*	RWY LENGTH
		Feet (MSL)		feet**
Colorado Springs	CO	6,184	17L-35R	13,500
Billings	MT	3,652	10L-28R	10,518
Great Falls	MT	3,677	03-21	10,502
Wichita	KS	1,333	01-19	10,300
Casper	MT	5,347	03-21	10,165
Fargo	ND	900	17-35	9,546
Omaha	NE	984	14R-32L	9,500
Bozeman	MT	4,471	12-30	9,000
Sioux Falls	SD	1,430	03-21	9,000
Bismarck	ND	1,661	13-31	8,794
Rapid City	**SD**	**3,204**	**14-32**	**8,701**
Grand Forks	ND	845	17R-35L	7,350

* Primary Runway
** Runway length does not include any displaced threshold
Source: AirNav.com and Kadrmas, Lee & Jackson analysis

PRECISION APPROACH ON RUNWAY 14

Runway 14 has a published non-precision GPS (Global Positioning System) approach for aircraft landing. Aircraft equipped with GPS are able to operate down to a minimum Decision Height (DH) of 300 feet before visual contact with the runway is required before landing. A review of recent airport runway usage shows an increased use of the runway during inclement weather where Instrument Flight Rules (IFR) typically apply. Chances of aircraft accidents and crashes could increase because of pilots using non-precision approach for landings on Runway 14 during poor conditions. A precision approach landing system would significantly enhance safety of operations under the IFR conditions. There are several precision approach systems available for use at the airport including:

- Instrument Landing System (ILS)
- Differential GPS

The selection of an appropriate system would depend upon factors specific to the airport. A typical analysis would consider availability of equipment, airport topography, installed system, and equipment cost, among other elements. Most systems, however, would require an unobstructed approach path for transmission of signals to the aircraft to ensure accuracy and dependability of installed equipment. Currently, a few minor obstructions are identified within the approach path of Runway 14, according to the Airport Layout Plan. These obstructions need to be verified and removed before a precision approach system could be certified by the FAA.

ILS System

Similar to the Runway 32 end, Runway 14 could be equipped with an ILS system for precision approach. The ILS system is a highly accurate and dependable landing system for operations in IFR conditions. The ILS provides the lateral and vertical guidance necessary to fly a straight-in precision approach. The ILS typically consists of:

- Localizer
- Glide path
- Approach lighting system
- Optional outer and middle markers

There are several different categories of ILS depending upon the ground installed equipment. Category I ILS provides precision approach down to a DH of 200 feet, while Category II/III ILS approaches have DH of 100 feet or less. All the stated equipment would need to be installed on Runway 14 including a *Medium Intensity Approach Lighting System with Alignment Indicator Lights* (MALSR) for CAT I ILS approach lights. The suggested system would be similar to the existing Runway 32 ILS system.

Differential GPS System

GPS is a satellite navigation system designed to provide instantaneous position, velocity and time information almost anywhere on the globe at any time. For aircraft navigation, GPS could be used for en route, terminal, and approach segments of the flight. In addition, the *Differential GPS system* is capable of providing precision approaches to Category I minima. This is done by locating a receiver on the ground at a precisely-surveyed position. Differential GPS would be a feasible alternative to the ILS installation on Runway 14 pending the removal of identified obstructions. In addition, installing a MALSR approach light would enhance safety of operations for precision approaches.

Current non-precision approach on Runway 14 end

TAXIWAY A RELOCATION

The FAA has issued operational restrictions on large aircraft movements on Taxiway A while another large aircraft occupy Runway 14-32. The restriction is based on a waiver issued by the agency dating back to 1970 with subsequent periodic updates. The operational restriction is necessary to ensure safety of operations because of substandard runway to taxiway separation for portions of the taxiway. Currently, aircraft must be held at the gate or reach holding bays located at the two opposite ends of the runway when a large aircraft occupies the runway. The large aircraft is presently defined as any aircraft in Group C-III or higher with a minimum wing span of 79 feet.

An evaluation was conducted for the relocation of Taxiway A to meet established FAA guidelines given that there are a number of possible ways to meet the separation standards in order to improve the airfield system. In this context, several alternatives were identified and assessed based on a set of evaluation criteria for the best outcome to ensure safe and efficient conduct of airport operations.

Planning Parameters

Many planning assumptions and parameters were identified to form a framework in which to develop a set of practical alternatives for the relocation of Taxiway A. The airfield planning criteria were primarily based on the standards and guidelines contained in the AC 150/5300-13, FAR Part 77, and the experience that Kadrmas, Lee, Jackson has developed through similar projects. The planning parameters and criteria are:

- The present ARC for Rapid City Regional Airport is C-III, according to the current Master Plan. The ARC will be upgraded to C-IV category in the future.
- Maintain a 75-foot width for the relocation and design of Taxiway A consistent with C-IV ARC category.
- The Runway 32 end is equipped with Category I Instrument Landing System (ILS-CAT I) for precision approaches. The Runway 14 end currently has a non-precision approach for landing. The proposed upgrade of Runway 14 to precision approach will not directly impact the Taxiway A relocation.
- An Army National Guard Complex and U.S. Forest Service facility are located south of the taxiway including an apron, helipad, and several buildings.
- Aircraft held or stopped at any exit taxiway on Runway 14-32 should not penetrate any part of Taxiway A.
- The minimum runway to taxiway separation considered is 400 feet for C-III and C-IV aircraft to meet the FAA standard.
- The Runway Safety Area for both Group C-III and C-IV is 500 feet.
- The minimum taxiway to fixed or movable objects is 93.0 feet for Group C-III and 129.5 feet for Group C-IV.
- Taxiway Object Free Area width is 186 feet for Group C-III and 259 feet for Group C-IV aircraft.

Alternatives Considered

Based on the established planning parameters and criteria, five alternatives were identified and evaluated for the relocation of Taxiway A. For the purpose of this analysis, the alternatives were assessed using a set of evaluation criteria to determine their impact on the airfield. The following briefly describes the evaluation criteria identified for analyzing the alternatives:

Airfield Operations—The impact on aircraft operations during landings and take-offs on Runway 14-32 and aircraft movement on Taxiway A. Compliance with the FAA separation standards is included in this category.

Navigational Aids—The requirements of airport navigational aids for clearance, signal transmission, and protection of critical areas to avoid any potential interference.

Facility Impact—The impact on the existing and planned airport facilities including the Army National Guard Complex, U.S. Forest Service facility, and other airport structures. Construction impact is also included under this category.

Construction Cost—Site development costs including earthwork, demolition, pavement, lights, and utilities.

Note that the environmental assessment of the taxiway relocation was completed earlier and submitted in a separate document. (i.e., Form C).

Alternative 1

265-Foot Separation—Do Nothing

The current separation of 265 feet between Runway 14-32 and Taxiway A would be maintained. Operational restrictions imposed by the FAA on airport operations would continue to exist. The status quo was not considered a viable alternative due to operational and safety concerns and was not evaluated for this study.

Alternative 2

400-Foot Separation

A 400-foot runway to taxiway distance would provide the minimum separation required to meet the FAA standards. In this case, airport operations would not be restricted on the taxiway while large aircraft are on Runway 14-32. However, the operation of Group IV on the runway would be restricted during the construction period because of construction surcharge during the expected two-year construction period. Aircraft wing tips could potentially penetrate the soil build up used for ground compacting which could cause operational safety hazards. In addition, the Taxiway Object Free Area (TOFA) would penetrate the National Guard apron by approximately 10 feet and impact the existing helipad. The relocation of the helipad would be required, while the impacted section of apron should be marked unusable. The total construction cost would be $10.1 million excluding the impact on the National Guard Complex.

Alternative 3

450-Foot Separation

This alternative would consider relocating Taxiway A by an additional 50 feet compared to Alternative 2. The additional 50 feet separation would provide necessary clearance for aircraft wingspan from the construction surcharge as part of relocating Taxiway A. Additionally, it would allow sufficient separation for any Group V aircraft to operate on the airport without operational restrictions, pending adequate pavement strength on the movement area. The National Guard apron would be impacted by about 60 feet because of the TOFA. The impacted section of the apron would be marked unusable. In addition, the helipad would require relocation to an alternate location. The estimated cost would increase by about $1.7 million to $11.8 million compared to Alternative 2.

Alternative 4

560-Foot Separation

This alternative would provide a 560-foot runway to taxiway separation of the northern and southern portions of Taxiway A from the runway to be fully realigned with the midsection. Similar to the previous alternative, the separation would allow all types of aircraft to operate on the taxiway without any operational restrictions. The impact on the National Guard would be significantly higher, including closing 170 feet of the apron and relocating the helipad. The U.S. Forest Service Complex would also be impacted. In addition, an evaluation of the Control Tower line-of-sight would be required to ensure clear view of the realigned Taxiway A is maintained. The construction cost is estimated at $15.5 million excluding any facility relocation and improvements needed to address issues with the tower line-of-sight clearance.

Alternative 5

Relocate Runway 14-32 450 Feet to the East

Under this alternative, Runway 14-32 would be relocated to the east by 450 feet while designating the existing runway as the parallel taxiway. The existing Taxiway A would remain at the current location. Facility impacts would include relocating navigational-aids, additional property acquisition, and a set of new exit and connecting taxiways. The Control Tower line-of-sight might also be compromised requiring relocating or elevating the structure. However, the National Guard and U.S. Forest Service Complexes would not be impacted.

In addition, potential environmental impact would be significant compared to other alternatives. No construction cost estimate was calculated for this alternative.

Recommended Alternative

This analysis evaluated five alternatives for the partial relocation of Taxiway A at Rapid City Regional Airport. Based on the evaluation criteria and planning parameters, the 450-feet separation (Alternative 3) is the preferred option for the taxiway relocation. Among many factors considered, meeting the FAA standards, operational flexibility, clearance from construction surcharge, and cost considerations were the most important issues identified in selecting the alternative. The preferred alternative would provide operational flexibility during the construction period as well as unrestricted operation of large aircraft at the airport. It would also have a limited impact on the Army National Guard and US Forest Service Complexes.

Airport: Rapid City Regional Airport
Aircraft: Boeing 757-300
Engine: PW2040
Typical Airline: Northwest Airline
Itinerary: RAP–MSP
Distance: 489 Miles
Runway: 14-32
Fuel Burn: 18 lbs/nm
Seating Capacity: 224
Cargo Capacity: 2382

			Runway at 8,701 feet[2]				Runway at 9500 feet[2]				Runway at 10,000 feet[2]				Runway at 10,500 feet[2]			
Temp. (F)	Max. Structural Take-off Weight[1]	OEW	Allowable Take-off Weight	Max. Allowable Payload[2]	No. of Pax	Cargo[3]	Allowable Take-off Weight	Max. Allowable Payload[2]	No. of Pax	Cargo[3]	Allowable Take-off Weight	Max. Allowable Payload[2]	No. of Pax	Cargo[3]	Allowable Take-off Weight	Max. Allowable Payload[2]	No. of Pax	Cargo
	(000 lbs)		(000 lbs)			(000lbs)	(000 lbs)				(000 lbs)			(000 lbs)	(000 lbs)			(000 lbs)
32	270.0	142	251.0	68	224	19	254.0	68	224	19	255.0	68	224	19	260.0	68	224	19
50	270.0	142	251.0	68	224	19	254.0	68	224	19	255.0	68	224	19	260.0	68	224	19
60	270.0	142	251.0	68	224	19	254.0	68	224	19	255.0	68	224	19	260.0	68	224	19
70	270.0	142	251.0	68	224	19	254.0	68	224	19	255.0	68	224	19	260.0	68	224	19
75	270.0	142	251.0	68	224	19	254.0	68	224	19	255.0	68	224	19	260.0	68	224	19
80	270.0	142	251.0	68	224	19	254.0	68	224	19	255.0	68	224	19	260.0	68	224	19
85	270.0	142	249.0	68	224	19	253.0	68	224	19	254.0	68	224	19	255.0	68	224	19
90	270.0	142	249.0	68	224	19	253.0	68	224	19	254.0	68	224	19	255.0	68	224	19
95	270.0	142	249.0	68	224	19	253.0	68	224	19	254.0	68	224	19	255.0	68	224	19
97	270.0	142	249.0	68	224	19	253.0	68	224	19	254.0	68	224	19	255.0	68	224	19
100	270.0	142	249.0	68	224	19	253.0	68	224	19	254.0	68	224	19	255.0	68	224	19

1. Maximum structural take-off weight is at standard temperature and pressure
2. Maximum Structural Payload: 68,200 lbs
3. Maximum Cargo Payload: 19,056 lbs
No wind or runway obstructions
Runway Gradient: 0.0%
Airport Elevation: 3202.4 feet
Max mean Temp.: 86 degrees
Assume 200 NM ALT plus 45 minutes airtime for fuel reserve.
Source: Boeing Airplane Characteristics for 757 series and Kadrmas, Lee & Jackson analysis

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60	270.0	142	251.0	68	224	19	254.0	68	224	19	255.0	68	224	19	260.0	68	224	19
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75	270.0	142	251.0	68	224	19	254.0	68	224	19	255.0	68	224	19	260.0	68	224	19
80	270.0	142	251.0	68	224	19	254.0	68	224	19	255.0	68	224	19	260.0	68	224	19
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90	270.0	142	249.0	68	224	19	253.0	68	224	19	254.0	68	224	19	255.0	68	224	19
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Aircraft:	Boeing 737-500	
Engine:	CFM56-3B-1	
Typical Airline:	United Airlines	
Itinerary:	RAP–MSP	
Distance:	489	Miles
Runway:	14-32	
Fuel Burn:	12	lbs/nm
Seating Capacity:	122	
Cargo Capacity:	546	ft3

	Max.		Runway at 8,701 feet[2]				Runway at 9500 feet[2]				Runway at 10,000 feet[2]				Runway at 10,500 feet[2]			
Temp. (F)	Structural Take-off Weight[1]	OEW	Allowable Take-off Weight	Max. Allowable Payload[2]	No. of Pax	Cargo[3]	Allowable Take-off Weight	Max. Allowable Payload[2]	No. of Pax	Cargo[3]	Allowable Take-off Weight	Max. Allowable Payload[2]	No. of Pax	Cargo[3]	Allowable Take-off Weight	Max. Allowable Payload[2]	No. of Pax	Cargo
	(000 lbs)		(000 lbs)			(000lbs)	(000 lbs)				(000 lbs)			(000 lbs)	(000 lbs)			(000 lbs)
32	133.5	69	130.0	33	122	4	133.0	33	122	4	133.5	33	122	4				
50	133.5	69	130.0	33	122	4	133.0	33	122	4	133.5	33	122	4				
60	133.5	69	130.0	33	122	4	133.0	33	122	4	133.5	33	122	4				
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97	133.5	69	128.5	33	122	4	131.0	33	122	4	132.0	33	122	4				
100	133.5	69	128.5	33	122	4	131.0	33	122	4	132.0	33	122	4				

1. Maximum structural take-off weight is at standard temperature and pressure
2. Maximum Structural Payload: 33,470 lbs
3. Maximum Cargo Payload: 4,368 lbs

No wind or runway obstructions
Runway Gradient: 0.0%
Airport Elevation: 3202.4 feet
Max mean Temp.: 86 degrees
Assume 200 NM ALT plus 45 minutes airtime for fuel reserve.
Source: Boeing Airplane Characteristics for 737 series and Kadrmas, Lee & Jackson analysis

Airport: Rapid City Regional Airport
Aircraft: Boeing 737-500
Engine: CFM56-3B-1
Typical Airline: United Airlines
Itinerary: RAP–ORD
Distance: 794 Miles
Runway: 14-32
Fuel Burn: 12 lbs/nm
Seating Capacity: 122
Cargo Capacity: 546 ft3

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	(000 lbs)		(000 lbs)			(000lbs)	(000 lbs)				(000 lbs)			(000 lbs)	(000 lbs)			(000 lbs)
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NOT APPLICABLE

1. Maximum structural take-off weight is at standard temperature and pressure
2. Maximum Structural Payload: 33,470 lbs
3. Maximum Cargo Payload: 4,368 lbs

No wind or runway obstructions
Runway Gradient: 0.0%
Airport Elevation: 3202.4 feet
Max mean Temp.: 86 degrees
Assume 200 NM ALT plus 45 minutes airtime for fuel reserve.
Source: Boeing Airplane Characteristics for 737 series and Kadrmas, Lee & Jackson analysis

Airport:	Rapid City Regional Airport		
Aircraft:	Boeing 737-500		
Engine:	CFM56-3B-1		
Typical Airline:	United Airlines		
Itinerary:	RAP–DTW		
Distance:	1,015	Miles	130208
Runway:	14-32		
Fuel Burn:	12	lbs/nm	
Seating Capacity:	122		
Cargo Capacity:	546	ft3	

			Runway at 8,701 feet[2]				Runway at 9500 feet[2]				Runway at 10,000 feet[2]				Runway at 10,500 feet[2]			
Temp. (F)	Max. Structural Take-off Weight[1]	OEW	Allowable Take-off Weight	Max. Allowable Payload[2]	No. of Pax	Cargo[3]	Allowable Take-off Weight	Max. Allowable Payload[2]	No. of Pax	Cargo[3]	Allowable Take-off Weight	Max. Allowable Payload[2]	No. of Pax	Cargo[3]	Allowable Take-off Weight	Max. Allowable Payload[2]	No. of Pax	Cargo
	(000 lbs)		(000 lbs)			(000lbs)	(000 lbs)				(000 lbs)			(000 lbs)	(000 lbs)			(000 lbs)
32	133.5	69	130.0	33	122	4	133.0	33	122	4	133.5	33	122	4				
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60	133.5	69	130.0	33	122	4	133.0	33	122	4	133.5	33	122	4				
70	133.5	69	130.0	33	122	4	133.0	33	122	4	133.5	33	122	4				
75	133.5	69	130.0	33	122	4	133.0	33	122	4	133.5	33	122	4				
80	133.5	69	130.0	33	122	4	133.0	33	122	4	133.5	33	122	4				
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97	133.5	69	128.5	33	122	4	131.0	33	122	4	132.0	33	122	4				
100	133.5	69	128.5	33	122	4	131.0	33	122	4	132.0	33	122	4				

NOT APPLICABLE

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No wind or runway obstructions
Runway Gradient: 0.0%
Airport Elevation: 3202.4 feet
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